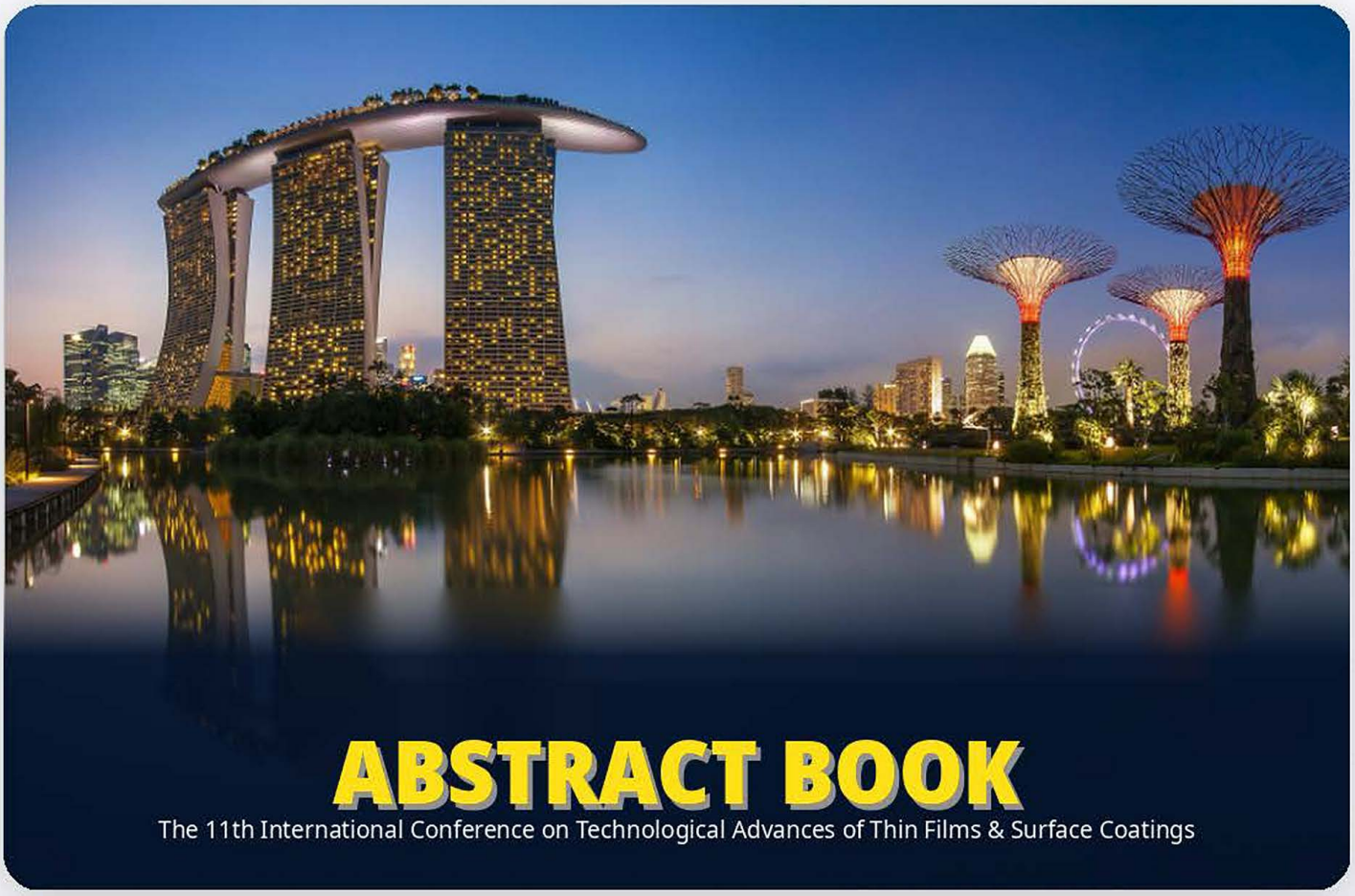
ThinFilms2026

The 11th International Conference on Technological Advances of Thin Films & Surface Coatings

13th – 17th July 2026 · Singapore



Organizers & Partners

Organized by

THIN FILMS SOCIETY TFS

Co-organized by

NANYANG TECHNOLOGICAL UNIVERSITY

Supported by

SINGAPORE EXHIBITION & CONVENTION BUREAU

Held in

SG singapore Passion Made Possible

SAFETY & ASSISTANCE

Emergency & Useful Contacts

Keep these numbers handy for the duration of ThinFilms 2026. In a life-threatening emergency, call the numbers below immediately — calls to 999 and 995 are free and answered 24/7.

IN AN EMERGENCY, DIAL

999
Police

995
Ambulance & Fire (SCDF)

NON-EMERGENCY AMBULANCE
1777

POLICE HOTLINE (NON-EMERGENCY)
1800 255 0000

POLICE EMERGENCY SMS
70999

TRAFFIC POLICE HOTLINE
6547 0000

TOURIST HOTLINE
1800 736 2000

SCAMSHIELD HELPLINE
1799

CONFERENCE VENUE

Holiday Inn Singapore Atrium

317 Outram Road, Singapore 169075

+65 6733 0188

Front desk · hiatrium@ihg.com

NEAREST HOSPITAL · 24H A&E

Singapore General Hospital

SGH Emergency / NNI Building, Level 3

1 Hospital Boulevard, Singapore 168581

+65 6222 3322

24-hour Emergency Department · ambulance access via College Road / Hospital Crescent

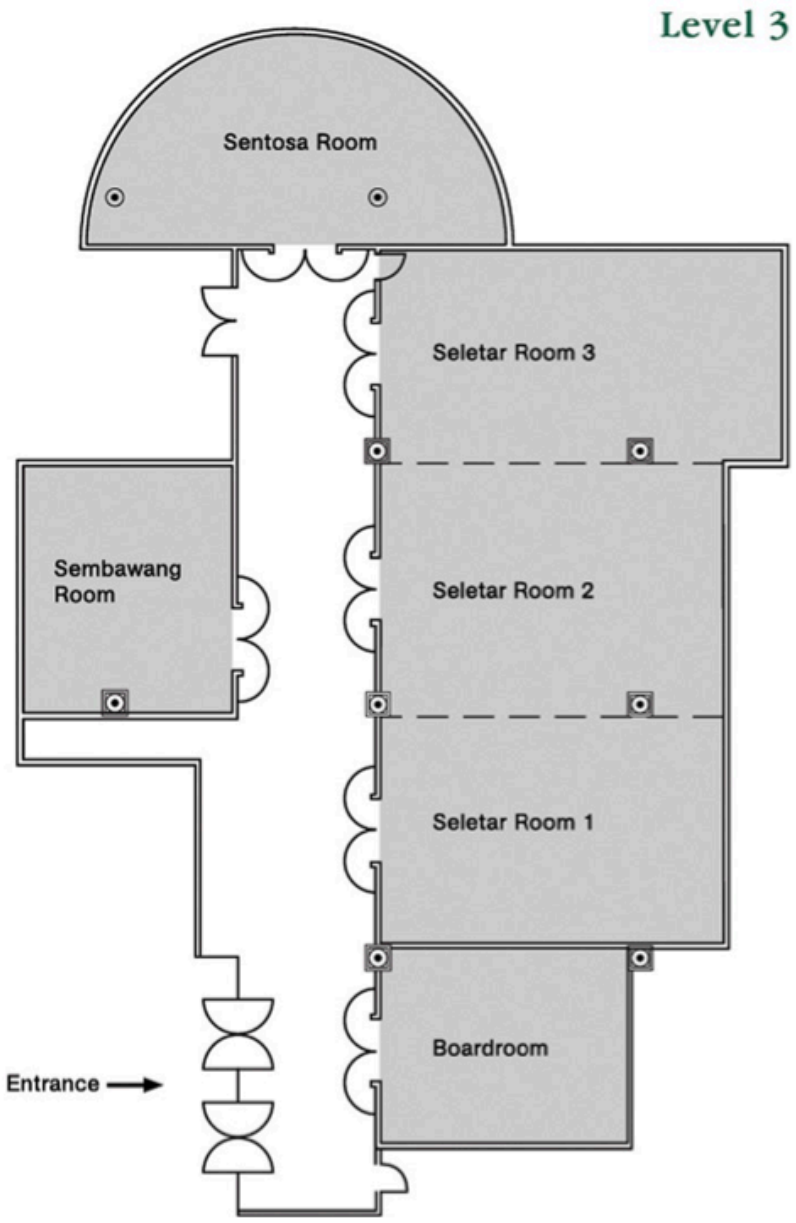
ON-SITE ASSISTANCE

Registration / Help Desk	Level 4 · Changi 1 & 2
TFS Secretariat Office	Level 4 · Foyer
Tea Break / Info Point	Level 4 · Changi 1 & 2

CONFERENCE VENUE

Level 3 — Symposia

Holiday Inn Singapore Atrium · 317 Outram Road, Singapore 169075 | Registration Desk: Level 4, Changi 1 & 2



SYMPOSIA · BREAKOUT ROOMS

Seletar 1 · Seletar 2 · Seletar 3 · Boardroom · Sembawang · Sentosa

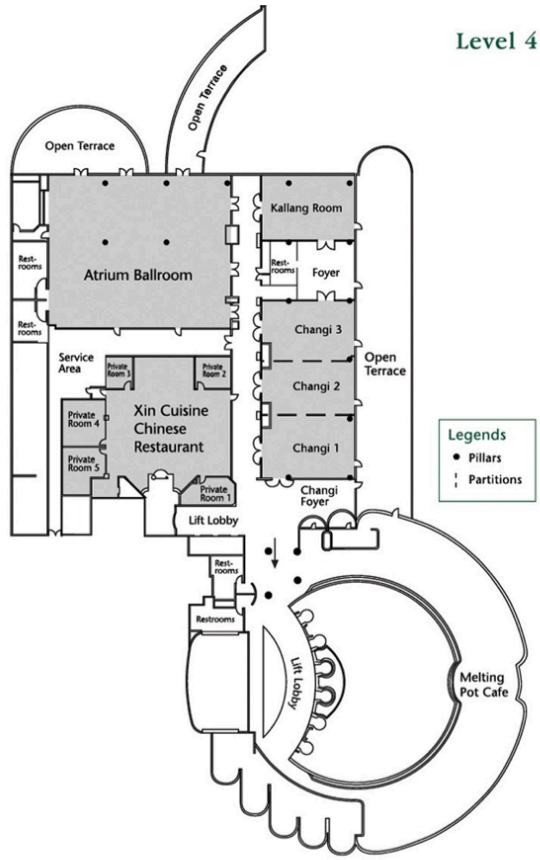
TEA BREAK

Corridor

CONFERENCE VENUE

Level 4 — Ceremony, Posters & Exhibition

Holiday Inn Singapore Atrium · 317 Outram Road, Singapore 169075 | Opening Ceremony, Symposia, Posters & Exhibition



OPENING CEREMONY
Atrium Ballroom

REGISTRATION
Changi 1 & 2

EXHIBITION
Changi 1 & 2

POSTERS
Atrium Ballroom

BREAKOUT ROOMS
Atrium Ballroom · Kallang · Changi 3

LUNCH
Changi 1 & 2

TEA BREAK
Changi 1 & 2

BANQUET
Atrium Ballroom

TFS OFFICE
Foyer

THINFILMS 2026

Program Overview

Full Programme at a Glance

MON 13/07

16:00-19:00	Registration @ Registration Counter - Level 4

TUE 14/07

08:00-08:20	Opening Ceremony and Photo Taking @ Atrium Ballroom - Level 4
08:20-09:00	Plenary 1: Prof. Chihaya ADACHI (Kyushu University) - Advanced Organic Optoelectronic Devices and Materials Enabled by Precise Charge-Transfer Control
09:00-09:40	Plenary 2: Prof. L. Jay GUO (University of Michigan) - Industrial Applications of Thin film Structures: structural colors and flexible transparent conductors, and how AI can help in the design process
09:40-10:20	Plenary 3: Prof. Sanjay MATHUR (University of Cologne) - Advanced Thin Film Engineering Steering Health and Energy Transition
10:20-10:50	Coffee & Tea Break

10:50-12:30 Session 1	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	-	S13 SMM	S1 2DM	S2 BHC	SS3 SOC	S10 OEP	S6 ENS	S14 STP	S3 PTA

12:30-13:20	Lunch

13:20-15:00 Session 2	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	-	S13 SMM	S1 2DM	S2 BHC	SS3 SOC	S10 OEP	S6 ENS	S14 STP	S3 PTA

15:00-15:30	Coffee & Tea Break

15:30-17:00 Session 3	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	-	S13 SMM	S1 2DM	S2 BHC	SS3 SOC	S10 OEP	S6 ENS	S14 STP	S3 PTA

17:00-19:00 — Poster Session @ Atrium Ballroom

S1 2DM · S2 BHC · S3 PTA · S4 CAM · S5 CIA · S6 ENS · S7 FFF · S8 HEA · S9 NNN · S10 OEP · S11 OTF · S12 TSP · S13 SMM · S14 STP · S15 TFD · SS1 KSR · SS3 SOC

WED 15/07

08:15-08:30	Opening @ Atrium Ballroom - Level 4
08:20-08:40	Plenary 4: Prof. Hyungjun KIM (Yonsei University) - Atomic Layer Deposition for emerging materials synthesis and applications
09:00-09:40	Plenary 5: Prof. Zhongyi JIANG (Tianjin University) - Organic Molecular Sieve Membranes for Energy-relevant Applications
09:40-10:20	Plenary 6: Prof. Jyh-Wei LEE (Ming Chi University of Technology) - Research and development of high entropy alloy coatings and their potential applications
10:20-10:50	Coffee & Tea Break

10:50-12:30 Session 4	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	S13 SMM	S4 CAM	S1 2DM	S2 BHC	SS3 SOC	S10 OEP	S11 OTF	S14 STP	

12:30-13:20	Lunch

13:20-15:00 Session 5	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	S13 SMM	S4 CAM	SS1 KSR	S2 BHC	SS3 SOC	S10 OEP	S11 OTF	S7 FFF	S12 TSP

15:00-15:30	Coffee & Tea Break

15:30-17:00 Session 6	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	-	S4 CAM	SS1 KSR	S9 NNN	SS3 SOC	S15 TFD	S11 OTF	S13 SMM	S12 TSP

19:00-23:00	Conference Banquet and Poster Voting Award (Atrium Ballroom)

THU 16/07

08:30-10:15 Session 7	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	S13 SMM	S5 CIA	S1 2DM	S2 BHC	SS3 SOC	S10 OEP	S9 NNN	S15 TFD	S7 FFF

10:15-10:45	Coffee & Tea Break

10:45-12:00 Session 8	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	S13 SMM	S5 CIA	S1 2DM	S2 BHC	SS3 SOC	S10 OEP	S9 NNN	S15 TFD	S7 FFF

12:00-13:30	Lunch

13:30-15:00 Session 9	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	S13 SMM	S4 CAM	S1 2DM	S2 BHC	S8 HEA	S10 OEP	S9 NNN	S14 STP	S7 FFF

15:00-15:45	Coffee & Tea Break

15:45-17:05 Session 10	Atrium	Kallang	Changi	Seletar1	Seletar2	Seletar3	Sentosa	Sembawang	Boardroom
	-	-	-	-	S8 HEA	S10 OEP	S6 ENS	S14 STP	-

FRI 17/07

09:00-17:00	**Technical Tour: National Metrology Centre (NMC), A*STAR and Nanyang Technological University (NTU)** 09:00-17:00 programme slot; tour duration approx. 2-3 hours; bus pick-up/drop-off at Holiday Inn; registration first-come, first-served; SGD 10 refundable deposit.

Source: ThinFilms 2026 EventsAir programme site, agenda API. Session cells use symposium code and acronym only.

Sponsors

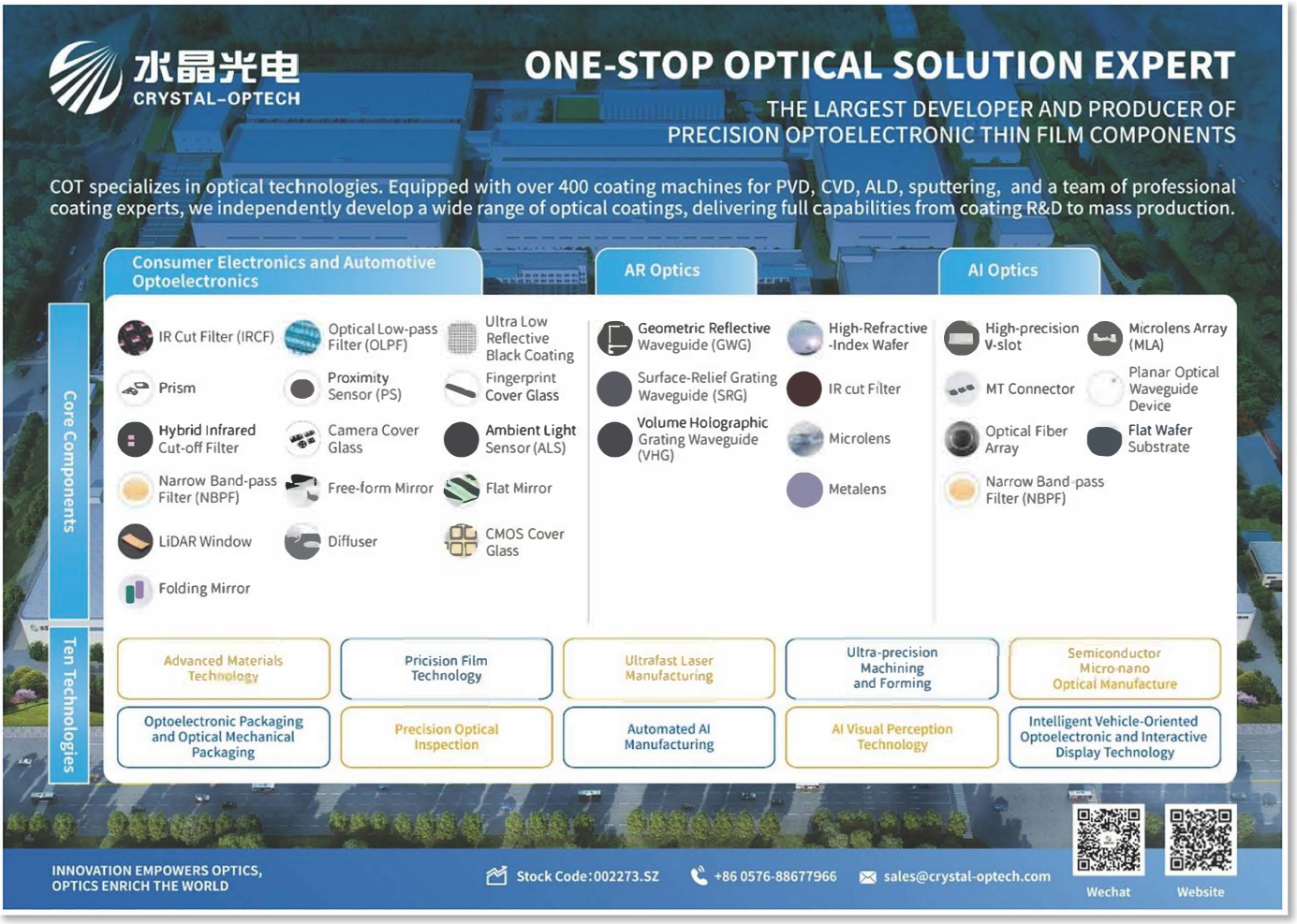
Universal Vapor Jet Corporation Pte. Ltd.

MDPI AG

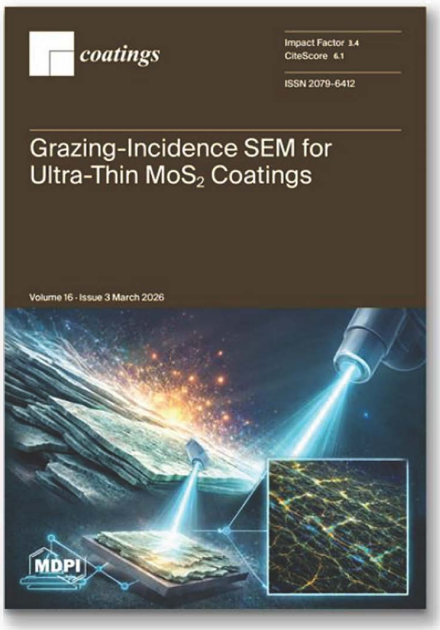
MSc Green Energy, NTU

Zhejiang Crystal-optech Co., Ltd.

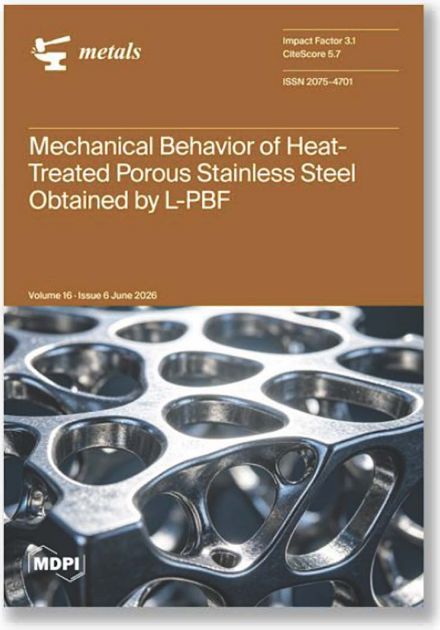
The Royal Society of Edinburgh


水晶光电
CRYSTAL-OPTECH
ONE-STOP OPTICAL SOLUTION EXPERT
THE LARGEST DEVELOPER AND PRODUCER OF PRECISION OPTOELECTRONIC THIN FILM COMPONENTS
COT specializes in optical technologies. Equipped with over 400 coating machines for PVD, CVD, ALD, sputtering, and a team of professional coating experts, we independently develop a wide range of optical coatings, delivering full capabilities from coating R&D to mass production.
Consumer Electronics and Automotive Optoelectronics
AR Optics
AI Optics
Core Components
IR Cut Filter (IRCF)
Optical Low-pass Filter (OLPF)
Ultra Low Reflective Black Coating
Prism
Proximity Sensor (PS)
Fingerprint Cover Glass
Hybrid Infrared Cut-off Filter
Camera Cover Glass
Ambient Light Sensor (ALS)
Narrow Band-pass Filter (NBPF)
Free-form Mirror
Flat Mirror
LiDAR Window
Diffuser
CMOS Cover Glass
Folding Mirror
Geometric Reflective Waveguide (GWG)
Surface-Relief Grating Waveguide (SRG)
Volume Holographic Grating Waveguide (VHG)
High-Refractive -Index Wafer
IR cut Filter
Microlens
Metalens
High-precision V-slot
MT Connector
Optical Fiber Array
Narrow Band-pass Filter (NBPF)
Microlens Array (MLA)
Planar Optical Waveguide Device
Flat Wafer Substrate
Ten Technologies
Advanced Materials Technology
Pricision Film Technology
Ultrafast Laser Manufacturing
Ultra-precision Machining and Forming
Semiconductor Micro-nano Optical Manufacture
Optoelectronic Packaging and Optical Mechanical Packaging
Precision Optical Inspection
Automated AI Manufacturing
AI Visual Perception Technology
Intelligent Vehicle-Oriented Optoelectronic and Interactive Display Technology
INNOVATION EMPOWERS OPTICS, OPTICS ENRICH THE WORLD
Stock Code:002273.SZ
+86 0576-88677966
sales@crystal-optech.com
Wechat
Website

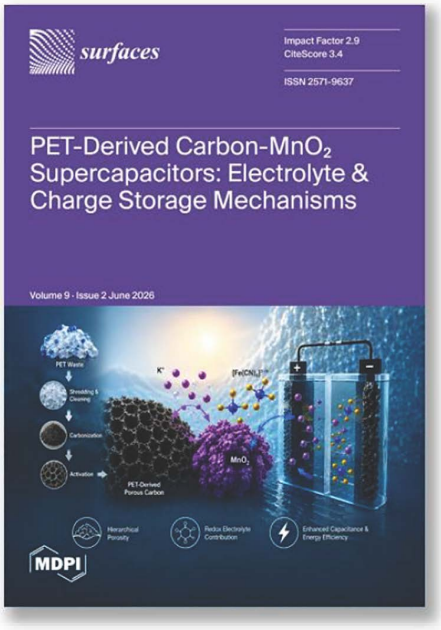
UVJC
NovaJet :
PRINT THE THIN FILMS OF THE FUTURE
NovaJet is a transformative platform designed to bridge materials discovery and manufacturing. By removing the constraints of solvents, masks, and rigid workflows, it opens the door to entirely new classes of materials and devices.
READY TO EXPLORE NEW MATERIAL POSSIBILITIES?
www.uvjc.com
contact@uvjc.com



mdpi.com/journal/coatings



mdpi.com/journal/metals



mdpi.com/journal/surfaces

MDPI

THINFILMS 2026

Abstract Book

Program Schedule and Abstracts

Contents

	Page
Tuesday, 14 July 2026 Schedule	1
Wednesday, 15 July 2026 Schedule	12
Thursday, 16 July 2026 Schedule	24
Abstracts Full abstract text begins	37

Arabic page numbering starts at Tuesday, 14 July 2026.

TUE 14 JUL

Tuesday, 14 July 2026

130 presentations - 9 symposia

PL Plenary Session

Atrium Ballroom - Level 4

Plenary speakers and abstracts

08:20	Advanced Organic Optoelectronic Devices and Materials Enabled by Precise Charge-Transfer Control PLENARY Prof. Chihaya ADACHI - Center for Organic Photonics and Electronics Research (OPERA), Kyushu University, Japan	Plenary 1 p. 37
09:00	Industrial Applications of Thin film Structures: structural colors and flexible transparent conductors, and how AI can help in the design process PLENARY Prof. L. Jay GUO - University of Michigan, US	Plenary 2 p. 38
09:40	Advanced Thin Film Engineering Steering Health and Energy Transition PLENARY Prof. Sanjay MATHUR - University of Cologne, Germany	Plenary 3 p. 39

S1 2D Materials (2DM)

Changi · Level 4

Chair: Daniel CHUA (National University of Singapore, Singapore)

10:50	Controlled reconstruction of pre-catalysts for improved electrochemical CO2 reduction INVITED Pan Hui - University of Macau	#95 p. 43
11:10	Piezocatalysis in Two-Dimensional Materials for Sustainable Energy Conversion INVITED Wu Jyh Ming - National Tsing Hua University	#181 p. 44
11:30	Growing process of native oxide layer on Si wafer INVITED Ken Okano - Shizuoka University	#513 p. 45
11:50	Quantum well made of amorphous chalcogenide and its application to photodetectors INVITED Tomoaki Mazusawa - Shizuoka University	#517 p. 46
12:10	Beyond Spheres: Microwave-Assisted Synthesis of Lanthanide-Doped Nanostructures INVITED Eva Hemmer - University Of Ottawa	#416 p. 47

AFTERNOON

13:20	Carbon Nanowalls: Plasma-Engineered Graphene Architectures for Energy and Bioelectrochemical Applications INVITED Mineo - Meijo University	#113 p. 48

13:40	Green synthesis of graphene usable in harsh liquid environments for energy and bio-related applications INVITED Masaki Tanemura - Nagoya Institute Of Technology	#142 p. 49
14:00	One- and Two-Dimensional Nanohybridization of Functional Oxides and Carbon-based Materials for Environmental and Sensing Application INVITED Tohru Sekino - The University Of Osaka	#461 p. 50
14:20	Upcycled photocatalysts from Sr-containing layered titanate sorbents INVITED Tomoyo Goto - Nara Institute Of Science And Technology	#681 p. 51
14:40	Photocatalytic Water Splitting Properties of (Ba,Sr)TiO3 Particles under Ultrasonic Irradiation INVITED Miki Inada - Kyushu University	#457 p. 52
	Break Time	
15:30	Atmospheric-Pressure Mist Chemical Vapor Deposition for Thin Film Growth INVITED Tomohiro Yamaguchi - Kogakuin University	#617 p. 53
15:50	2D covalent organic framework (COF) membranes INVITED Jiangtao Liu - University of Science and Technology of China	#301 p. 54
16:10	Electrochemical water splitting for clean fuel production through nanoengineered materials INVITED Isabella Concina - Luleå University Of Technology	#491 p. 55
16:30	Gradient-Controlled Growth of Two-Dimensional ·-InSe Thin Films for Enhanced Structural Quality and Phase Stability Htet Soe Min - Tatung University	#376 p. 56

S2 Biomedical and Healthcare (BHC)

Seletar1 · Level 3

Chair: Kui CHENG (Zhejiang University, China)

10:50	Electroactive PVTF coatings with heterogeneous microdomain potentials for osteogenesis application INVITED Cheng Kui - Zhejiang University	#369 p. 91
11:10	Hydrophilization of nickel-titanium alloy surfaces through pulse anodization for biomedical application INVITED Ohtsu Naofumi - Kitami Institute of Technology	#174 p. 92
11:30	Biomimetic Engineering of Robust Gradient Antibacterial Coatings using Hollow Nanoframes of Prussian Blue Analogues He Xiaodong - Southwest University	#87 p. 93
11:45	Cell activity on pulsed-anodized NiTi alloy surfaces with enhanced hydrophilicity Amon Kitayama - Kitami Institute Of Technology	#589 p. 94
	AFTERNOON	
13:20	Flexible optoelectronic devices for wearable and implantable photodynamic therapy INVITED Li Peng - Northwestern Polytechnical University	#63 p. 95

13:40	Pinpoint On-Demand Deposition of Self-Assembled Monolayers from Vapor Precursors INVITED Gregory McGraw - Universal Vapor Jet Corp.	#492 p. 96
14:00	Hydrogel-Based Ultrasonic Sensor for Long-term Wireless Monitoring INVITED Yang Yueying - Northwestern Polytechnical University	#59 p. 97
14:20	Design and Fabrication of a Non-Invasive Sweat Glucose Sensor Using Graphene Oxide Daniel Christina - College of Engineering Pune	#649 p. 98
14:35	Self-Powered Bioelectronic Hydrogel Patches for Tissue Repair Enabled by Nanogenerators Chen Chuanrui - Zhejiang University	#351 p. 99
14:50	Design and Extreme Environment Adaptation of a Portable Wearable Multimodal Physiological Acquisition and Neuromodulation Closed-Loop System Zhang Huiqing - Northwestern Polytechnical University	#66 p. 101
	Break Time	
15:30	Synergistic Antibacterial Strategies and Surface/Interface Engineering of Biomaterials for Infection Control INVITED Xu Liqun - Southwest University	#53 p. 102
15:50	Antimicrobial Polymers for Combating Multidrug Resistant Bacterial Infections INVITED Si Zhangyong - Ningbo Institute of Materials Technology and Engineering	#136 p. 103
16:10	Bacterial Adhesion-Based Antibiotic-Free Dressings for Infected Wound Healing INVITED Lu Zhentan - Wuhan Textile University	#552 p. 104
16:30	Synergistic Photothermal and Photodynamic Nanocoatings on Titanium Implants for Rapid Bactericidal Action and Enhanced Osseointegration Liu Yihan - Northwestern Polytechnical University	#736 p. 105
16:45	A Multilayered Responsive Dressing for Programmable Exudate Control and Regenerative Therapy of Infected Wounds Zhang Zhicheng - Southwest University	#67 p. 106

S3 Plasma Technology and Application for Thin Films (PTA)

Boardroom · Level 3

Chair: Lang HU (Jihua Lab, China)

10:50	Breaking Mobility Limits in Flexible Transparent Conductive InOx Thin Films: Precursor Engineering and Crystallization Control INVITED Junichi Notomoto - National Institute of Advanced Industrial Science and Technology (AIST), Japan	#739 p. 134
11:10	Synergetic Reactions between HF adsorption and Plasmas enabling atomic-layer processes INVITED Shih-nan Hsiao - Nagoya University	#19 p. 135
11:30	Self-Consistent Fluid-Circuit Modeling of Impedance Matching for Ar/SiH4 PECVD INVITED Ya Zhang - Wuhan University Of Technology	#186 p. 136
11:50	Combined effect of MRSR mechanism and E×B drift in magnetized capacitively coupled plasma Ze-Xuan Liu - Dalian University of Technology	#519 p. 137

12:05	Multiscale Simulation of Magnetron Sputtered Thin-Film Growth Based on Direct Simulation Monte Carlo and Kinetic Monte Carlo Methods Yating Huang - Beijing Technology And Business University	#426 p. 138

AFTERNOON

13:20	Simulation Study on Radio-Frequency Ion Source and Ion Extraction System for Thin-Film Deposition Processes INVITED Quan-zhi Zhang - Dalian University Of Technology	#570 p. 139
13:40	Microwave Remote Plasma Source in Semiconductor Manufacturing: Cleaning, Surface Modification, Post-Oxidation, and Atomic Layer Deposition INVITED Xingxing Huang - Jihua Laboratory	#633 p. 140
14:00	Multi-Scale Modeling of HF Cryogenic Etching of SiO2 and Si3N4: From Plasma Kinetics to Surface Reactions Xingyu Li - Dalian University Of Technology	#520 p. 141
14:15	Influence of Bias Power on the Etching Behavior of Aluminum Alloy in ICP with an HBr/Cl2/N2/O2 Gas Mixture Xianxiu Mei - Dalian University Of Technology	#208 p. 142
14:30	In-situ post doping plasma process for improving electrical properties of ZrO2-TiN based capacitors Sangwon Lee - Postech	#484 p. 143
14:45	Key Scientific Issues in Plasma Interaction with Porous Complex Surfaces and Their Applications Lan Li - Tsinghua University	#110 p. 144
15:00	Mechanical and Tribological Performance of Magnetron-Sputtered MoS2/ZrN Composite Coatings: Influence of Composition and Ambient Conditions Ahraf Gulzar - National Institute of Technology Srinagar	#42 p. 145
15:15	Flow-Field Reconstruction in Spin-Coating Chambers via Rectifying Plates for Uniform Coating on Square Substrates INVITED Ying Yan - Dalian University Of Technology	#160 p. 146
15:35	Uniformity modulation of large-area very-high-frequency capacitively coupled plasmas driven by multi-frequency sources INVITED Yu-Ru Zhang - Dalian University Of Technology	#209 p. 147
15:55	Simple and scalable large-scaled plasma plume generated via merged series-connected APPJ array Dingyuan Peng - GuangDong Engineering Technology Research Center of High Voltage Discharge and Plasma Applications	#172 p. 148
16:10	Atmospheric Pressure Plasma Jet Synthesis and Deposition of Metal Organic Films Andrianne Thoma - University College London (UCL) / A*STAR	#394 p. 149
16:25	Customizing Tribological Interface Structure On Tc6 Alloy By Plasma Electrolytic Oxidation And Cathodic Deposition Yunhui Wang - Shaanxi University of Technology	#623 p. 151
16:40	Unveiling 3D Plasma Dynamics in Magnetron Discharges: Implications for PVD and Thin-Film Processing Pengze Xiao - Huazhong University Of Science And Technology	#337 p. 152

16:55	Magnetic field effects on magnetized inductively coupled plasmas for thin film deposition: a PIC/MCC study Minglun Tian - Huazhong University Of Science And Technology	#314 p. 153

S6 Energy & Sustainability (ENS)

Sentosa · Level 3

Chair: Lidong SUN (Chongqing University, China)

10:50	Alkaline aqueous redox flow batteries using non-vanadium active materials INVITED Yongchai Kwon - Seoul National University of Science and Technology	#118 p. 226
11:10	Doped metal oxide of Ti as multi-functional material for degradation of Indigo carmine dye in wastewater INVITED Chandra Mohan - K. R. Mangalam University, Gurugram	#13 p. 227
11:30	Thin-Film Surface Engineering of Graphite Anode with N/Co-Doped Carbon Coating for Lithium-Plating Suppressed High-Safety Lithium-Ion Batteries Ling Che - Northwestern Polytechnical University	#161 p. 228
11:45	Nanotube-Patterned Microchannels for Durable Osmotic Energy Harvesting Lidong Sun - Chongqing University	#23 p. 229
12:00	Achieving Multi-Dimensional Stability in O3-Type Sodium Layered Cathodes through High-Entropy Design and Liquid-Phase Engineering Wujiu Zhang - Northwestern Polytechnical University	#171 p. 230
12:15	Enabling the Circular Carbon Economy: Using Density as a Key Factor to Directly Convert Composite Waste into Battery Anodes Wendi Chen - Northwestern Polytechnical University	#197 p. 231

AFTERNOON

13:20	Study on the conductivity and corrosion resistance of M-Al-C (M=Ti/Cr) coating on the surface of PEMFC metal plate INVITED Guanshui Ma - Ningbo Institute Of Materialstechnology And Engineering, Chinese Academy Of Sciences	#245 p. 232
13:40	Hydrogen-free carbon-based coatings deposited by the combined HiPIMS INVITED Yixiang Ou - Beijing Academy of Science And Technology	#22 p. 233
14:00	Effect of TiO2-doped half-layer PDMS on the output performance of Al-PDMS TENG Chen-Kuei Chung - National Cheng Kung University	#652 p. 234
14:15	Enhancing Low-Humidity Performance of PEMFCs via Magnetron Sputtered ITZO Coatings on Anodic Gas Diffusion Layers Po-sen Yang - National Chung Hsing University	#149 p. 235
14:30	Dynamic Synergy of Cu0/Cu+/Cu2+ for CO2 Electroreduction: Unlocked by Spatiotemporally Resolved Characterizations Yatai Li - University of Macau	#43 p. 236
14:45	Unraveling Nitrogen Reduction Pathways on Transition Metal Electrocatalysts: Insights from First-Principles Calculation Deepak Gorai - Indian Institute of Technology Kanpur	#151 p. 237

Break Time

15:30	Critical thickness effect on fracture path and interfacial delamination in plasma sprayed NiCr/NiAl coated revealed by DIC INVITED Xiuyang Fang - Southwest Jiaotong University	#643 p. 238
15:50	Fast-Response Self-Powered Ultraviolet Photodetector Based On Cs2CuBiI6 Thin Films INVITED Baofei Sun - Guizhou Medical University	#657 p. 239
16:10	Monomeric Pyrrole for additive engineering and stability enhancement in MAPbI· Perovskite thin films Nalini Venkatesan - IIT Madras	#430 p. 240
16:25	Low-Power PS-PVD for Coating Deposition: Processing and Performance Bingru Song - Beihang University	#353 p. 242
16:40	Dual governing effects of nanocrystalline Cr-N barrier layer thickness on high-temperature interfacial stability and fretting wear resistance of Cr-N/FeCrAl coatings Xiaohan Deng - Chongqing University	#661 p. 243
16:55	Enhancing electrochemical properties of Loofah sponge with spirulina-derived carbon through physical activation and self-doping Huang Chung Hao - National Chung Hsing University	#192 p. 244

S10 Organic Electronics and Photonics (OEP)

Seletar3 · Level 3

Chair: Xiaotao HAO (Shandong University, China)

10:50	Thermally robust organic photovoltaic devices based on a low content of amorphous donor polymers INVITED Mats Andersson - Flinders University	#27 p. 341
11:10	Impact of Metal·Electron Transport Layer Interfacial Reactions on Electron Collection in Organic Photovoltaics INVITED Hiroyuki Yoshida - Chiba University	#630 p. 342
11:30	Organic Solar Cells: From Low Band-gap Materials to Mechanism Study INVITED Ke Gao - Shandong University	#106 p. 343
11:50	Enhancing the Performance of Organic Photovoltaics through Spatial Control of Spontaneous Orientation Polarization Seita Kyogoku - Chiba University	#635 p. 344
12:05	Suppressing Static and Dynamic Disorder for High-Efficiency and Stable Thick-Film Organic Solar Cells via Synergistic Dilution Strategy Zhen Fu - Shandong University	#242 p. 346

AFTERNOON

13:20	All-Perovskite Tandem Solar Cells - Sn(II) oxidation and suppression INVITED Dewei Zhao - Sichuan University	#577 p. 347
13:40	Lattice-Reservoir Semiconductors for next generation optoelectronic applications INVITED Xiaoming Wen - RMIT University	#117 p. 348

14:00	Organic Photocatalytic and Photoelectrochemical Systems for Sustainable Hydrogen Production INVITED Han Young Woo - Korea University	#35 p. 349
14:20	Interface and Morphology Engineering for Organic and Perovskite Solar Cells INVITED Chih-Ping Chen - Ming Chi University of Technology	#69 p. 350
14:40	High Performance 2D/3D Tin-Lead Perovskite Solar Cells Achieved by Phenethylamine Acetate Post-Treatment Xiangyu Xue - Taiyuan University Of Technology	#532 p. 351
14:55	Uncovering the Origin of Fullerenes Superiority as Electron Transport Layers in Perovskite Solar Cells Ryota Tozaki - Chiba University	#632 p. 352
	Break Time	
15:30	High-Performance p- and n-Type Organic Single-Crystal Semiconductors INVITED Toshihiro Okamoto - Institute of Science Tokyo	#541 p. 353
15:50	Optoelectronic clusters for film devices INVITED Hui Xu - Heilongjiang University	#642 p. 354
16:10	Anisotropic polaronic nature of band structure in rubrene single crystal INVITED Keisuke Fukutani - Institute for Molecular Science	#627 p. 355
16:30	The Surface and Interface Physics of Novel Organic-Inorganic Hybrid Semiconductor Optoelectronic Devices Jia Zhang - Fudan University	#613 p. 356
16:45	Modulation of carrier dynamics via (4-(Trifluoromethyl) benzohydrazine for high-efficiency Sn-Pb perovskite solar cells Na Yang - Taiyuan University Of Technology	#524 p. 358

S13 Smart Materials and Microsystems (SMM)

Kallang · Level 3

Chair: Yongqing FU (Northumbria University, UK)

10:50	Microenergy harvesting technology enabled fully self-powered real-time wireless sensing KEYNOTE Jikui Luo - Zhejiang University, China	#616 p. 447
11:15	Bio-inspired Structural Materials and Devices Based on 2D Materials KEYNOTE Pingan Hu - Harbin Institute Of Technology, China	#597 p. 448
11:40	Acoustic wave enhancement of free space optical communication system Alex Cameron - Northumbria Univesity at Newcastle, UK	#15 p. 449
11:55	Acousto-Optogenetics Bandpass Stabilizer: A Programmable Platform for Mapping Single-Cell Phenotypic Life Trajectories Yuxin Wang - University of Macau, China	#395 p. 450
12:10	Dielectric Breakdown Fabrication of TMD Nanopore Sensors Jinyan Cheng - Gdut	#425 p. 451

AFTERNOON

13:20	Harnessing the giant and switchable surface energy of liquid metals for robotics KEYNOTE Shiyang Tang - University of New South Wales, Australia	#139 p. 452
13:45	Ferroelectric Photovoltaic Effect and Device KEYNOTE Shigeng Song - University Of The West Of Scotland, UK	#703 p. 453
14:10	Controllable Preparation of Se-Vacancy Bi·O·Se Thin Films and Their Integrated Photosensing-Memory Devices INVITED Jia Zhang - Harbin Institute of Technology, China	#188 p. 454
14:30	A Flexible Thin-Film Multimodal Intracranial Sensing System for Real-Time Brain Injury Monitoring Tiezhu Liu - Harbin Institute of Technology, China	#322 p. 455
14:45	Plasma-Driven Surface Functionalization of Common Polymers for Smart Material and Microsystem Applications Ayesha Armani - University of Engineering and Technology, Lahore, Pakistan	#128 p. 456
15:00	Stiffness-Programmed 3D Microelectrodes for Near-Linear and Tunable Iontronic Pressure Sensing Fengling Zhuo - Zhejiang University, China	#390 p. 457

Break Time

15:30	A 3D-Printed Miniaturized Electromagnetically Actuated Compliant Parallel Delta Robot for Precision Micromanipulation KEYNOTE Hejun Du - Nanyang Technological University, Singapore	#388 p. 458
15:55	A MEMS Self-Calibrating Tactile Sensor Based on Precision Force Source Drive Technology KEYNOTE Linxi Dong - Hangzhou Dianzi University, China	#299 p. 459
16:20	Flexible Superoxide Anion Electrochemical Sensor Based on Piezoelectric Substrate for Synergistic Enhancement via Electric Double Layer Reconstruction and Oxygen Vacancy Enrichment INVITED Yubo Li - Zhejiang University, China	#489 p. 460
16:40	A High-Performance Bi-directional Flexible Strain Senor Based on Liquid Metal for Versatile Application Wihuang Yang - Hangzhou Dianzi University, China	#456 p. 461
16:55	Simultaneous Characterization of Full Elastic Constants and Thickness of Freestanding Membranes Using Ultrafast Optoacoustics Shuchang Zhang - The Hong Kong Polytechnic University	#234 p. 462

S14 Surface Treatment & Protection (STP)

Sembawang · Level 3

Chair: Wan-Yu WU (National United University, Taiwan)

10:50	Plasma-Engineered Amorphous TiZrNbTaFe High Entropy Alloy Coatings for Integrated Mechanical and Biological Surface Protection INVITED Bih-show Lou - Chang Gung University	#393 p. 504

11:10	Surface finish and hardness improvements of selective laser melted aluminium alloy by surface mechanical attrition treatment INVITED Yong Sun - Jihua Laboratory	#250 p. 505
11:30	Laser Polishing Strengthening Mechanism and Mechanical Performance of Nickel-Based Alloys Zongsheng Ye - Nanjing University of Aeronautics and Astronautics·	#478 p. 506
11:45	Influence of Substrate Bias and Plasma Density on the Peeling Behavior of FCVA-Deposited DLC Films Yuheng Deng - Nanyang Technological University	#163 p. 507
12:00	Stoichiometry and mechanical properties of (TiZrTa)Bx thin films Guan-Ting Lu - National Taiwan Ocean University	#215 p. 508
12:15	Construction of tough and corrosion-resistant (CrMoNbTi)Six high-entropy alloy coatings and coupled damage mechanisms in deep-seaenvironment Jianguo Qian - Ningbo Institute of Materials Technology & Engineering, CAS	#470 p. 509

AFTERNOON

13:20	Dynamic Anti/Deicing Performances of the Hierarchical Structure Surfaces Based on Flow Environments with Microdroplets INVITED Yizhou Shen - Nanjing University Of Aeronautics And Astronautics	#479 p. 510
13:40	A photothermal superhydrophobic coating for passive anti-icing and active de-icing INVITED Cong Li - Xi'an Jiaotong University	#18 p. 511
14:00	Environmentally Friendly Underwater Superhydrophobic Surface for Anti-Biofouling Applications INVITED Xinghua Wu - Guangdong University Of Technology	#26 p. 512
14:20	Patterned hybrid surfaces for efficient dew water harvesting Zhong Chen - Nanyang Technological University	#12 p. 513
14:35	Construction of Multifunctional Superhydrophobic Wood Coatings via the Sand-In Method and Their Interfacial Regulation Mechanisms Xingzhou Yao - Nanjing University Of Aeronautics And Astronautics	#481 p. 514
14:50	Steam oxidation behavior of Cr coatings without and with a Mo diffusion barrier: Kinetics and oxidation mechanisms Qining Zheng - Northwestern Polytechnical University	#170 p. 515

Break Time

15:30	Constructing Superhydrophobic Dental Resin-Based Material to Inhibit Bacterial Adhesion INVITED Shunli Zheng - Anhui Medical University	#335 p. 516
15:50	Multiscale surface engineering on the interfacial adhesion of steel-CFRTP hybrid structures for pipe coupler applications INVITED Qi Wang - Singapore Institute of Manufacturing Technology (SIMTech), Agency for Science, Technology and Research (A*STAR)	#221 p. 517
16:10	Plasma electrolytic polishing for surface finishing of metal alloys INVITED Hongfei Liu - Institute Of Materials Research And Engineering	#620 p. 518

16:30	Degradation of Antenna Performance Induced by Substrate Warpage in 76·81 GHz Radar Systems Yu-Hsun Chang - Yuan Ze University	#58 p. 519
16:45	A general strategy towards improving the strength and thermal shock resistance of glass-ceramics through microstructure regulation Min Feng - Beihang University	#262 p. 520

SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells

Seletar2 · Level 3

Chair: Pei-Chen SU (Nanyang Technological University, Singapore)

10:55	A new thin-film protonic ceramic fuel cell based on a Mg-doped perovskite electrolyte INVITED Zongping Shao - Curtin University	#316 p. 637
11:20	Ultrasonic Spraying of Ceria based nano-catalysts for Highly efficient LSGM based Electrolysis Cells; with a Particular Focus on CO2 Electrolysis INVITED Tae-Ho Shin - Korea Institute of Ceramic Engineering And Technology	#377 p. 638
11:45	Investigating SOFC Electrode Reaction Mechanism Using Atomically Flat Thin Films INVITED Di Chen - The Hong Kong Polytechnic University (PolyU)	#104 p. 639
12:10	Key Technologies to Overcome the Limitations of Solid Oxide Cells (SOCs) INVITED Jae-Ha Myung - Incheon National University	#90 p. 640

AFTERNOON

13:20	Tuning the electrochemical properties of oxide nanostructures for energy applications using surface modification INVITED Matthias T. Elm - Justus-Liebig-University Giessen	#116 p. 641
13:45	Nanoscale Oxygen Exchange at Solid Oxide Cell Electrodes: Insights from Model Thin Films and Operando Characterization INVITED WooChul Jung - Seoul National University	#33 p. 642
14:10	Characterisation of ion transport processes in solid oxide thin films INVITED Stephen Skinner - Imperial College London	#359 p. 643
14:35	Tailoring Interfacial Oxygen Kinetics via Defect-Engineered Ceria Interlayers for Advanced SOCs INVITED Kang Taek Lee - KAIST	#51 p. 644

Break Time

15:30	Quantitative framework for interface analysis and engineering in protonic ceramic electrochemical cells INVITED Wonyoung Lee - Sungkyunkwan University	#28 p. 645
15:55	Application of Nickel and Rare Earth Metal co-doped Ceria for Direct Ammonia Solid Oxide Fuel Cells INVITED Jong-Eun Hong - Korea Institute of Energy Research	#629 p. 646

16:20 Surface and Interface Engineering for Performance Enhancement of Protonic Ceramic Fuel Cells #596 p. 647

INVITED

Chung-jen Tseng - National Central University

16:45 High-entropy nanocomposite for stabilizing· oxygen electrode enables robust solid oxide cells beyond 2 W cm-2 #356 p. 648

INVITED

ChengCheng Wang - Shenzhen Polytechnic University

WED 15 JUL

Wednesday, 15 July 2026

154 presentations - 14 symposia

PL Plenary Session

Atrium Ballroom - Level 4

Plenary speakers and abstracts

08:20	Atomic Layer Deposition for Emerging Materials Synthesis and Applications PLENARY Prof. Hyungjun KIM - Yonsei University, Korea	Plenary 4 p. 40
09:00	Organic Molecular Sieve Membranes for Energy-relevant Applications PLENARY Prof. Zhongyi JIANG - Tianjin University, China	Plenary 5 p. 41
09:40	Research and development of high entropy alloy coatings and their potential applications PLENARY Prof. Jyh-Wei LEE - Ming Chi University of Technology, Taiwan	Plenary 6 p. 42

S1 2D Materials (2DM)

Changi · Level 4

Chair: Daniel CHUA (National University of Singapore, Singapore)

10:50	Nanowire solar cells and the need for their dimensional characterization INVITED Martin Foldyna - Cnrs, Ecole Polytechnique	#440 p. 57
11:10	Persistent Homology Analysis of AFM Images for Carrier Mobility Assessment in Graphene INVITED Yuki Okigawa - National Institute of Advanced Industrial Science And Technology	#465 p. 58
11:30	Thin Film Characterization by Imaging Ellipsometry INVITED Shun Okano - Parksystems Gmbh.	#397 p. 59
11:50	High-Frequency Tunable and Switchable Film Bulk Acoustic Wave Resonators Based on 2D multilayer ·-In2Se3 Flakes Shun Jiayi - Nanyang Technological University	#339 p. 60
12:05	Engineering MoS2 Nanopores for Next-Gen 2D Membranes Shen Jie - Nanyang Technological University	#723 p. 61
12:20	2D inorganic/organic material interfaces for optoexcitonics INVITED Parag Deotare - University of Michigan, Ann Arbor	#743 p. 62

S2 Biomedical and Healthcare (BHC)

Seletar1 · Level 3

Chair: Kui CHENG (Zhejiang University, China)

10:50	Self-Assembled Nanoparticles for Antibacterial Applications INVITED Jin Qiao - Zhejiang University	#99 p. 107
11:10	Synthesis and Characterization of ·all-in-one· Nanomedicine Platform Applied for Rheumatoid Arthritis INVITED Chen San-Yuan - National Yang Ming Chiao Tung University	#176 p. 108
11:30	Hydrogen Selenide Releasing Micelles for Antibacterial Therapy INVITED Wang Tengjiao - Northwestern Polytechnical University	#61 p. 109
11:50	Self-assembled bioactive protein/HA/CUR-based amyloidogenic nanohydrogel dressing for rapid infected diabetic wound healing via enhanced angiogenesis and anti-inflammation Saurabh Kumar Srivastava - Iit(bhu)	#420 p. 110
12:05	Design of Highly Selective Sulfonium Polypeptides and Their Antibacterial Performance Zhang Zhenyan - Northwestern Polytechnical University	#60 p. 111

AFTERNOON

13:20	Phytic Acid-Enabled Hydrogel Sensors for Biomedical and Healthcare Monitoring INVITED Wang Rong - Ningbo Institute of Materials Technology and Engineering	#328 p. 112
13:40	Angle-Optimized TiO2/CaF2 One-Dimensional Photonic Crystal Biosensor for High-Sensitivity Label-Free Uric Acid Detection INVITED K Kathiresan - Psna College Of Engineering And Technology, Dindigul	#381 p. 113
14:00	Translational Collagen·MXene Hybrid Surgical Thin Film for Diabetic Wound Management INVITED Prakash Jayabal - Translational Health Science And Technology Institute	#46 p. 114
14:20	Salt-Triggered Electroactive Dressing with Controlled Drug Release for Enhanced Healing of Exudative Wounds Wu Huajun - Southwest University	#88 p. 115
14:35	Laser-Induced Graphene Coated Wearable Smart Textile Electrodes for Biopotential Signal Monitoring C M Vidhya - Indian Institute Of Technology Delhi, India	#466 p. 116
14:50	Biodegradable Scaffolds for Electrical Stimulation Enhanced Tissue Repair Yang Xi - Zhejiang University	#406 p. 117

S4 Computation and AI for Materials & Thin Films (CAM)

Kallang · Level 3

Chair: Jianwei ZHENG (Institute of High Performance Computing, Singapore)

10:50	AI for crystal structure optimization INVITED Lei Shen - National University Of Singapore	#158 p. 169
11:10	Physics AI Empowers the New Paradigm of Digital Materials R&D INVITED Kui Gong - Hongzhiwei Technology (shanghai) Co., Ltd.	#553 p. 170

WED 15 JUL

11:30	Introducing the High-Throughput Computational Platform of Chinese Materials Genome Engineering INVITED Tianruo Shen - National Supercomputer Center in Tianjin	#712 p. 171
11:50	Revealing the effects of NbHx on the dehydrogenation of MgH2 from first-principles Jianchuan Wang - Central South University	#612 p. 172
12:05	Hydrogen adsorption on group IV and III·V 2D honeycombs: Designing an electronegativity-based descriptor Yi Sheng Ng - Xiamen University Malaysia	#297 p. 173

AFTERNOON

13:20	Computational and Data-Driven Design of Strong Physical Response Materials INVITED Yan Sun - Institute Of Metal Research, Chinese Academy of Sciences	#624 p. 174
13:40	Molecular dynamics and lattice dynamics for ion transport and thermal conduction in complex solid systems INVITED Yongqing Cai - University Of Macau	#184 p. 175
14:00	Determination of the embedded electronic states at nanoscale interface via the simulation based on surface-sensitive electron structure spectroscopies INVITED Hui-Qiong Wang - Xiamen University	#673 p. 176
14:20	Tunable Magnonic Chern Insulators: Rational Design and Material Realization Chengwang Niu - Shandong University	#690 p. 178
14:40	Ferroelectric-Engineered Valley Physics in Two-Dimensional Systems Xinru Li - Shandong University	#688 p. 179
14:55	Excitonic Instability in Quantum Spin Hall Insulators Wei Wei - Shandong University	#689 p. 180

Break Time

15:30	Enhanced erosion resistance of BaZrO3 mold against TiAl alloy melt during directional solidification through an in situ formed Y2O3 protective layer INVITED Chonghe Li - Shanghai University	#187 p. 181
15:50	Erosion Behavior and Failure Mechanisms of Plasma-Sprayed YSZ Coatings Under Prolonged Aluminum alloy melts Pengyue Gao - Shanghai University	#119 p. 182
16:05	Design, Synthesis, and Structural Characterization of Novel Sulfide Perovskite Materials BaCeS3 and SrCeS3 Haitao Li - Shanghai University	#121 p. 183
16:20	Influence of Surface Defects on the Fatigue Behavior and Phase Transformation Mechanisms in NiTi Alloys Fabricated by Laser Powder Bed Fusion Dongdong He - Shanghai University	#120 p. 184
16:35	The Impact of Silver Addition on the Stability and Biocorrosion Resistance of Passive Films in Ti-15Zr Alloy Rulin Zhang - Shanghai University	#619 p. 185
16:50	A hybrid model for plasma discharge and transport during CrN deposition by reactive DOMS Jianying Gao - Avic Manufacturing Technology Institute	#424 p. 186

S7 Ferroelectric Films & Functional Devices (FFF)

Sembawang · Level 3

Chair: Yu ZHOU (Central South University, China)

13:10	Room-temperature two-dimensional multiferroic metal with strong magnetoelectric coupling INVITED Lan Chen - Institute Of Physics, Chinese Academy Of Sciences	#256 p. 264
13:30	Non-volatile optical response in sliding ferroelectric 3R-MoS2 via exciton tuning INVITED Jing Liang - Shenzhen International Quantum Academy	#130 p. 265
13:50	Ferroelectric vortex domain configuration for dielectric energy-storage INVITED Ziming Cai - China University of Mining and Technology	#352 p. 266
14:10	From oxides to nitrides: Epitaxial thin films for energy harvesting and conversion INVITED Weisea Chang - National Yang Ming Chiao Tung University	#621 p. 267
14:30	Schottky Barrier-Conductive Wire Channel Synergistically Regulated Ultra-High Nonlinear Jumping Self-Rectifying Memristor INVITED Minghua Tang - Xiangtan University	#674 p. 268
14:50	Multiscale heterogeneous-structure design for BNT-based energy storage ceramics INVITED Chaoqiong Zhu - UniversityChina University of Mining and Technology	#342 p. 269
15:10	Orbital Guided Design of Unconvensional Two-dimensional multiferroic material INVITED Yunhao Lu - Zhejiang University	#354 p. 270
15:30	Nanoscale dielectrics and ferroelectric semiconductors for informational devices INVITED Yu Zhou - Central South University	#682 p. 271

S9 Nanostructures, Nanocomposites & Nanoparticles (NNN)

Seletar1 · Level 3

Chair: Yingchun GUAN (Beihang University, China)

15:30	3D Photonic Crystal Additives on Piezoelectric Response of PVDF/TPU Nanofiber Sensors INVITED Wu Yongling - Shandong University Of Technology	#86 p. 304
15:50	Confined Pyrolysis-Driven Evolution of g-C·N·/PAN nanofibers into Nitrogen-Doped 1D/2D Carbon Heterostructures for Highly Efficient Microwave Absorption Li Jingwei - Harbin Institute of Technology	#249 p. 305
16:05	Armoring Boron Nitride with Pyrolytic Carbon Layers for Tunable Rigidity and Flexibility Lan Meng - Northwestern Polytechnical University	#94 p. 306
16:20	Laser-Textured Bionic Functional Suarfaces for Controlled Droplet Transport Wang Kongbo - Shandong University Of Technology	#100 p. 307
16:35	Backside Electrostatic Patterning Enables Programmable Droplet Capture on a Superhydrophobic Surface Li Enzhe - National United University	#472 p. 308
16:50	Multiscale Ultrafast Laser Texturing for Structural and Functional Metals Ma Yi - Beihang University	#216 p. 309

S10 Organic Electronics and Photonics (OEP)

Seletar3 · Level 3

Chair: Xiaotao HAO (Shandong University, China)

10:50	Carbazole SAM Interfaces and NFAs for Organic Photovoltaics INVITED Ergang Wang - Chalmers University Of Technology	#49 p. 359
11:10	Organic Diodes Bridging Electroluminescence and Photovoltaic Conversion: Interfacial Engineering of MR-TADF Thin Films for Full-Color Devices INVITED Hirohiko Fukagawa - Chiba University	#622 p. 360
11:30	Semitransparent Organic Solar Cell based on Nonfullerene Photocharge Generation INVITED Han Yan - Xi'an Jiaotong University	#240 p. 361
11:50	Mitigating Energy Loss in Organic Solar Cells through Solid-State Emissive Molecular Design Sai Ho Pun - The Hong Kong University Of Science And Technology	#611 p. 362
12:05	Origin of Annealing Induced Work Function Changes in PEDOT:PSS Kaito Ban - Chiba University	#647 p. 363

AFTERNOON

13:20	Toward Stable and High-Performance Sn Halide Perovskite Electronics: Thin-Film Transistors and NIR Photodetectors INVITED Hui Joon Park - Hanyang University	#663 p. 364
13:40	Chiral-perovskite optoelectronics INVITED Guankui Long - Nankai University	#275 p. 365
14:00	Lateral Heterogeneity of 2D Ruddlesden-Popper Perovskite Films and Its Impact on Photovoltaic Performance INVITED Fei Zheng - Ningbo University	#691 p. 366
14:20	Guideline for Carbazole-based Hole-Collecting Monolayers in p-i-n Perovskite Solar Cells from the Viewpoint of Energy Level Alignment Koki Sawai - Chiba University	#648 p. 367
14:35	Phase Stabilization and Defect Passivation in Lead Halide Perovskite Films Handong Jin - Shandong Jiaotong University	#705 p. 368
14:50	Perovskite Crystallization Regulation via Antimonene Quantum Sheets for Highly Efficient and Stable Solar Cells Kangning Li - Taiyuan University of Technology	#536 p. 369

S11 Optical Thin Films (OTF)

Sentosa · Level 3

Chair: Jianqi ZHU (Harbin Institute of Technology, China)

10:50	Transparent Materials for Extreme Environments INVITED Liangge Xu - Harbin Institute of Technology	#32 p. 397
11:10	Particle Swarm Optimization-Driven Intelligent Design of Multilayer Thin-Film Structures for Multispectral Infrared Stealth Applications Shijie Chen - Harbin Institute Of Technology	#54 p. 398

11:25	Phase-Change Optical Thin Films Synergized with Graphene Electrical Tuning for Broadband Reconfigurable Metasurface Absorbers Pingping Min - Zhengzhou Advanced Research Institute of Harbin Institute of Technology	#363 p. 399
11:40	Chemical Composition Modulation and Synergistic Enhancement Mechanisms of the Opto-Mechanical Properties of YOxNy Thin Films for High-Performance Infrared Windows Zheqiu He - Harbin Institute Of Technology	#193 p. 400
11:55	Thickness Control and Thermal Stability of Large-diameter Mo/Si Multilayers Zhe Zhang - Tongji University	#704 p. 401
12:10	Medium-entropy to high-entropy sesquioxide X·O· infrared transparent ceramics Wenqi Li - Harbin Institute Of Technology	#74 p. 402
12:25	Ultra-Fine Fractal Silver Meshes via Laser Direct Writing for High-Performance Transparent Electrodes with Suppressed Moiré Wen-Yen Chang - National Chung Hsing University	#148 p. 403

AFTERNOON

13:20	Coatings for space observations in the far ultraviolet INVITED Juan I. Larruquert - Instituto De Optica - Csic	#16 p. 404
13:40	Enabling Scalable Manufacturing of Diffractive Micro-/Nano-Optical Devices for AR/VR Applications INVITED Wali Zhang - YongJiang Laboratory	#340 p. 405
14:00	Effect of RF power on structure, mechanical and infrared optical properties of La-, d Er-co-doped Y2O3/ZnS films by magnetron sputtering Zhaoyang Xing - Harbin Institute Of Technology	#211 p. 406
14:15	Effect of Dilute Y·O· Co-doping on the Lattice Structure and Properties of Al-doped ZnO Thin Films Yi-Yen Chen - National Formosa University	#133 p. 407
14:30	High-entropy design of new zirconate transparent ceramics with synergistic enhancement of mechanical and optical properties Xuanyu Wang - Harbin Institute of Technology	#73 p. 408
14:45	Simultaneous Infrared Camouflage and Effective Multiband Thermal Management Xiangqing Teng - Harbin Institute of Technology	#384 p. 409
15:00	Achieving High Transparency and High Wear Resistance in Ceramics: A High-Entropy Strategy Coupled with Advanced Sintering Technology Peng Wan - Harbin Institute Of Technology	#76 p. 410

Break Time

15:30	Morphology-engineered coatings on periodic nanostructures for guided resonances, anomalous reflection, and plasmon canalization INVITED Yi-Jun Jen - National Taipei University Of Technology	#631 p. 411
15:50	p-type conductive infrared transparent Cu2-xSe thin film Quanming Ding - Harbin Institute Of Technology	#294 p. 412
16:05	Medium to high entropy sesquioxide infrared transparent ceramics with high performance Linbo Wang - Harbin Institute of Technology	#75 p. 413

16:20	Hard and infrared-transparent HfScTiYZr high-entropy oxide coating Jingchuan Li - Harbin Institute of Technology	#190 p. 414
16:35	A General Framework for Optical Optimization and Mechanical Property Enhancement of Multilayer Films Based on Deep Learning Ateer Bao - Harbin Institute of Technology	#91 p. 415
16:50	The fabrication of 3D GaN and 2D WS2 heterostructures by plasma-assisted molecular beam epitaxy Aminudin Zuhri - National Dong Hwa University	#375 p. 416
17:05	Periwinkle Petal·Templated Microstructured PDMS for Enhanced Hydrophobicity Aneela Perumalla - Indian Institute of Technology, Madras	#247 p. 417
17:20	Degradation Mechanisms of Al/LiF/eMgF2 Thin Films under Low-Energy Proton Irradiation Shuangying Li - Zhengzhou Advanced Research Institute Of Harbin Institute Of Technology	#554 p. 418

S12 Thin Film for Semiconductor Fabrication and Packaging (TSP)

Boardroom · Level 3

Chair: Yong Jing YOON (KAIST, Korea)

13:20	Transition metal carbide thin films prepared by atomic layer deposition: A new enabler for advanced metallization process INVITED Prof. Soo-Hyun KIM - Ulsan National Institute of Science and Technology (UNIST)	#323 p. 427
13:40	Electronic packaging enhancement engineered by reducing the bonding temperature via modified cure cycle INVITED Prof. Seong Su KIM - Korea Advanced Institute of Sceince and Technology (KAIST)	#503 p. 428
14:00	Advanced Consumables and Processing in Chemical Mechanical Polishing for Semiconductor Packaging INVITED Prof. Sanha KIM - Korea Advanced Institute of Sceince and Technology (KAIST)	#252 p. 429
14:20	Evaporation-Driven Marangoni Control for Uniform and Scalable Nanocomposite Thin Films INVITED Prof. Hyoungsoo KIM - Korea Advanced Institute of Sceince and Technology (KAIST)	#257 p. 430
14:40	Plasma-Enhanced Atomic Layer Etching of Ru via Gas Activation Jeongmin OH - Pohang University of Science and Technology (POSTECH)	#372 p. 431
14:55	Artificial Intelligence for Quantifying Stochastic Damage Evolution in Freely-Stretched Ultra-Thin Films Myoung SONG - Korea Advanced Institute of Sceince and Technology (KAIST)	#380 p. 432
15:10	Effect of substrate roughness on the formation of electroless nanotwinned copper and its thermal stability Yu-Ting YU - Yuan Ze University	#57 p. 433
	Break Time	
15:30	Active Control of Thin-Film Processing Plasma via a Tunable Metamaterial INVITED Prof. Sanghoo PARK - Korea Advanced Institute of Sceince and Technology (KAIST)	#515 p. 434
15:50	Thermal atomic layer etching: Principles and applications for nanodevice fabrication INVITED Prof. Taewook NAM - Sejong University	#45 p. 435

16:10 Detection of Pinholes in Thin-Film Solid Oxide Electrolytes via Selective Adsorption of Ag Nanoparticles Generated by Spark Discharge
Prof. Jong Dae BAEK - Yeungnam University
#364 p. 436

16:25 AI-Driven Thermal Design Framework for Advanced Semiconductor Packaging
INVITED
Prof. Haeun LEE - Yeungnam University
#687 p. 437

16:45 Epitaxial growth of high-quality GaN on CVD MoS·/c-sapphire by plasma-assisted molecular beam epitaxy
Prof. Iwan SUSANTO - Jakarta State Polytechnic
#653 p. 438

17:00 Phase-Controlled Electronic Structure Engineering in Doped HfO2: A High-Throughput Graph Neural Network Study of Y, La, Al, Si, Ti, and Ce Dopants
Mr. Zunair MASROOR - Incheon University
#399 p. 439

17:15 Atomic-Scale Control of Stoichiometry and Oxygen Vacancies in Ferroelectric HfxYyOz Films via Atomic Layer Modulation
Mr. Ngoc Le TRINH - Incheon University
#400 p. 440

S13 Smart Materials and Microsystems (SMM)

Atrium Ballroom · Level 4

Chair: Yongqing FU (Northumbria University, UK)

10:50 Ultrafast Optoacoustic Metrology: A Non-Destructive Approach for 3D Nanoscopic Characterization of Semiconductor Devices
KEYNOTE
Zhongqing Su - Hong Kong Polytechnic University, China
#233 p. 463

11:15 Interaction Between Surface Acoustic Waves and Electrons
KEYNOTE
Wei Luo - Huazhong University Of Science And Technology
#260 p. 464

11:40 Self-powered wearable piezoelectric nanogenerators enabled by functional thin films for HMIs, IoTs, and biomedical systems
INVITED
Sasikumar Ragu - Korea University Of Technology And Education, South Korea
#80 p. 465

12:00 Minimalist Design Strategies for Stretchable and Flexible Triboelectric Sensors: From Scalable Fabrication to Intelligent Wearable Systems
INVITED
Shuting Liu - Hangzhou City University, China
#434 p. 466

AFTERNOON

13:20 Piezoelectric Thin-Film·Enabled Acoustofluidic Microsystem for Deterministic Single-Cell Dispensing and Native-State Proteomics
KEYNOTE
Chris Xin Yang - Cardiff University UK
#428 p. 467

13:45 Droplet acoustofluidics technology facilitate the precise analysis of miRNA
INVITED
Jingui Qian - Hefei University of Technology, China
#327 p. 468

14:05 A Programmable SAW-Activated Microneedle Microfluidic Chip for Integrated Cell Lysis, RNA Purification, and Quantitative PCR Detection
INVITED
Zenan Wang - Shenzhen Institutes Of Advanced Technology, China
#231 p. 469

14:25 Single-beam acoustical tweezers for the trapping and assembly of a single cell for lab-on-a-chip applications — #124, p. 470
INVITED
Zhixiong Gong - Shanghai Jiaotong University, China

14:45 Autonomous underwater acoustic propulsion system via lithium niobate ultrasonic transducer — #251, p. 471
INVITED
Deqing Kong - Toyota Technological Institute, Japan

Break Time

16:00 Acoustic Microfluidics for Precision Medicine — #490, p. 472
KEYNOTE
Ye Ai - Singapore University of Technology and Design

16:25 Flexible and multimodal acoustofluidics enabled by piezoelectric thin films and bulk piezoelectric materials — #315, p. 473
INVITED
Yong Wang - Hangzhou City University, China

16:45 Surface Acoustic Wave-Assisted Swing-Angle Spray: From Mechanism Investigation to Deposition Characteristics and In Vivo Wound Healing — #455, p. 474
INVITED
Chenhui Gai - Harbin Institute of Technology, Shenzhen

17:05 Acoustic Separation and Sensing Based on Flexible ZnO Piezoelectric Thin Films — #410, p. 475
INVITED
Tengfei Zheng - Xi'an Jiaotong University, China

17:25 Ice nucleation and detachment on acousto-dynamic surfaces — #72, p. 476
Deyu Yang - Northwestern Polytechnical University

17:40 Effect of boron concentration on the corrosion resistance of boron doped diamond films — #447, p. 477
KEYNOTE
Haitao Ye - Fudan University, China

S14 Surface Treatment & Protection (STP)

Sembawang · Level 3

Chair: Wan-Yu WU (National United University, Taiwan)

10:50 Interfacial Free Energy Governs Nucleation Transition in Cu Interconnects for Advanced Packaging — #68, p. 521
INVITED
Chia-Hua Lin - Tunghai University

11:10 Interfacial Adhesion Improvement and Pool Boiling Heat Transfer Augmentation of GNPs/Epoxy Coatings via Plasma Treatment — #62, p. 522
INVITED
Jhao-Yu Guo - National Taiwan Ocean University

11:30 Enhanced corrosion resistance and mechanical stability of superhydrophobic micro-nano particles/epoxy coatings for the protection of cements — #463, p. 523
INVITED
Zongjing He - Harbin Institute of Technology

11:45 CO2 Laser-Fabricated Heterowetting PTFE/Al2O3 Platform for Geometry-Controlled Droplet Enrichment and Raman Enhancement — #270, p. 524
Cheng-Han Yu - National United University

12:00 Hybrid Post-Processing for Surface Smoothening of Additively Manufactured Ti-6Al-4V — #266, p. 525
Joseph Kee Seng Wong - Singapore Institute Of Manufacturing Technology (simtech)

12:15	Development of electroless copper plating and PVDF coating methods for improving the corrosion resistance of La·Co·Fe·Si magnetocaloric alloy Dong-Hyeon Lee - Department of Mechanical Engineering, chosun university	#409 p. 526

S15 Thin Film Devices (TFD)

Seletar3 · Level 3

Chair: Dong-Sing WUU (National Chi Nan University, Taiwan)

15:30	Development of a Sophisticated Cross Over Flow Atomic Layer Deposition Module for High Aspect Ratio Device Application INVITED Ching-Chiun Wang - Industrial Technology Research Institute	#450 p. 556
15:50	Study on P-Type ·-Ga·O· Epilayers Grown by MOCVD INVITED Ray Hua Horng - National Yang Ming Chiao Tung University	#714 p. 557
16:10	Research on thin-film-based micro-nano photonic devices INVITED Shaowei Wang - East China Normal University	#200 p. 558
16:30	Research on acoustic tweezers and their manipulation Siying Lin - Jimei University	#417 p. 559
16:45	Investigation of a high sensitivity pH sensor based on Graphene oxide/Gallium oxide heterostructure Shu-Bai Liu - National Kaohsiung University Of Science And Technology	#591 p. 560
17:00	Scalable Fabrication of Ultrathin Freestanding Oxide Films for Pyroelectric Device Applications Hanwen Chi - Zhejiang University	#464 p. 561
17:15	The role of oxygen vacancies induced by Ag ion implantation in promoting the electrochemical properties of BiVO4 Shilpa Chauhan - Upes, Dehradun, India	#671 p. 562
17:30	Optimization of MoO3 Transparent Electrode by Sputtering Process and Its Application in High-Performance CZT Nuclear Radiation Detectors Zhaoran Guan - School Of Materials Science And Engineering, Shanghai University	#264 p. 564

SS1 Korea-Singapore Research Collaboration

Changi · Level 4

Chair: Suk Won CHA (Seoul National University, Korea)

13:20	Carbon Nanomaterials and Progress Toward International Standardization INVITED JOHN Hong - Kookmin University	#287 p. 618
13:35	Laser-Based Manufacturing for Multi-functional Robotic Skins in Extreme Environments INVITED Bongchul Kang - Kookmin University	#344 p. 619
13:50	Flat Object Handling Technology Based on Controllable Adhesion INVITED Jaekang Kim - Kookmin University	#368 p. 620
14:05	Eutectic Gallium Indium Composite for Next-generation Wearable Biosignal Monitor INVITED Minwoo Kim - Kookmin University	#445 p. 621

14:20	Molten Lithium-Induced Gradient Copper Sulfide Interphase for Long-Cycle Lithium Metal Batteries Min Kyeong Kim - Kookmin University	#290 p. 622
14:35	Multiscale Surface Coating Approaches for Durable and Scalable Anti-Icing Properties Yujin Jeon - Kookmin University	#403 p. 623
14:50	Non-Visual Object Recognition via Active Exploration with Thin-Film Multimodal Sensory Integration Seunghoon Jung - Kookmin University	#506 p. 625
	Break Time	
15:30	Ultrafast Flame Synthesized CuRu and NiFe Catalysts for Alkaline Water Electrolysis INVITED SangWook Park - Seoul National University	#115 p. 626
15:45	AI-Driven Additive Manufacturing and Packaging for TF-SOFC Integrated Drone Systems: Toward High-Endurance, Scalable Tactical Platforms INVITED Yong-Jin Yoon - Korea Advanced Institute Of Science and Technology (KAIST)	#229 p. 627
16:00	Thermoreflectance-Based Thermal Characterization for Semiconductor Devices and Packaging INVITED Jungwan Cho - Sungkyunkwan University	#320 p. 628
16:15	Direct Laser Writing of CuOx Nanoparticle Inks: Reductive Sintering for Functional Thin Film Fabrication INVITED Daeho Lee - Gachon University	#329 p. 629
16:30	Numerical assessment of residual stress in hardfaced layers formed by metal additive manufacturing process INVITED Dong-Gyu Ahn - Chosun University	#444 p. 630
16:45	Polypyrrole-coated 3D Printed Highly Porous Graphene Electrodes for Bio-Photovoltaic Energy Generation INVITED Wonhyoung Ryu - Yonsei University	#500 p. 631
17:00	Motion-Adaptive SMP Skin Patches for Wearable Electronics INVITED Hoon Eui Jeong - UNIST	#525 p. 632

SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells

Seletar2 · Level 3

Chair: Pei-Chen SU (Nanyang Technological University, Singapore)

10:50	The integration of cryo atom probe tomography and transmission electron microscopy to study light elements important for the energy transition. INVITED Finn Guiliani - Imperial College London	#422 p. 649
11:15	Improving Conductivity of Protonic-Ceramic Electrolytes via Thin-Film Transient Lanthanum-Based Sintering Layers INVITED Ryan O'Hayre - Colorado School of Mines	#103 p. 650

WED 15 JUL

11:40	Emerging Carbon-Coupled Electrochemical Systems for Energy-Efficient Hydrogen Production and CO· Utilization INVITED Guntae Kim - Shanghai Institute Of Applied Physics, Chinese Academy Of Sciences	#286 p. 651
12:05	Engineering NiFe-based Cermet Anodes for High-Performance and Durable Direct Ammonia Solid Oxide Fuel Cells INVITED Kongfa Chen - Fuzhou University	#93 p. 652

AFTERNOON

13:20	Strain-induced structure and oxygen-vacancy distribution in solid-oxide fuel-cell cathode materials INVITED Zaoli Zhang - Erich Schmid Institute, Austrian Academy of Sciences	#295 p. 653
13:45	Mass and charge transport in thin oxide films driven by an external voltage INVITED Manfred Martin - RWTH Aachen University	#126 p. 654
14:10	Microstructure and performance of dense nanostructured Sc2O3 doped ZrO2 thin film deposited by ultrasonic spraying pyrolysis for metal supported solid oxide fuel cells INVITED Chengxin Li - Xi'an Jiaotong University	#21 p. 655
14:35	Intermediate-temperature proton-conducting solid oxide fuel cells and electrolyzers for Taiwan·s multi-fuel clean energy future INVITED Sheng-Wei Lee - National Central University	#31 p. 656

Break Time

15:30	Oxygen Electrodes for Reversible Protonic Ceramic Electrochemical Cells INVITED Yu Chen - South China University of Technology	#318 p. 657
15:55	Mass transportation optimization in air electrode of scaled-up protonic electrolysis cells fo high faradaic efficiency INVITED Bin Chen - Shenzhen University	#373 p. 658
16:20	Conformally coated scaffold electrode for reversibe solid oxide cells and its operational robustness INVITED Hanchen Tian - Xi·an Jiaotong University	#122 p. 659
16:45	Inkjet Printing of Thin Film Electrochemical Applications INVITED Joong Hyung Shim - Korea University	#331 p. 660
17:10	Hierarchical Core-Shell cathode with Triple Conductivity: Toward Efficient and Durable Protonic Ceramic Fuel Cells INVITED Wenlu Li - Hubei University	#398 p. 661

THU 16 JUL

Thursday, 16 July 2026

159 presentations - 13 symposia

S1 2D Materials (2DM)

Changi · Level 4

Chair: Daniel CHUA (National University of Singapore, Singapore)

08:30	Dielectric constant of strained monolayer MoS2 INVITED Shuo Deng - Wuhan University of Technology	#154 p. 63
08:50	Rippled graphene pores as fluidic memristive devices with synaptic and neuromorphic functionalities INVITED Sun Pengzhan - University Of Macau	#720 p. 64
09:10	Realization of a 2D Tungsten Disulfide (WS·) Diode Probe for Nanoscale Surface Temperature Sensing in MEMS/IC Chips INVITED Lu Chih-Cheng - National Taipei University Of Technology	#585 p. 65
09:30	Electrostatically gated graphene nanofluidic membranes for enhanced thermoelectric and mechanoelectric conversion INVITED Xue Yahui - Southen University Of Science And Technology	#269 p. 66
09:50	Defect and Strain Engineered Room-Temperature Ferromagnetism in Few-Layered MoS2 Films Anbalagan - Brookhaven National Laboratory	#155 p. 67
10:05	Choices of Gas Phase Precursors for 2D Materials Kalaisarasan - University Of Chemistry And Technology	#546 p. 68
	Break Time	
10:45	Thin Films Meet Photonics: Nanostructured Optical Fiber Platforms for Ultra-Sensitive Gas Detection INVITED Ong Boon Hong - National Chung Hsing University	#162 p. 69
11:05	Biosensing membrane for dynamic blood separation and monitoring INVITED Chu Zhenyu - Nanjing Tech University	#692 p. 70
11:25	Angstrofluidics in 2D MoS2 Multichannels INVITED Park Hyung Gyu - Postech	#441 p. 71
11:45	Center-concave 2D nanosheets based handheld microchip-devices for ultrasensitive lysine determination Song Huaiyu - Nanjing Tech University	#696 p. 72
12:00	Medium and high entropy alloy coatings fabricated by co-sputter deposition of common engineering alloys Santosh Routu - Ming Chi University Of Technology	#483 p. 73
12:15	Asymmetric spin valve based on Fe3GaTe2/Fe3GaTe2 via the synergy of the anomalous Hall effect and spin-dependent scattering Gao Zhuoqing - Zhejiang University	#438 p. 74

AFTERNOON

13:30	Accurate controlling of the transport channels in 2D nanosheet membranes for efficient H2 purification INVITED Wei Yanying - South China University of Technology	#542 p. 75
13:50	Interplay of Dehydration and Electronic Polarization Governs Ion Transport through Carbon Nanopores INVITED Misra Rahul - National University Of Singapore	#338 p. 76
14:10	Bioinspired Multi-modal Electronic Skin Based on Thin-Film Organic Electrochemical Transistors Ji Tianyi - Nanyang Technological University	#548 p. 77
14:25	Bifunctional CuS/rGO separation-sensing membrane for online monitoring of whole-blood lactate Zhang Shaoqi - State Key Laboratory Of Materials-oriented Chemical Engineering, College Of Chemical Engineering, Nanjing Tech Universit	#697 p. 78
14:40	Interlayer Engineering of MXene Nanofiltration Membranes via Cyclodextrin Crosslinking for Stable and Selective Ion Transport Li Yanan - Nanyang Technological University	#523 p. 79

S2 Biomedical and Healthcare (BHC)

Seletar1 · Level 3

Chair: Kui CHENG (Zhejiang University, China)

08:30	Fabrication of Main-Chain Betulin-based Polymer Nanofibers as Antibacterial Surface Coatings INVITED Ma Zhiyuan - Donghua University	#451 p. 118
08:50	Metal-enhanced ZIF-8 nanohybrid for advancing metastatic breast cancer treatment INVITED Singh Swati - Indian Institute of Technology Ropar	#303 p. 119
09:10	Study of Antimicrobial OIMS (oligo-imidazoliums) Internalization Mechanism, Structure-activity Relationship and Toxicity Property INVITED Tan Chongyun - Ningbo Institute of Materials Technology and Engineering	#724 p. 120
09:30	Antioxidant PDA/CeO2 coating on PLLA stent for intestinal ROS scavenging Zuo Shangyong - Zhejiang university	#413 p. 121
09:45	Heterostructured metal/metal oxide thin films for electrochemical biosensing applications Lakshmi Narayanan Muralidharan - Bharathiar University	#543 p. 122
10:00	3D printable/injectable personalized amyloidgenic hydrogel for accelerated wound healing and tissue regeneration Tripathi Shikha - Indian Institute Of Technology, BHU, Varanasi	#421 p. 123

Break Time

10:45	Enhanced corrosion resistance and osteogenic activity of PEO-coated Ti-Mg composites INVITED Tian Sirui - China Medical University	#253 p. 124
11:05	Multi-functional nanofibrous membrane with antibacterial abilities for infected diabetic wound healing and long-lasting air filtration INVITED Ye Junwei - Dalian University Of Technology	#568 p. 125

11:25	Improving durability of stainless steel nanopillar surface structure to prevent antibacterial activity deterioration induced by abrasion INVITED Mitsuhiro Hirano - Kitami Institute of Technology	#514 p. 126
11:45	Interfacial Behavior of Functionalized Short Quartz Fibers for Dental Resin Composites INVITED Wang Ruili - Donghua University	#476 p. 127

AFTERNOON

13:30	Ultrasound-responsive PVTF coated GaIn Microspheres for biomedical application Xin Xin - Zhejiang University	#449 p. 128
13:45	Amyloid-like Protein-Metal Sulfide Nanocoatings for Synergistic Photothermal and Antibacterial Implant Surface Protection Li Kexin - Southwest University	#70 p. 129
14:00	Self-Assembled Mechanochromic Nano Thin-Film Structures for Wearable Health Monitoring BISWAS SRIJEETA - Indian Institute of Science	#97 p. 130
14:15	Shikonin-loaded porous graphdiyne nanofilm on titanium surface for enhanced antibacterial activity and osseointegration Zhang Xiaojing - Southwest University	#71 p. 131

S4 Computation and AI for Materials & Thin Films (CAM)

Kallang · Level 3

Chair: Jianwei ZHENG (Institute of High Performance Computing, Singapore)

13:30	Advancing sustainable food processing: molecular-scale understanding of incipient protein fouling in falling-film evaporators INVITED Jia Wei Chew - Chalmers University Of Technology	#147 p. 187
13:50	Computationally Efficient Data-Driven Predictive Control for the Economic Operation of Membrane Reactors in Water Treatment INVITED Xunyuan Yin - Nanyang Technological University	#677 p. 188
14:10	Directional Droplet Rebound Dynamics on Anisotropic Superhydrophobic Surfaces: Implications for Self-Cleaning Polymer Thin Films Sushanta Sethi - Iit Dharwad	#415 p. 189
14:25	Molecular Dynamics Study of Chemical and Physical Crosslink Contributions to Rubbery Modulus in Photocurable Shape Memory Polymer Networks Taehyub Lee - Nanyang Technological University	#404 p. 190
14:40	Molybdenum dz2 and Sulphur p orbitals form resonant channels during Hydrogen Evolution Reaction in thin film MoS2 Jesaya Christian Ido Raja - Nanyang Technological University	#125 p. 191
14:55	Polysulfide Anchoring in Sodium-Sulfur Batteries by Non-Metal Doped VS2: A DFT Study Deepak Gorai - Indian Institute of Technology Kanpur	#152 p. 192

S5 Coating towards Industrial Applications (CIA)

Kallang · Level 3

Chair: Hongfei LIU (Institute of Materials Research and Engineering, A*STAR, Singapore)

08:30	Transparent conductive coatings with tunable properties for various industrial applications INVITED Shijie Wang - FEAT & IMRE, A*STAR	#156 p. 200

08:50	Gradient Multi-Principal Element Nitride Coatings: A Platform for Wide-Temperature-Range Wear Protection INVITED Haiyang Yu - Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences	#274 p. 201
09:10	Microstructural and Chemical Influences on Colour Stability in Brass Bluing - A Failure Analysis Approach INVITED Zhaohong Huang - A*STAR Singapore Institute Of Manufacturing Technology	#599 p. 202
09:30	Effect of energy gradient on wear resistance of TiN coatings deposited by magnetron sputtering with stepwise tuning working pressure Jia-Hong Huang - National Tsing Hua University	#550 p. 203
09:45	Ceramic Coatings on Stainless Steel Substrate by Plasma Spray: Comparison between Y2O3 and YF3 Yuefan Wei - SIMTech & A*STAR	#708 p. 204
10:00	Writable electronic textiles based on ACEL fiber coatings Jiajun Qin - Fudan University	#639 p. 205
	Break Time	
10:45	Coating edge distortion measurement for slot die roll to roll process during manufacturing INVITED Hussam Muhamedsalih - University of Huddersfield	#530 p. 206
11:05	Ultrasonic and Shearography Techniques for Non-Destructive Evaluation of Coatings INVITED Lei Zhang - IMRE, A*STAR	#603 p. 207
11:25	Thermal barrier coating removal process based on plasma technology INVITED Hong Liu - Shenyang Aerospace University	#646 p. 208
11:45	Surface modification and integrity enhancement of duplex stainless steel 2205 by severe shot peening Guangxu Yan - IMRE, A*STAR	#232 p. 209
12:00	Selective oxide layer formation on NiAl alloys by anodization with electrolyte variation Ryota Kawakami - Kitami Institute of Technology	#566 p. 210
12:15	Protective Coating by Plasma Electrolytic Oxidation (PEO) and Its Industrial Applications Zheng Jie Ong - A*STAR	#307 p. 211
12:30	Investigation on the low secondary electron emission mechanism of magnetron sputtered TiN nanofilms Jialong He - Institute of Fluid Physics	#666 p. 212

S6 Energy & Sustainability (ENS)

Sentosa · Level 3

Chair: Lidong SUN (Chongqing University, China)

15:45	Investigation and Modification Optimization of Taiwania cryptomerioides-Derived Biochar for Microporous Layer Applications in Proton Exchange Membrane Fuel Cells Wen-Wei Chang - National Chung Hsing University	#168 p. 245
16:00	Water-Free Surface Modification with Amorphous Nb2O5 Coating for Improved Stability of High-Ni NCM Cathodes via Plasma-Enhanced Atomic Layer Deposition Jaeyun Lim - Pohang University of Science and Technology (POSTECH)	#469 p. 246

16:15	Engineering Localized Graphitic Domains in Jute-Fiber-Derived Carbon Microspheres for Superior Energy Storage Ming-Che Cheng - National Chung Hsing University	#235 p. 247
16:30	·Regulating Interfacial Charge Transport to Stabilize Ni-Rich Cathodes via Atomic Layer Deposited Al-doped Molybdenum Oxide Hyeonmin Lee - Pohang University of Science and Technology (POSTECH)	#534 p. 248
16:45	Ultra-High Performance Symmetric Supercapacitors Based on Nitrogen-Doped Biomass Carbon and Graphene Composites Shih-lung Lee - National Chung Hsing University	#237 p. 249

S7 Ferroelectric Films & Functional Devices (FFF)

Boardroom · Level 3

Chair: Yu ZHOU (Central South University, China)

08:30	Design and Exploration of 2D Quantum Matters with Exotic Properties INVITED Yi Du - Beihang University	#378 p. 272
08:50	Neuron-Inspired Ferroelectric Bioelectronics INVITED Xuemin Du - Shenzhen Institute Of Advanced Technology (siat), Chinese Academy Of Sciences (cas)	#296 p. 273
09:10	Tunable threshold voltage of solution-processed metal oxide thin film transistors INVITED Zaixing Yang - Shandong University	#391 p. 274
09:30	Lead Salts Semiconductors-based Infrared Sensors INVITED Qisheng Wang - Nanchang University	#84 p. 275
09:50	Design and comparison of AlN/··Ga2O3 and AlScN/··Ga2O3 Heterostructure High electron mobility transistor Chih-Jou Tseng - National Yang Ming Chiao Tung University	#332 p. 276
	Break Time	
10:45	Ferroelectric devices for in-memory computing INVITED Bobo Tian - East China Normal University	#684 p. 277
11:05	Modulating Ferroelectricity in van der Waals Moiré Superlattices INVITED Yangbo Zhou - Nanchang University	#302 p. 278
11:25	Observation and manipulation of 2D topological polar texture confined in moiré interface INVITED Er Pan - University Of Electronic Science And Technology Of China	#382 p. 279
11:45	Spatial confinement hot carrier beyond unity quantum efficiency detection Yu Wan - Nanchang University	#96 p. 280
	AFTERNOON	
13:30	Room-temperature electrically switchable spin-valley coupling in a van der Waals ferroelectric halide perovskite INVITED Jie Jiang - Zhejiang University	#407 p. 281

13:50	Harnessing Interfaces to Tailor Phase Transitions, Polarization, and Toughness in 2D Ferroelectrics INVITED Xiaodong Zheng - Hebei University of Technology	#367 p. 282
14:10	BPVE Synaptic Array in BiFeO3 for Polarization-Sensitive In-Sensor Computing INVITED Lin Sun - East China Normal University	#695 p. 283
14:30	Ferroelectric optoelectronic sensor for intelligent flame detection and in-sensor motion perception INVITED Wei Han - Hubei University	#605 p. 284
14:50	High-Quality AlN Thin Films Grown by HiPIMS: A Comparative Analysis with Conventional DC and RF Sputtering Ya-Hsuan Chen - National Yang Ming Chiao Tung University	#360 p. 285

S8 High Entropy and Amorphous Coatings (HEA)

Seletar2 · Level 3

Chair: Yong ZHANG (Fuyao University of Science and Technology, China)

13:30	On the micromechanics of refractory-metal-based high entropy nitrides INVITED Pavel Sou·ek - Masaryk University	#14 p. 288
13:50	Entropy-Engineered MnAlCrCoCu High-Entropy Alloy/CNT Flexible Thin Films for Efficient Water Splitting and Hydrogen Generation Aswini Kumar Nath - Yuan Ze University	#317 p. 289
14:05	Energy-modulated structural evolution in amorphous alloys Xing Tong - Songshan Lake Materials Laboratory	#701 p. 291
14:20	Multi-scale guided optimization of (Hf-Zr-Ta-Nb)C coatings above 2000 °C: Element, Composition and Ablation property Xiaoxuan Li - Northwestern Polytechnical University	#165 p. 292
14:35	Enhancing CFRP drilling performance using multi-layer ta-C coatings: morphological, mechanical, and tribological evaluation Wenxuan Zhao - Nanjing University of Aeronautics and Astronautics	#83 p. 293
	Break Time	
15:45	Structures and Properties of CrMoNbSiC High-Entropy Films Prepared by Magnetron Sputtering Jiasheng Wang - University Of Science And Technology Beijing	#175 p. 294
16:00	Tribological and Adhesion Behaviour of Cold-Sprayed Ti-HEA Composite Coatings on Laser-Textured SS316L J Sharath Kumar - Dr B R Ambedkar National Institute of Technology Jalandhar	#40 p. 295
16:15	Mechanical properties and wear behavior of high entropy (TiZrHfCrW)Nx coatings Hsiu-ming Chang - National Taiwan Ocean University	#259 p. 296
16:30	Study on Electrochemical and Tribological Properties of ReCN Coatings Prepared by Magnetron Sputtering Yuan Liu - Nanjing University of Aeronautics and Astronautics	#82 p. 297

S9 Nanostructures, Nanocomposites & Nanoparticles (NNN)

Sentosa · Level 3

Chair: Yingchun GUAN (Beihang University, China)

08:35	Laser Processing-Assisted Fabrication of Si/YbDS/GYbZ Thermal and Environmental Barrier Coatings and Their Mechanisms of Functional Realization INVITED He Jian - Beihang University	#429 p. 310
08:55	Plasma-Assisted Reduction of Silver Nanoparticles on Various Substrates for Raman Signal Enhancement INVITED Vasquez Magdaleno Jr - University of the Philippines Diliman	#626 p. 311
09:15	Improvement the stability of the localized surface plasmon resonance of copper nanoparticles fabricated by vacuum coating Fang Yingcui - Hefei University Of Technology	#105 p. 312
09:30	Construction of 3D Hetergeneous Carbon Conductive Pathways for Efficient Thermal Management Wang Zhongkai - Northwestern Polytechnical University	#272 p. 313
09:45	SiO· Nanoparticle Surface Charge Modulation of Ion Selectivity and Energy Conversion in AAO Nanochannels Pai Fengwei - Tamkang University	#651 p. 314
10:00	High-throughput composition screening of Pt-modified aluminide coating for corrosion resistance in molten Na2SO4-NaCl salts Mengqi Li - Beihang University	#357 p. 315
	Break Time	
10:45	Laser-Assisted Engineering of Functional Nanostructures: From Super-Tetragonal Ferroelectric Films to High-Performance Flexible Sensors INVITED Li Zhipeng - University Of Science And Technology Beijing	#485 p. 316
11:05	Design and Development of BiFeO··Activated Carbon Nanocomposite for high density Supercapacitors applications INVITED Ahmad Mohammad - University of Guyana, South America	#248 p. 317
11:25	Construction of a core-shell structured SiC nanowires@nano-carbon hybrid conductive network for supercapacitors and electromagnetic interference shielding Liu Huimin - Northwestern Polytechnical University	#334 p. 318
11:40	Multi-stimulus responsive anisotropic slippery surfaces Sang Junhao - Shandong University Of Technology	#507 p. 319
11:55	Wet-chemical-assisted 3D printing of functionalized comb structures for efficient and scalable fog harvesting Yu Shen - Shandong University Of Technology	#508 p. 320
	AFTERNOON	
13:30	Two-nozzle Electrospinning-Derived Dual-Fiber TVDF@GPU Nanofibrous Scaffolds for Piezoelectric Nanogenerator Sensors Li Yunlong - Shandong University Of Technology	#325 p. 321
13:50	Dual-layer coated flaky carbonyl iron powder with enhanced high-temperature oxidation resistance and microwave absorption performance Zan Yuchen - Beihang University	#311 p. 322

14:10 Electronic and Transport Properties of Doped GeSe Nanoribbons: A First-Principles Analysis
Yadav Banti - ABV-Indian Institute of Information Technology and Management Gwalior (M.P.) India
#655 p. 323

S10 Organic Electronics and Photonics (OEP)

Seletar3 · Level 3

Chair: Xiaotao HAO (Shandong University, China)

08:30 Realization of Blue-Emissive Perovskite Nanocrystals Via Size Control and Post-Treatment of Organic Ligand
INVITED
Chang-Lyoul Lee - Gwangju Institute of Science And Technology (GIST)
#11 p. 370

08:50 Revealing Spin and Charge States in Thin Film Semiconductor Devices via Operando Electron Spin Resonance
INVITED
Kazuhiro Marumoto - University of Tsukuba
#518 p. 371

09:10 Tailoring spontaneous orientation polarization in organic thin-film devices for improved performance
INVITED
Yutaka Noguchi - Meiji University
#446 p. 372

09:30 An Insight in the Role of Dopamine Acted in the Electroless Deposition Process using Surface and Interface Force Spectroscopy
INVITED
Xiaomin Kang - University Of South China
#595 p. 373

09:50 New hole-transporting materials based on the NPB and m-MTDATA skeletons for optoelectronics
Audrius Bucinskas - Kaunas University of Technology
#131 p. 374

10:05 Electronic structure of an organic Mott insulator ···(BEDT-TTF)·ICl· observed by angle-resolved photoelectron spectroscopy
Ryotaro Nakazawa - Chiba University
#670 p. 375

Break Time

10:45 Organic chiral spin materials
INVITED
Wei Qin - Shandong University
#173 p. 376

11:05 Intrinsically Stretchable Polymer Semiconductors for Polarimetric Organic Photodetectors
INVITED
Byoung Hoon Lee - Ewha Womans University
#313 p. 377

11:25 Intentional Reduction of Charge-Carrier Density in Conducting Polymer Films for Organic Transistors
INVITED
Felix Sunjoo Kim - Chung-ang University
#664 p. 378

11:45 Ion-Regulated Flexible Thin-Film Devices for Biomimetic Actuation and Intelligent Sensing
INVITED
Shasha Wang - Nanjing University Of Posts And Telecommunications
#304 p. 379

12:05 Direct Observation of the Conduction Band Structure of Crystalline Pentacene by Angle-Resolved Low-Energy Inverse Photoemission Spectroscopy
Issei Ishimori - Chiba University
#650 p. 380

AFTERNOON

13:30	HTL- & ETL-free Metal-Semiconductor-Metal Structure Organic Solar Cells INVITED Shinuk Cho - University of Ulsan	#129 p. 381
13:50	Molecular and Electronic Structural variations in semiconducting polymers for organic photovoltaics INVITED Kyohei Nakano - RIKEN CEMS	#482 p. 382
14:10	Quinoxaline-based Nonfullerene Acceptors for Highly Efficient Organic Solar Cells INVITED Feng Liu - Shanghai Jiao Tong University	#598 p. 383
14:30	Engineering Exciton Dissociation Pathways for Efficient and Stable Organic Photovoltaic Devices INVITED Kangning Zhang - Shandong University	#305 p. 384
14:50	Critical length screening enables high-performance thick-film organic solar cells Yuan Meng - Shandong University	#474 p. 385

Break Time

15:45	High-Performance All-Polymer Solar Cells INVITED Yanming Sun - Beihang University	#166 p. 386
16:05	Effect of Intramolecular Vibrations on Electron and Hole Transport in Organic Semiconductors INVITED Hiroyuki Ishii - University of Tsukuba	#460 p. 387
16:25	Self-Assembled Electret Thin Films: From Spontaneous Orientation Polarization to Charge-Free Vibrational Energy Harvesters INVITED Yuya Tanaka - Gunma University	#637 p. 388
16:45	Revealing the influence of the dispersion property of charge transport on the stability of organic solar cells INVITED Hang Yin - Shandong University	#386 p. 389

S13 Smart Materials and Microsystems (SMM)

Atrium Ballroom · Level 4

Chair: Yongqing FU (Northumbria University, UK)

08:35	Aluminum Nitride Piezoelectric Thin Films and FBAR Filters KEYNOTE Bin Yang - Hunan University, China	#140 p. 478
09:00	Structural Designs of Flexible Strain Sensors for High Performance Sensing Based on Strain Synergetic Strategy INVITED Weijuan Wang - Hong Kong Polytechnic University, China	#283 p. 479
09:20	Dynamic Control Method and Mechanism of Surface Acoustic Waves Mediated by Optical Virtual Interdigital Transducers INVITED Dengmu Cheng - Southwest Petroleum University, China	#562 p. 480

09:40 Surface acoustic wave ice protection via piezoelectric film integrated aircraft wing leading edges
Danny Blackburn - Northumbria University at Newcastle, UK
#24 p. 481

09:55 High-Transconductance and Biocompatible OECTs for Direct, High-Precision Electrophysiological Signal Acquisition
Mingxuan Huang - Zhjiang University, China
#365 p. 482

Break Time

10:45 Nitrogen Doping Induced Synergistic Tuning of SP^3/SP^2 Bonds in Diamond-Like Carbon Films
KEYNOTE
Yufei Liu - Chongqing University, China
#157 p. 483

11:10 Spontaneous droplet transport on shape-evolving microfiber rails
INVITED
Pingan Zhu - City University of Hongkong, China
#326 p. 484

11:30 Ultrasound-Enabled Physical Catalysis for Electrochemical Energy and Biosensing Systems
INVITED
Pengzhan Liu - Nanjing Univrsity, China
#347 p. 485

11:50 An ultrasensitive multimodal intracranial pressure biotelemetric system enabled by exceptional point and iontronics
INVITED
Jie Li - Hangzhou Dianzi University, China
#179 p. 486

AFTERNOON

13:30 Decoding Lipid Membrane Interactions via Electrical Signals for Intelligent Screening of Nanoscale Analytes
INVITED
Quannan Xue - Tianjin University, China
#412 p. 487

13:50 Silicon-based piezoelectric MEMS ultra-thin active cooling device
Jiafeng Ni - Zhejiang Univetrsity, China
#330 p. 488

14:05 Ultraviolet Light-Activated Ultrahigh-Frequency Surface Acoustic Wave Sensor for DMMP Gas Detection with a 10 ppb Limit of Detection at Room Temperature
Shengyu Wen - Hunan University, China
#202 p. 489

S14 Surface Treatment & Protection (STP)

Sembawang · Level 3

Chair: Wan-Yu WU (National United University, Taiwan)

13:30 Fibers surface treatment to enhance fiber-polymer interfacial bonding and strengthen the composite properties
INVITED
Junhua Kong - A*STAR
#145 p. 527

13:50 Plasma-Polymerized Organosilane Films as a Versatile Platform for Biofunctional Surface Engineering of Metallic and Ceramic Implants
INVITED
Shu-Chuan Liao - Tamkang University
#291 p. 528

14:10 Modulating Surface States for Photoelectrocatalytic Selective Oxidation of Biomass-Derived Sugars
INVITED
Xin ZHAO - China Agricultural University
#37 p. 529

14:30	Regulation Mechanism of Oxygen Plasma Etching on the Initial Frictional Interface and Long-Term Wetting Stability of Tetrahedral Amorphous Carbon (ta-C) Films INVITED Zhenhuai Yang - Jihua Laboratory	#488 p. 530
14:50	Stability of titanium deuteride films irradiated with pulsed ion beams Tao Wang - Institute Of Fluid Physics, Caep	#634 p. 531
15:05	Ultrathin Carbon-Based Overcoats for Superior Tribological Performance and Oxidation Control Rajesh Kumar - CSIR-AMPRI, Bhopal	#196 p. 532
	Break Time	
15:45	Multiscale Fabrication Pathways and Their Effects on Phase Stability, Microstructure, and Corrosion Resistance in CoCrFeNi Based HEAs INVITED Aphichart Rodchanarowan - Kasetsart University	#437 p. 533
16:05	Enhancing Water Vapor Corrosion Resistance of Yb·SiO··-Based Environmental Barrier Coatings on Nb Alloy via Oxide-Modifications Hongkang Ou - Northwestern Polytechnical University	#109 p. 534
16:20	Adsorption and Corrosion Inhibition Behaviour of 1,3,4-Thiadiazole Schiff Base on Mild Steel: A Thermodynamic and Electrochemical Study Sheetal Kundu - Netaji Subhas University Of Technology, New Delhi, India	#593 p. 535
16:35	Polydopamine Enabled Localized Boronic-Ester Vitrimer Interphase for Enhanced Interlaminar Fracture Toughness and Impact Recoverability in CFRP Laminates Ruonan Zhang - Northwestern Polytechnical University	#300 p. 536

S15 Thin Film Devices (TFD)

Sembawang · Level 3

Chair: Dong-Sing WUU (National Chi Nan University, Taiwan)

08:30	PEALD-grown HfO2-based thin films and their applications in thin film transistors INVITED Xiao-Ying Zhang - Xiamen University Of Technology	#389 p. 565
08:50	Conformal Ultrathin Metal Films on Curved Substrates: Fabrication and Applications INVITED Heyan Wang - IHPC	#636 p. 566
09:10	Ultra-Thin Diffractive Axicon Thin-Film Sensor Fabricated by Femtosecond Laser for High-Precision Tilt Angle Detection Shufan Li - Xiamen University of Technology	#586 p. 567
09:25	Manufacturing of thin-film thermocouples on curved surfaces Xiaoyi Zhang - Beihang University	#545 p. 569
09:40	High-Performance Light-Emitting Transistors with 3D Mesh Source Electrodes Fabricated by Laser Direct Writing Lithography Qizhen Chen - Xiamen University Of Technology	#544 p. 570
09:55	Development of novel ··In2Se3 thin films based Electrochemical Metallization Random Access Memory Satyam Garg - Miranda House, University Of Delhi - 110007	#700 p. 571
10:10	Development of Broadband Photodetectors using Semiconductor-based Thin Films Y. Ashok Kumar Reddy - Indian Institute of Information Technology, Design And Manufacturing (IIITDM) Kancheepuram	#261 p. 573
	Break Time	

10:45	Electronic synapses based on ZnTiO3 memristors INVITED Zhen Liu - Guangdong University of Technology	#582 p. 574
11:05	From Radical Engineering to Manufacturing: A Complete Technical Roadmap for Nitride Thin Films via Microwave Plasma-Enhanced ALD INVITED Pao-Hsun Huang - Jimei University	#587 p. 575
11:25	Realization of asymmetric resistive switching (RS) characteristics in p-NiO/CFO/n-ZnO multilayers for nonvolatile memory applications Shahnaz Kossar - GNA University Punjab	#10 p. 576
11:40	Process Window and Growth Characteristics of 8-Inch TiN Thin Films by Microwave Plasma-Assisted Atomic Layer Deposition zongyue Li - Jimei University	#590 p. 578
11:55	Optimizing Li3xLa{2/3-x}TiO3 Thin Films deposited on Al2O3 substrate via Physical Vapor Deposition technique for pH Sensor Applications Thi Thuy Linh Nguyen - Paris-saclay University	#55 p. 579
12:10	The influence of performance optimization of W doped MoO3 transparent electrode on the properties of cadmium zinc telluride nuclear radiation detector Zhaoran Guan - School Of Materials Science And Engineering, Shanghai University	#159 p. 580
12:25	Low-Hysteresis MoS· thin film Transistors with Intrinsic Carrier Switching Enabled by Polymer-Capped Gate Dielectrics Rupali Srivastava - Iit Delhi	#614 p. 581

SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells

Seletar2 · Level 3

Chair: Pei-Chen SU (Nanyang Technological University, Singapore)

08:30	Atomic Layer Surface Engineering of Solid Oxide Cell Electrodes INVITED Jihwan An - Pohang University of Science and Technology (POSTECH)	#164 p. 662
08:55	Solid Oxide Fuel Cells: From Materials Research to Industrial Fabrication INVITED Li Zhipeng - Northwestern Polytechnical University	#604 p. 663
09:20	Alloy-Based Electrode Active Materials for Solid-State Fluoride Batteries INVITED Munekazu Motoyama - Kyushu University	#227 p. 664
09:45	Dense Thin-Film BZCYYb Electrolyte via Perovskite-Assisted Low temperature-Sintering for High-Performance Protonic Ceramic Cells Kwangho Park - Nanyang Technological University	#321 p. 666
10:00	Enhanced Stability and Electrocatalytic Activity of Nanoporous Silver Cathodes via Two-Step Electrochemical Deposition of PrOx Overlayers Hyunseung Kim - Nanyang Technological University	#267 p. 667
	Break Time	
10:45	Toward Understanding and Regulating the Electrode-Electrolyte Interfacial Chemistry of Layered Oxide Cathodes under High-Voltage Operation for Sodium-Ion Batteries Zhigao Chen - Northwestern Polytechnical University	#411 p. 668

11:00	Rare-Earth Nd-Doped Sr2Fe1.6Cu0.4O6-· Double Perovskite Cathode: Mechanistic Insights into Oxygen Electrocatalysis for Reversible LT-SOFCs Yuzheng Lu - Nanjing Xiaozhuang University	#452 p. 669
11:15	Efficient Fabrication of LaGaO3-Based SOFCs via Low-Temperature Electrode Co-sintering Hye Young Kim - Korea Institute Of Ceramic Engineering And Technology	#493 p. 670
11:30	Enhanced proton transport and chemical stability in multi-cation doped perovskites enabled by grain boundary engineering and bilayer electrolyte design Baoshui Wu - China University Of Mining And Technology	#535 p. 671
11:45	DIRECT AMMONIA TUBULAR PROTONIC CERAMIC FUEL CELLS Zichen Zhuang - China University of Mining and Technology	#540 p. 672
12:00	Hydrogen-free exsolution of Ir·Fe nanoalloys on the surface of solid oxide cell perovskite air electrodes Jiyoon Shin - Nanyang Technological University	#293 p. 673

PLENARY TALK | PLENARY 1

July 14, 2026 | Plenary | 8:20 AM - 9:00 AM | Atrium Ballroom - Level 4

Advanced Organic Optoelectronic Devices and Materials Enabled by Precise Charge-Transfer Control

Prof. Chihaya ADACHI

Center for Organic Photonics and Electronics Research (OPERA), Kyushu University, Japan

The first current-injection organic electroluminescence (EL) was demonstrated in the 1960s using anthracene single crystals. However, these early devices required millimeter-thick crystals and operated at extremely high voltages, ranging from several hundred to several thousand volts, leaving a substantial gap toward practical applications. Even at that stage, the formation ratio of singlet to triplet excitons (1:3) under electrical excitation had already been recognized, highlighting the critical importance of utilizing triplet excitons for achieving high efficiency.

When we began working on OLEDs in the late 1980s, one of the central challenges was the lack of suitable electron-transport materials. While weak donor molecules such as triphenylamine derivatives exhibited excellent hole-transport properties, strong acceptor materials often induced excessive charge-transfer (CT) interactions at interfaces, leading to inefficient exciton formation despite enabling charge transport. To address this issue, we proposed a molecular design concept based on "weak acceptor character with a wide energy gap," which led to the discovery of electron-transport materials such as oxadiazole derivatives.1 This development enabled the realization of double heterostructures consisting of hole-transport, emissive, and electron-transport layers, thereby establishing the fundamental architecture of modern OLEDs with efficient carrier and exciton confinement.2

Interestingly, exciplex formation-initially regarded as a loss pathway-became the key to the next breakthrough. At donor-acceptor interfaces, CT complexes and exciplexes are formed and were once considered detrimental to emission. However, we later recognized that precise control of intermolecular CT interactions can minimize the singlet-triplet energy gap to a few hundred meV or less, thereby enabling efficient utilization of triplet excitons. Based on this concept, thermally activated delayed fluorescence (TADF) was realized in 2012 using donor-acceptor molecules.3 In TADF systems, triplet excitons are converted into singlet excitons via reverse intersystem crossing, enabling 100% internal quantum efficiency.

From this historical perspective, the essence of OLED technology lies in the precise control of CT interactions between weak donors and weak acceptors. These interactions govern not only charge transport and exciton formation but also molecular orientation, electronic polarization, charge separation, and even device degradation processes. The advancement of OLEDs has therefore been achieved through the integration of molecular design and process technologies such as thin-film formation and impurity control.

Today, the control of CT interactions extends far beyond OLEDs. It underpins the operation of organic photovoltaics, persistent luminescent systems,4 thermoelectric devices,5 and charge-generation layers in tandem OLEDs. Furthermore, fundamental photophysical properties-including large radiative decay rates and orientation-dependent optical phenomena-are deeply rooted in intra- and intermolecular CT interactions. Looking ahead, organic electronics is expected to evolve into a broader platform encompassing quantum, molecular, and bioelectronics, serving as a fundamental principle for next-generation devices. In this talk, I will revisit the past and present of organic electronics and discuss future directions driven by the precise control of charge-transfer interactions.

References: [1] C. Adachi et al., Appl. Phys. Lett., 55, 1489 (1989). [2] C. Adachi et al., Appl. Phys. Lett., 57, 531 (1990). [3] T. Uoyama et al., Nature, 492, 234 (2012). [4] R. Kabe and C. Adachi, Nature, 550, 384 (2017), [5] S. Kondo et al., Nat. Commun.,15, 8115 (2024).

PLENARY TALK | PLENARY 2

July 14, 2026 | Plenary | 9:00 AM - 9:40 AM | Atrium Ballroom - Level 4

Industrial Applications of Thin film Structures: structural colors and flexible transparent conductors, and how AI can help in the design process

Prof. L. Jay GUO

University of Michigan, US

Light interacting with metallic and dielectric structures can produce various interesting optical effects. Structural color is one of them, where structure-property relationship determines the optical response, more so than the constituent materials. Structural colors can be produced by exploiting optical resonances in 1D, 2D and 3D structures, offering advantages over conventional colored pigments such as high brightness, durability, and environmental safety and sustainability. For sub-micron structures, scalable nanopatterning technique is the key to enable large area manufacturing. Simpler yet is multilayer structure that can be realized by industrial-scale vapor deposition, with a wide range of applications. Another effort is to seek ITO replacement with an ultrathin and stable silver film as the flexible transparent electrode, which was used in OPV, and in OLED, with which the waveguide mode can be completely eliminated, leading to enhanced light extraction efficiency. Such transparent conductors have been commercialized by mature industrial sputtering process and applicable to a wide range of applications, e.g. photovoltaics, writable touch screens, electrochromic windows, to name a few. Regarding the structure design, we show that deep learning approach (reinforcement learning and GPT) can automatically design sophisticated structures to satisfy the design objective, and can facilitate researchers to gain insight on the working mechanism.

PLENARY TALK | PLENARY 3

July 14, 2026 | Plenary | 9:40 AM - 10:20 AM | Atrium Ballroom - Level 4

Advanced Thin Film Engineering Steering Health and Energy Transition

Prof. Sanjay MATHUR

University of Cologne, Germany

Advanced materials are driving innovation across a wide range of technological sectors, including energy conversion and storage, microelectronics, mobility, healthcare, and sustainable manufacturing. Among these, functional thin films and coatings play a particularly important role, as they enable the precise tailoring of surface and interfacial properties that govern the performance, efficiency, and durability of advanced devices. Their technological relevance extends from established industrial applications to emerging technologies, offering significant opportunities for value creation and sustainable innovation.

In the context of resource-efficient manufacturing, critical raw material substitution, and the transition toward climate-neutral technologies, the chemical design and processing of nanostructured ceramic thin films have become increasingly important. Through controlled synthesis and surface functionalization, key properties such as charge transport, catalytic activity, corrosion resistance, optical response, and interfacial stability can be optimized to meet demanding application requirements. This lecture will highlight recent advances in the chemical engineering of functional thin films and nanostructured ceramic interfaces for energy and healthcare applications. Examples will include functional oxide coatings for electrolysers and hydrogen production, interface engineering strategies for high-performance perovskite photovoltaics, and the role of tailored ceramic thin films in enhancing photon harvesting and charge-transfer processes. In addition, chemically functionalized SiO2 nanomaterials will be presented as advanced drug-delivery platforms capable of transporting higher therapeutic payloads while minimizing off-target effects.

PLENARY TALK | PLENARY 4

July 15, 2026 | Plenary | 8:20 AM - 8:40 AM | Atrium Ballroom - Level 4

Atomic Layer Deposition for Emerging Materials Synthesis and Applications

Prof. Hyungjun KIM

Yonsei University, Korea

PLENARY TALK | PLENARY 5

July 15, 2026 | Plenary | 9:00 AM - 9:40 AM | Atrium Ballroom - Level 4

Organic Molecular Sieve Membranes for Energy-relevant Applications

Prof. Zhongyi JIANG

Tianjin University, China

A number of emerging microporous organic polymers have exhibited the great potential as building blocks of molecular or ionic separation membranes. In this presentation, the concept of organic molecular sieve membranes (OMSMs) will be first introduced with the focus on the precise construction of membrane hierarchical structures and efficient intensification of membrane separation processes. The platform chemistries, designing principles, assembly methods for the precise construction of OMSMs are elaborated. Confined mass transport mechanisms for the membrane separation process intensification are elucidated based on the multiple interactions between OMSMs and permeants. 'STEM' (Synergistic rigidity and flexibility, Tunable pore/channel size, Even philicity and phobicity, Moderate reaction activity) guidelines on the rational design of OMSMs are highlighted. The major research activities and advances in covalent organic framework membranes for fuel cells and chemical separations in our research group will be reviewed as examples of OMSMs.

PLENARY TALK | PLENARY 6

July 15, 2026 | Plenary | 9:40 AM - 10:20 AM | Atrium Ballroom - Level 4

Research and development of high entropy alloy coatings and their potential applications

Prof. Jyh-Wei LEE

Ming Chi University of Technology, Taiwan

Since the pioneering work of Prof. Yeh and Prof. Cantor in 2004, high entropy alloys (HEAs) have revolutionized materials design by enabling unprecedented compositional flexibility and synergistic property optimization. Extending this concept to thin films, HEA coatings synthesized via advanced plasma-based deposition techniques offer a powerful platform for engineering multifunctional surfaces for extreme environments and next-generation energy systems. In this work, we present a comprehensive research framework for the design, synthesis, and application of refractory HEA coatings, including oxides, carbides, borides, and nitrides, fabricated primarily using the high power impulse magnetron sputtering (HiPIMS) technique. By tailoring elemental composition and plasma conditions, we demonstrate how phase stability, defect structure, and surface chemistry can be precisely controlled to achieve superior functional performance. Representative examples include oxygen-rich VNbMoTaWO· oxide coatings that significantly enhance electrochemical activity in vanadium redox flow batteries under strongly acidic conditions, and CrMoNbTiWC· carbide coatings that exhibit outstanding corrosion resistance for proton exchange membrane fuel cell bipolar plates. Additionally, (HfVTiZrW)B2 boride coatings show remarkable resistance to both sulfuric acid chemical corrosion and HF plasma-induced degradation, while nitrogen-engineered AlCoCrFeNiN· coatings enable efficient electrocatalysis in alkaline saline environments, highlighting their promise for seawater electrolysis. These results underscore a central paradigm: through compositional complexity and plasma-enabled synthesis, HEA coatings can be rationally designed to meet the demands of harsh and multifunctional applications. This work not only advances the fundamental understanding of HEA thin films but also opens new pathways for their deployment in sustainable energy, advanced manufacturing, and harsh environment technologies.

Controlled reconstruction of pre-catalysts for improved electrochemical CO2 reduction

Professor Hui Pan[1]

[1]University of Macau, Avenida da Universidade Taipa, Macau, China, Macao

Session 01 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 10:50 AM - 12:30 PM

The uncontrollable reconstruction in electrochemical precesses, leading to the destruction of well-defined structure and subsequence low durability, is the main obstacle to the performance of catalysts toward highly electrochemical CO2 reduction (eCO2R). In this work, we present a novel approach to address this issue by in-situ reconstruction of pre-catalysts. (1) A durable β-Bi2O3/Bi2O2CO3 composite was designed and fabriated, which showed a structural evolution from a Janus junction to a multi-interface heterojunction in the eCO2R. In situ Raman spectroscopy demonstrated that the electrochemical reduction of Bi-based materials to metallic Bi can be effectively resisted by modulating a more alkaline local environment. The synergistic interactions and directional electron transfer between the β-Bi2O3 and Bi2O2CO3 components within the heterojunction play a critical role for its superior activity and selectivity for the production of formate, and a remarkable durability. (2) A novel core-shell nanowire catalyst, composed of bismuth oxyformate nanowires encapsulated by a hydrophobic polypyrrole (PPy) layer (BiOCOOH NWs@PPy-2) achieved exceptional performance toward eCO2R, which was ascribed to the unique design of the bismuth-based catalyst. (3) The Sn/Zn ratios in Sn-Zn alloy precursors were modulated to promote CO2-to-formate ($HCOO^-$) conversion through a self-adaptive reconstructed structure with potential changing. Notably, the electrocatalyst exhibited exceptional CO2-to-$HCOO^-$ performance at a Sn/Zn ratio of 1:1 (SnZn-55), achieving a Faraday efficiency (FE) >82% across a wide potential range, a high $HCOO^-$ partial current density of 45.75 mA cm^{-2} at potential of highest FE formate and stability for up to 2000 hours. These findings provide deep insights into the interplay between elemental composition, reconstructed structure, and eCO2R performance, offering valuable guidance for designing advanced electrocatalysts for efficient CO2 reduction in broad potential range.

July 14, 2026 | 11:10 AM

Piezocatalysis in Two-Dimensional Materials for Sustainable Energy Conversion

Professor JYH-MING Wu[1]

[1]National Tsing Hua University, 101, Section 2 Kuang Fu Road,, Taiwan

Session 01 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 10:50 AM - 12:30 PM

In this work, I present recent advances in piezocatalysis based on two-dimensional (2D) materials as a novel platform for sustainable energy conversion. Particular emphasis is placed on piezocatalytic routes for hydrogen evolution and ammonia synthesis (from N_2 and H_2O) driven by mechanical energy inputs. I will show that coupling mechanical stimulation with photo-irradiation significantly enhances interfacial redox kinetics, enabling improved performance in hydrogen generation, ammonia production, and wastewater treatment. The enhanced catalytic activity arises from key mechanisms intrinsic to 2D materials. Ferroelectric phase-boundary fields promote efficient charge separation and directional transport, while stress-induced piezoelectric polarization enhances carrier mobility and suppresses charge recombination. These features make 2D systems particularly effective for mechanochemically driven catalysis. Additionally, I will highlight prototype systems powered by ambient mechanical energy sources—such as gravity, fluid flow, and acoustic waves—demonstrating the feasibility of self-powered catalytic systems operating under real-world conditions. The presentation will trace the evolution from early piezocatalytic concepts to current advanced material architectures with significantly improved performance. Finally, I will discuss key challenges, including materials stability, mechanochemical energy conversion efficiency, and large-scale implementation, and provide an outlook on how 2D piezocatalysts can enable next-generation multifunctional platforms for sustainable energy harvesting and environmental remediation.

July 14, 2026 | 11:30 AM

Growing process of native oxide layer on Si wafer

Prof. Ken Okano[1], Koji Izunome[2], Haruo Sudo[2], Naoya Niwa[2], Takeshi Senda[2], Jongduk Kim[3], Yuya Wagatsuma[3], Shun Okano[4], Prof. Tomoaki Masuzawa[5], Prof. Shuichi Ogawa[6]
[1]International Christian University, 3-10-2 Osawa, Japan, [2]GlobalWafers Japan, 6-861-5 Higashiko, Seiro-machi, Japan, [3]Park Systems Japan, 1-17-1 Kanda-Nishikicho, Japan, [4]Park Systems GmbH, Stresemannstrasse 30, Germany, [5]Shizuoka University, 3-5-1 Johoku, Chuo-ku, Japan, [6]Nihon University, 1-2-1 Izumicho, Japan
Session 01 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 10:50 AM - 12:30 PM

In Si wafer fabrication in general, it is mandatory to remove SiO_2 before they start the polishing and cleaning processes and it seems the removing process is well established. However, some of the processes are based, surprisingly, on their long experiences without the background of science. This is largely because the nature of native oxide layer on Si has not yet been understood completely.

The aim of this research is to clarify the growth mechanism of native oxide layer on Si wafer using AFM, Raman spectroscopy, ISE (Imaging Spectroscopic Ellipsometry) and XPS. According to the literature, the research started in 1990's and the researchers tried to clarify the mechanism and there seems to be a few interesting reports but none of which lead to the dramatic change in the Si wafer industries largely because most of the characterization techniques, at that time, require way too long time for all-wafers/whole area measurements dreamed in the industries.

More than 30 years have been passed and there are a few very promising techniques, which might be able to clarify the growing mechanism of native SiO_2 on Si wafers. In our presentation, our attempts and the results will be introduced and discussed.

July 14, 2026 | 11:50 AM

Quantum well made of amorphous chalcogenide and its application to photodetectors

Prof. Tomoaki Masuzawa[1], Dr. Joshua John[2], Prof. Ken Okano[3]

[1]Shizuoka University, 3-5-1 Johoku, Chuo-ku, Japan, [2]University of Technology in Chemnitz, Straße der Nationen 62, Germany, [3]Internatioal Christian University, 3-10-2 Osawa, Japan

Session 01 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 10:50 AM - 12:30 PM

Amorphous, or non-crystalline, films of selenium are getting much attention for their photoconductivity, low-noise, and high-resolution compatibility: application of this material ranges from xerography to x-ray imagers. Especially, HARP (High-gain Avalanche Rushing amorphous Photoconductor) is known to have a very high quantum efficiency, which is potentially comparable to latest Si SPAD (Single-Photon Avalanche Diode). However, mechanism of signal multiplication in HARP was not well understood.

In our previous studies, it was found that the high quantum efficiency of amorphous Se(a-Se) originated in carrier cascade across quantum wells of thin a-Se layers. Based on this discovery, we developed a model to estimate the level of signal multiplication using the number of layers and applied electric field.

This study introduces some of our works in a-Se based photo conductors, quantum well model to calculate their carrier multiplication characteristics, and photodetectors made of amorphous selenium and diamond electron beam source.

Beyond Spheres: Microwave-Assisted Synthesis of Lanthanide-Doped Nanostructures

Dr. Eva Hemmer[1]

[1]University Of Ottawa, 10 Marie-Curie Private, Canada

Session 01 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 10:50 AM - 12:30 PM

Lanthanide-based nanoparticles (Ln-NPs) are known for their outstanding optical properties. Yet, challenges remain, including low emission intensity and efficiency of small Ln-NPs, and reliable, fast synthesis routes. As material chemists, we tackle these challenges with new designs of Ln-NPs by chemically controlled synthesis and the establishment of structure-property-relationships. NaGdF4 being one of the preferred host materials for luminescent Ln-NPs, we developed a fast and reliable microwave-assisted synthesis approach allowing crystalline phase and size control in the sub 20 nm realm. Such control is crucial for the understanding of fundamental structure-property relationships and to optimize their optical properties when aiming for the design of multifunctional probes. Lanthanide fluorides, oxyfluorides, and oxysulfides is an alternative host material of interest. However, the synthesis of nanoscale Ln2O2S remained challenging as, for instance, the size control and uniformity of the particles could not keep up with other conventional NaLnF4 upconverting and NIR emitting nanoparticles. Control over precursor chemistry and reaction conditions allowed us to obtain nanoscale Ln-doped Gd2O2S, exhibiting various 2-dimensional morphologies and photoluminescence in the visible and NIR spectral regions. Similarly, precise control of reaction parameters during microwave-assisted synthesis is a promising approach for selectively producing LnF_3 and LnOF nanostructures. This presentation will highlight recent advances and remaining challenges in the microwave-assisted synthesis of luminescent nanostructures beyond NaLnF4.

July 14, 2026 | 1:20 PM

Carbon Nanowalls: Plasma-Engineered Graphene Architectures for Energy and Bioelectrochemical Applications

Dr. Mineo Hiramatsu[1]

[1]Meijo University, 1-501 Shiogamaguchi, Tempaku, Japan

Session 02 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 1:20 PM - 3:00 PM

Plasma-enhanced chemical vapor deposition (PECVD) provides a versatile platform for the synthesis of carbon nanostructures with controllable morphology and orientation. Among them, carbon nanowalls (CNWs), also referred to as vertical graphene or three-dimensional graphene, form vertically aligned few-layer graphene sheets with open edges and high surface area. These unique structural features make CNWs attractive as functional electrode materials for electrochemical and sensing applications.

In this talk, we highlight recent progress in the plasma growth of CNW architectures and discuss how plasma parameters influence their morphology, orientation, and hierarchical structure. Using radio-frequency PECVD, CNWs can be synthesized under controlled gas composition and pressure conditions, allowing systematic tuning of their structural characteristics.

Beyond structural control, we explore the potential of plasma-grown CNW architectures in emerging electrochemical devices. Owing to their high conductivity, abundant edge sites, and porous structure, CNWs provide an effective scaffold for functional materials. One example is lithium–sulfur batteries, where sulfur can be incorporated into CNW networks to form conductive composite cathodes capable of accommodating volume changes and suppressing polysulfide diffusion. Another promising direction is bioelectrochemical energy systems such as glucose biofuel cells, where the high surface area and biocompatible carbon surface enable efficient enzyme immobilization and electron transfer.

These examples demonstrate that plasma-grown graphene architectures provide a powerful design space for tailoring carbon nanostructures toward advanced device applications. The integration of plasma synthesis with electrochemical functionality opens new opportunities for developing high-performance electrodes for energy storage and bioenergy harvesting systems.

Green synthesis of graphene usable in harsh liquid environments for energy and bio-related applications

Prof. Masaki Tanemura[1]

[1]Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Japan

Session 02 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 1:20 PM - 3:00 PM

The sustainable development goals (SDGs) are a critical issue, and it is also the case for the synthesis of advanced materials for energy- and environment-related applications. Two-dimensional (2D) nanomaterials, such as graphene, are promising for those applications including batteries and supercapacitors. Graphene is typically synthesized by chemical vapor deposition (CVD) from a gas phase at elevated temperatures, sometimes close to the melting point of the catalyst metal. So, it is a high temperature process. How can we achieve its lower temperature synthesis with less energy consumption? One possible approach is the solid phase reaction method based on the solid-state transformation of segregated carbon. In this method, a composite or stacked film of amorphous C and a catalyst metal is simply vacuum annealed.

For Ni case, for example, which is the typical catalyst for the CVD graphene synthesis, the growth temperature of multilayer graphene can be reduced to 350°C for Ni-C composite films deposited onto any substrate [1]. The multilayer graphene thus synthesized onto a W probe was usable as an electrode in an all-solid-state nanobattery for in-situ transmission electron microscopy observations of, for instance, the intercalation of Li into graphene interlayers to form LiC_6 [2]. This solid phase reaction method can be extended to the porous graphene formation, such as, promising for applications including virucidal activity against the influenza virus [3]. Thus, the graphene synthesized by this method can be used even in harsh liquid environments and is quite promising for a variety of applications.

[1] S. Giri, et al., Adv. Mater. Technol. 11 (2026) e00936. [2] W. M. Lin, et al., Adv. Mater. Technol. 9 (2024) 2301564. [3] V. P. Gupta, et al., Mater. Chem. Phys. 347 (2026) 131435.

One- and Two-Dimensional Nanohybridization of Functional Oxides and Carbon-based Materials for Environmental and Sensing Application

Professor Tohru Sekino[1]

[1]SANKEN, The University of Osaka, Mihogaoka 8-1, Japan

Session 02 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 1:20 PM - 3:00 PM

Titania and titanate nanotubes (TNTs) could be synthesized through facile solution chemical routes at sufficiently low temperature below 120 °C. Obtained nanotube was around 10 nm in diameter with high specific surface area ~300 m^2/g, which was larger than common TiO_2 nanoparticles and thus exhibited better physicochemical and photocatalytic properties. This study focuses on the nanoscale hybridization of 1D oxides (TNTs) with low-dimensional carbon-based substances, specifically 2D graphene oxide (GO), 1D carbon nanotube (CNT) and functional polymers (polyaniline: PANI) to enhance their functions further.

TNT and nanocarbon hybrids was synthesized via the alkaline-based solution chemical processes, where pristine CNT or GO was put into 10 M NaOH solutions together with TiO_2 raw powders, and reflexed at 110 °C for 24h to form TNTs in-situ. Unique “core-shell” hybrids were obtained for TNT-CNT system, where TNT covering CNT. When 2D GO was used, two-dimensional nanohybrids, where the TNTs aligned on the GO surfaces could be synthesized. Based on these unique low-dimensional morphologies, enhanced photocatalytic performances for TNT/CNT hybrids and excellent room-temperature gas sensing characteristics for TNT/GO respectively were achieved, due to dense nanoscale oxides-carbon interactions that accelerated carrier transport through the heterointerfaces.

Core-shell TNT/PANI could be synthesized by the “direct photo-induced polymerization” without the use of any polymerization initiators. TNT was mixed with aniline monomer in acidic solutuion, and ultraviolet (UV) light was irradiated to initiate polymelization owing to the active radicals generated on TNTs. Greenish-colored electrical conductive PANI was successfully formed on the TNT surfaces with a few nm in thickness. The hybrids showed photocatalytic properties under the visible-light irradiation. These facts imply that the self-photopolymerization route is proising way for fabricating 1D nanotubular core-shell hybrids with better functions. Detailed processing, structures, physicochemical and photochemical properties and their correlations for these 1D and 2D nanohybrids will be discussed.

July 14, 2026 | 2:20 PM

Upcycled photocatalysts from Sr-containing layered titanate sorbents

Prof Tomoyo Goto[1], Dr Yoshifumi Kondo[2], Prof Tohru Sekino[2]

[1]Nara Institute of Science and Technology, 8916-5 Takayama-cho, Japan, [2]The University of Osaka, 8-1 Mihogaoka,, Japan

Session 02 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 1:20 PM - 3:00 PM

Layered sodium titanates, which shows the ion-exchange and photocatalytic properties, is well known as one of the suitable inorganic sorbents and photocatalysts for environmental remediation and energy materials. Recently, we reported the synthesis of seaweed-like sodium titanate mat (SST) with unique sheet structure consisting of layered sodium dititanate nanofibers by a simple hydrothermal process. Therefore, this study focused on the properties of SST, which can introduce cations while maintaining an ordered structure through ion-exchange, and investigated the possibility of utilizing used SST sorbents as upcycled raw materials for functional materials. Specifically, Sr2+ containing SST was prepared by ion-exchange reaction, and simple heat treatments were performed at various temperatures. Then, the changes in the crystalline phase and morphology of the sample after treatment were investigated. Furthermore, its photocatalytic properties were evaluated using a hydrogen evolution reaction and investigated the effectiveness of using used SST as a raw material. This presentation will introduce the detailed research content and results.

July 14, 2026 | 2:40 PM

Photocatalytic Water Splitting Properties of (Ba,Sr)TiO3 Particles under Ultrasonic Irradiation

Dr. Miki Inada[1]

[1]Kyushu University, 744 Motooka, Nishi-ku, Japan

Session 02 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 1:20 PM - 3:00 PM

$BaTiO_3$ synthesized by conventional hydrothermal methods typically crystallizes in a cubic phase with an isotropic cuboidal morphology. In contrast, we have previously demonstrated that hydrothermal synthesis in ethyleneglycol–containing solvents yields rod-like $BaTiO_3$ particles with a stable tetragonal structure, originating from the stabilization of a metastable oxyhydroxide phase.

Detailed experimental and computational studies revealed that excess OH species incorporated at oxygen lattice sites play a key role in stabilizing the tetragonal lattice. Although hydroxyl groups are often regarded as structural defects, they were found to contribute positively to the formation of highly ordered perovskite frameworks through precursor-mediated phase transformation. These findings indicate that the controlled introduction of nonstoichiometric anionic species provides a powerful degree of freedom for crystal-structure engineering.

In the present work, this metastable-phase approach is extended to the synthesis of tetragonal $Ba_{1-x}Sr_xTiO_3$ solid-solution particles using Ba_{1-(1/2)y}TiO_{3-y}(OH)_y as a precursor. Emphasis is placed on clarifying the structural evolution induced by Sr incorporation and OH removal, as well as the resulting changes in crystallographic anisotropy. Phase purity, lattice distortion, and local structural symmetry were systematically analyzed using X-ray diffraction, electron microscopy, and spectroscopic techniques.

Furthermore, correlations between crystal structure, surface characteristics, and electronic properties were investigated in the context of photocatalytic water splitting. The influence of tetragonal distortion and compositional modulation on charge separation behavior and reaction activity is discussed. This study highlights the importance of metastable precursors and anisotropic structures for designing oxide materials with tailored physical and catalytic properties, relevant to low-dimensional and interface-dominated material systems.

July 14, 2026 | 3:30 PM

Atmospheric-Pressure Mist Chemical Vapor Deposition for Thin Film Growth

Prof. Tomohiro Yamaguchi[1], Prof. Hiroki Nagai, Prof. Takeyoshi Onuma, Prof. Tohru Honda

[1]Kogakuin University, 2665-1 Nakano-machi, Japan

Session 03 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 3:30 PM - 4:45 PM

Atmospheric-pressure mist chemical vapor deposition (MCVD) is a recently developed thin-film growth technique characterized by a simple experimental configuration. In this method, a metal complex is first dissolved in an aqueous solvent to form a precursor solution, which is then atomized using an ultrasonic transducer and transported into a furnace by a carrier gas. Thin films are deposited when the mist reaches the substrate, and epitaxial growth can be achieved by employing single-crystalline substrates. Owing to the use of aqueous solutions, MCVD is particularly advantageous for the fabrication of oxide films. Nevertheless, we have also successfully demonstrated the growth of nitride films.

In this talk, we introduce atmospheric-pressure MCVD for thin film growth, focusing on oxide and nitride materials such as Ga_2O_3, In_2O_3 and Cu_3N. We also discuss the potential of MCVD for the growth of two-dimensional (2D) materials.

2D covalent organic framework (COF) membranes

Dr. Jiangtao Liu[1]

[1]University of Science and Technology of China, No.96, JinZhai Road Baohe District, Hefei, Anhui, 230026, P.R.China., China

Session 03 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 3:30 PM - 4:45 PM

The increasing contamination of organic micropollutants in environmental and biological systems has become one of the most serious global challenges faced by humanity, posing significant threats to ecological balance, public health, and sustainable development. Compared with conventional absorbents, membrane technology exhibits remarkable merits, including high separation efficiency, low energy consumption, mild operation temperature, cost-effectiveness, and the absence of cross-contamination. Inspired by the magical nature that can construct sophisticated and smart functional systems through precise atomic-level assembly, researchers are committed to developing smart membranes by rationally assembling diverse building blocks in well-defined and controllable ways.

Covalent organic frameworks (COFs) are an emerging class of crystalline porous materials characterized by low density, high specific surface area, adjustable pore structure, and excellent physicochemical stability, which endow them with great potential in membrane separation. However, it remains a paramount and urgent challenge to fabricate smart 2D COF membranes with self-regulating pore apertures that can realize gradient separation of different substances. Herein, the ingenious design strategy proposed for 2D COF membranes not only endows traditional separation membranes with new vitality and fascination but also opens new perspectives and development directions for the field of separation science and technology.

Different from traditional membranes with fixed and immutable pore channels, the pore size of 2D COF membranes can be tuned by external stimuli such as pH or UV/Vis light irradiation. Consequently, the permeance and separation factor can be flexibly adjusted according to actual separation needs, achieving efficient and precise separation. The development of COF-based smart membranes with a periodic honeycomb lattice is expected to provide a promising solution for a wide variety of separation scenarios, including wastewater treatment (e.g., removal of organic micropollutants and heavy metal ions), purification of valuable drugs in pharmaceutical industry (such as vitamin or antibiotic refinement), oil extraction and purification in food industry.

Electrochemical water splitting for clean fuel production through nanoengineered materials

Professor Isabella Concina[1]

[1]Luleå University Of Technology, 97187 Luleå, Sweden

Session 03 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 3:30 PM - 4:45 PM

The production of clean fuels, such as H_2 and O_2, through electrochemical and photocatalytic water splitting is nowadays the subject of many investigations within the community of materials scientists: a search on the Web Of Science results in more than 75 000 papers published in last decade, testifying the worldwide engagement of scientists in this field.
However, the sluggish kinetics of oxygen evolution reaction is still the bottleneck for practical exploitations of water splitting, and further efforts are definitely needed to design systems featuring efficiency, long-term stability, and possibility of integration in real scenario devices.

This lecture presents and critically discusses some approaches recently explored by our research groups to engineer nanostructured composite materials for water splitting, such as core@shell Co_3O_4 nanoparticles@$NiMnO_4$ microrods, MoS_2 2D nanosheets, engineered Cu_2O surfaces.
We will discuss the successes and failures of these and other systems, in terms of materials-by-design strategies, H_2 generation, photostability, structural and morphological changes induced by bias application.
Emphasis will be given to current limitations and future perspectives of the field, with particular reference to the role of the scientific community in the so-called green transition.

Gradient-Controlled Growth of Two-Dimensional γ-InSe Thin Films for Enhanced Structural Quality and Phase Stability

Dr. Soe Min Htet1, Mr. Soe Min Htet1, Mr. Chun-Yu Kuo1, Dr. Sheng-Wei Hsiao2, Dr. Shen-Rui Jian3, Dr. Chao-An Jong4

1Tatung University, No.40, Sec. 3, Zhongshan N. Rd., Taiwan (R.O.C.), 2National Synchrotron Radiation Research Center, , Taiwan (R.O.C.), 3 I-Shou University , , Taiwan (R.O.C.), 4Taiwan Semiconductor Research Institute, National Institute of Applied Research, , Taiwan (R.O.C.)

Session 03 - S01: 2D Materials (2DM), Changi - Level 4, July 14, 2026, 3:30 PM - 4:45 PM

Two-dimensional (2D) layered γ-InSe thin films have emerged as promising materials for next-generation electronic, optoelectronic, and energy devices due to their unique structural anisotropy and tunable physical properties. However, achieving high crystalline quality, controlled phase formation, and low defect density remains a critical challenge, as thin film growth is highly sensitive to temperature distribution and kinetic processes during deposition. In this work, we propose a gradient-controlled growth strategy to improve the structural and phase quality of 2D thin films. By systematically varying the substrate temperature during deposition while maintaining controlled source conditions, a gradual transition from initial nucleation to subsequent crystal growth is achieved. The gradient ratio is controlled from 0.5 to 5.0 degree/min. This approach enables enhanced adatom mobility at later growth stages while preserving high nucleation density at the early stage, resulting in improved film continuity and uniformity. Comparative analysis with conventionally grown films demonstrates that gradient-grown samples exhibit significantly improved structural characteristics. Raman spectroscopy reveals sharper and more intense characteristic vibrational modes, indicating enhanced crystallinity and reduced disorder. X-ray diffraction further confirms improved phase purity and preferred orientation in gradient-grown films. The suppression of secondary phases and reduction in peak broadening suggest improved phase stability and minimized defect formation. The results highlight the effectiveness of thermal gradient engineering in controlling nucleation kinetics and growth dynamics in 2D materials. This scalable approach provides a versatile pathway for fabricating high-quality thin films with tailored structural properties, offering strong potential for integration into advanced electronic and optoelectronic applications.

July 15, 2026 | 10:50 AM

Nanowire solar cells and the need for their dimensional characterization

Phd Martin Foldyna[1]

[1]CNRS, LPICM, Ecole Polytechnique, France

Session 04 - S01: 2D Materials (2DM), Changi - Level 4, July 15, 2026, 10:50 AM - 12:40 PM

Nanowires have long been studied as highly promising candidates for very thin photovoltaic devices due to their efficient light trapping, reduced material usage, defect tolerance, and potential for multi-junction architectures. Research on nanowire solar cells has explored a variety of different materials, including Si, GaAs, InP, GaN, InGaN, and InAs. Studies indicate that thin-film solar cells based on nanowires can achieve significant energy conversion efficiencies, provide enhanced mechanical flexibility, and be integrated into solar modules using light scribing techniques.

Because the geometry of nanowire arrays - including length, diameter, and spatial arrangement- strongly influences device performance, there is a pressing need for reliable and practical methods to accurately characterize all critical geometrical parameters. Characterization techniques depend on both the device architecture and the fabrication method employed, and limitations in current approaches can hinder quantitative assessment.

In this talk, we introduce and discuss methods developed for the characterization of nanowire samples prepared via plasma-enhanced chemical vapor deposition, metal-assisted etching, and electron-beam lithography followed by etching. We will highlight the limitations of specific techniques and emphasize the importance of key geometrical parameters in determining device performance. The presented approaches aim to provide practical tools for systematic analysis, enabling more accurate correlations between nanowire geometry and photovoltaic efficiency.

Persistent Homology Analysis of AFM Images for Carrier Mobility Assessment in Graphene

Yuki Okigawa[1], Takatoshi Yamada

[1]National Institute of Advanced Industrial Science and Technology, Central 5, 1-1-1 Higashi, Japan

Session 04 - S01: 2D Materials (2DM), Changi - Level 4, July 15, 2026, 10:50 AM - 12:40 PM

It is essential to evaluate the electrical properties of graphene in the absence of field-effect transistor fabrication or electrical contact formation, in order to facilitate rapid process optimization and in-line inspection. As previously reported, strain information obtained from Raman 2D band shifts [1] and lock-in thermography images of graphene under Joule heating [2] can be utilized to assess graphene electrical properties.

In this study, the relationship between carrier mobility and the surface morphology of CVD graphene channels observed by AFM is investigated, with persistent homology analysis [3] being utilized for this purpose. The objective of this study is to identify morphology-derived descriptors that demonstrate a strong correlation with carrier mobility [4].

Single-layer CVD graphene grown on Cu foil was transferred onto HPHT-grown h-BN flakes or SiO2 substrates, followed by the fabrication of four-terminal devices to characterize electrical properties. AFM observations revealed characteristic surface features such as wrinkles and bubbles. The relationship between carrier mobility and conventional roughness parameters, including arithmetic mean roughness (Sa) and maximum height (Sz), was not found to be statistically significant.

In order to analysis more detailed morphological information from AFM images, the persistent homology was applied to the AFM height images. Zero-dimensional persistence diagrams were generated from grayscale representations of the AFM data, and topology-based descriptors focusing on the distribution of high-multiplicity points near the diagonal were analyzed. The persistent homology analysis indicates that subtle variations in graphene channel height undulations are closely related to enhanced carrier mobility in graphene.

References

[1] T. Yamada et al., AIP Adv. 10, 085309 (2020).

[2] H. Nakajima et al., Sci. Adv. 5, eaau3407 (2019).

[3] I. Obayashi et al., J. Phys. Soc. Jpn. 91, 091013 (2022).

[4] Y. Okigawa et al., Adv. Electron. Mater., 12, e00448 (2025).

July 15, 2026 | 11:30 AM

Thin Film Characterization by Imaging Ellipsometry

Shun Okano[1], Matthias Duwe[1], Sebastian Schaper[1], Arash Mirhamed[1], Peter Thiesen[1]
[1]Parksystems Gmbh., Stresemann Straße 30, Germany
Session 04 - S01: 2D Materials (2DM), Changi - Level 4, July 15, 2026, 10:50 AM - 12:40 PM

Ellipsometry is a widely used technique for the non-destructive and highly precise evaluation of thin film thickness and optical constants by analyzing changes in the polarization state of light reflected from a sample surface. Conventional ellipsometry offers exceptionally high resolution in both thickness and refractive index, with a theoretical thickness resolution as low as 0.01 nm, making it one of the most precise methods for thickness measurement. However, because measurements are performed at a single point, direct acquisition of spatial distributions across the sample surface is challenging.

In contrast, imaging ellipsometry enables visualization of two-dimensional distributions of film thickness and optical properties by simultaneously acquiring polarization responses across the field of view. While the measurable physical parameters are essentially the same as those obtained by conventional single-point ellipsometry, the acquisition of spatially resolved data significantly increases the amount of information, not only in terms of data density but also by enabling intuitive visual interpretation. This makes the technique particularly powerful for analyzing material properties and surface conditions. In addition to thickness measurement, it provides access to optical constants that can be correlated with material properties and surface conditions, enabling more comprehensive characterization of thin films. This capability allows evaluation of thickness inhomogeneity and local structural variations that are difficult to detect using conventional methods. Moreover, whereas the spatial resolution of conventional ellipsometry is limited by the spot size—typically several millimeters, or several tens of micrometers in high-resolution systems—imaging ellipsometry is independent of spot size. Instead, it is governed by the objective lens magnification and detector pixel size, enabling spatial resolution down to approximately 1 µm.

In this presentation, the principles and instrumentation of imaging ellipsometry are outlined, and applications are presented, with a focus on two-dimensional materials such as graphene, along with other examples.

July 15, 2026 | 11:50 AM

High-Frequency Tunable and Switchable Film Bulk Acoustic Wave Resonators Based on 2D multilayer α-In2Se3 Flakes

Dr. Jiayi Sun[1,2], Dr. Weifan Cai[3], Dr. Yang Yang[4], Mr. Yihao Zhuang[1,2], Prof. Dr. Qing Zhang[1,2]

[1]Centre for Micro-/Nano-electronics, School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, 638798, Singapore, [2]UMI 3288 CINTRA CNRS-NTU-THALES, Nanyang Technological University Research Techno Plaza, 50 Nanyang Drive, Singapore 637553, Singapore, [3]Institute of Materials Research and Engineering, Agency for Science, Technology and Research, 138634, Singapore, [4]Univ. Bordeaux, CNRS, Bordeaux INP, IMS UMR 5218, F33400, France

Session 04 - S01: 2D Materials (2DM), Changi - Level 4, July 15, 2026, 10:50 AM - 12:40 PM

Advanced multi-band radio frequency (RF) communication systems, including 5G and beyond, require adaptive components capable of real-time frequency tuning and switching. Traditional film bulk acoustic wave resonators (FBARs) based on conventional ferroelectric materials face significant performance degradation at submicron thicknesses due to acoustic wave scattering from surface defects and inconsistent crystal orientation. To address this, we investigate α-In2Se3 a 2D van der Waals layered material that exhibits stable room-temperature ferroelectricity and robust out-of-plane piezoelectricity, even at the atomically thin limit. Because these flakes can be physically exfoliated to achieve atomically flat surfaces (roughness < 0.5 nm), acoustic wave scattering is minimized, making the material highly suitable for next-generation, high-frequency FBARs. In this work, we present the first batch of tunable and switchable FBAR chips based on 2D α-In2Se3 flakes. We fabricated air-gap FBAR devices that demonstrate a high resonant frequency, representing the first tunable FBARs capable of functioning beyond the sub-6 GHz band. These devices operate normally in the on-state and can be completely switched off at a small bias. The physical mechanism driving this tunability and switchability is the electric-field modulation of the vertical dislocation between indium and selenium ion centers, which dynamically alters the out-of-plane piezoelectricity and internal strain of the α-In2Se3 domains. This study establishes 2D ferroelectric materials as highly promising candidates for advanced, multi-band RF communication systems.

July 15, 2026 | 12:05 PM

Engineering MoS2 Nanopores for Next-Gen 2D Membranes

Dr. Jie Shen[1]

[1]School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore, Singapore, [2]Singapore Membrane Technology Centre, Nanyang Environment and Water Research Institute, Nanyang Technological University, 1 Cleantech Loop, Singapore 637141, Singapore, Singapore

Session 04 - S01: 2D Materials (2DM), Changi - Level 4, July 15, 2026, 10:50 AM - 12:40 PM

Selective molecular transport through nanoporous membranes forms the basis of many important separation and purification processes (1–2). In principle, two-dimensional (2D) materials, such as graphene, are ideal for preparing high-performance separation membranes. This is because they are extremely thin, thereby maximizing the molecular transport efficiency in the presence of nanopores (3). However, it is difficult to generate nanopores with precise molecular dimensions on 2D materials, especially over large areas, as required for practical applications. Previous physical and chemical methods were used to create nanopores on 2D materials. However, these methods offer limited control of pore size and pore density. The obtained membranes typically have a nonuniform distribution of pore size, resulting in low permeability or poor selectivity when used for molecular separation (4). In this presentation, I will report that the well-defined eight-membered ring (8-MR) pores, typically formed at the boundaries of two antiparallel grains of monolayer molybdenum disulfide (MoS2), can serve as molecular sieves for efficient water-ion separation. The density of grain boundaries and, consequently, the number of 8-MR pores can be tuned by regulating the grain size. Optimized MoS2 membranes outperformed the state-of-the-art membranes in forward osmosis tests by demonstrating both ultrahigh water/sodium chloride selectivity and exceptional water permeance. Creating precise pore structures on atomically thin films through grain boundary engineering presents a promising route for producing membranes suitable for various applications.

References:

1. Science 356, eaab0530 (2017)
2. Nat. Nanotechnol. 15, 426–436 (2020)
3. Science 374, eabd7687 (2021)
4. Sci. Adv. 5, eaav1851 (2019)

SYMPOSIUM S1 | ABSTRACT #743

July 15, 2026 | Invited | 12:20 PM - 12:40 PM | Changi - Level 4

2D inorganic/organic material interfaces for optoexcitonics

Parag B. Deotare 123

1Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor
2Department of Physics, University of Michigan, Ann Arbor
3Quantum Research Institute, University of Michigan, Ann Arbor

Invited - S1: 2D Materials (2DM), Changi - Level 4

Understanding exciton dynamics in two-dimensional (2D) semiconductors, particularly transition metal dichalcogenides (TMDs), is essential for advancing room-temperature stable excitonic devices. In this talk, I will present our group's efforts on understanding exciton dynamics in TMDs and their interfaces with organic semiconductors. The results provide important insights into the synthesis of hybrid interfaces as well as the role of localized excitons in charge transfer processes, with implications for the development of quantum photonic circuits, energy-harvesting platforms, and next-generation optoelectronic devices.

Dielectric constant of strained monolayer MoS2

Prof. Shuo Deng[1]

[1]Wuhan University of Technology, NO. 122, Luoshi Road , China

Session 07 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 8:30 AM - 10:20 AM

Monolayer MoS2 exhibit a direct bandgap about 1.8 eV, which generates great potentials for it to be made into optoelectronic devices. In order to have a thorough understanding on opto-mechanical properties of monolayer MoS2, we investigate the dielectric constant of monolayer MoS2 versus the strains by first-principles simulation and surface plasmon resonance methods, respectively.

Our results suggest that the peak wavelength of the real and imaginary parts of dielectric constant are red-shift from compression to tensile strains. For the largest tensile strain, the amplitudes of both the real and imaginary parts are much higher, which demonstrates that a large number of inter-band transitions occur, corresponding to the concentrated band near the Fermi level. In addition, we also investigate the development of refractive index, extinction coefficient, reflectivity, and absorption coefficient of monolayer MoS2 versus the strain. Results reveal that the peak wavelengths of the refractive index, extinction coefficient, reflectivity and absorption coefficient also shift toward longer wavelengths from compression to tensile strains. This red-shift is almost uniform with the increasing strain value. Moreover, the peak amplitudes of the refractive index, extinction coefficient and reflectivity increase with the increase of the tensile deformation. However, the change of the absorption coefficient is the opposite to the refractive index, extinction coefficient and reflectivity.

These results indicate that the monolayer MoS2 will have great potential application in mechanical tunable optoelectronic devices.

July 16, 2026 | 8:50 AM

Rippled graphene pores as fluidic memristive devices with synaptic and neuromorphic functionalities

Professor Pengzhan Sun[1]

[1]University of Macau, , Macao

Session 07 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 8:30 AM - 10:20 AM

Nanofluidic memristive devices work with nanoscale pores (or channels) and ions dissolved in water, which harness the ionic memory effect aiming to store and process information. These devices share the same charge carriers as biological systems and bring hope for better emulating the neural functions and developing ionic circuits for neuromorphic applications. Specially, theory and experiments suggest that nanoconfinement is essential for inducing a memory effect, which places limit on the pore size to nm-scale or smaller. Such devices are difficult to scale up with precision and operate with long-term stability. In this talk, I will present research showing that a micrometer size pore, generally expected to exhibit a linear ion transport, can display a pronounced memory effect, if its rim is wrapped by strongly curved and tightly stacked graphene. We attribute the observation to slow ion dynamics confined in the rippled graphene edges. The devices are easy to scale up and integrate into fluidic circuits. The memory effect is ion-selective and, crucially, exhibits long endurance comparable to the lifetime of synaptic proteins, which enables reversible modification of the conductance states using programmable voltage spikes and various electrolytes over a long time, akin to biological synaptic plasticity. Thanks to this plasticity, our devices and their integrated circuits enable storing, transmitting and processing information with exceptionally high reliability, fidelity and accuracy. Our results highlight nanoscale morphology of the pore wall as an important parameter regulating ion transport, in addition to the well-documented pore's charge and size, and indicate that the stringent nanoconfinement for ionic memory can be lifted from restricting the pore size to designing its rim structure. The devices and their integrated circuits may find use in ionic neuromorphic applications.

July 16, 2026 | 9:10 AM

Realization of a 2D Tungsten Disulfide (WS_2) Diode Probe for Nanoscale Surface Temperature Sensing in MEMS/IC Chips

Dr Chih-Cheng Lu[1], Dr. Jeff Tsung-Hui Tsai[2], Mr Sirui Chen[3], Mr Kuan-Lung Su[4]
[1]National Taipei University of Technology, 1, Chung-Hsiao E. Rd.,, Taiwan, [2]National Taiwan Ocean University, , Taiwan, [3]National Taipei University of Technology, 1, Chung-Hsiao E. Rd.,, Taiwan, [4]National Taiwan Ocean University, , Taiwan

Session 07 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 8:30 AM - 10:20 AM

This study presents a point-contact diode probe based on a self-fabricated two-dimensional tungsten disulfide (WS_2) nanomaterial. The proposed probe is designed for sub-microscale surface temperature sensing in MEMS/IC chips, addressing a critical challenge for conventional thermal measurement techniques. Leveraging the temperature-dependent characteristics of the WS_2 diode, the probe enables nanoscale thermal sensing at localized regions on the chip surface. Furthermore, the measured data can be utilized to infer microscale heat transfer effects, allowing estimation of the actual temperature and power consumption of underlying nanoscale components. This capability may facilitate validation of the design specifications of IC circuits or MEMS devices. Experimental results show strong agreement with calibration data from the infrared (IR) camera, thus confirming the reliability of the WS_2-based diode sensor. The proposed approach demonstrates significant potential for high-precision thermal sensing, offering an accurate and flexible alternative to conventional on-chip CMOS sensors and other thermal imaging techniques.

July 16, 2026 | 9:30 AM

Electrostatically gated graphene nanofluidic membranes for enhanced thermoelectric and mechanoelectric conversion

Dr. Yahui Xue[1]

[1]Southen University Of Science And Technology, Xueyuan Avenue 1088, China

Session 07 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 8:30 AM - 10:20 AM

Biological ion channels rely on ultrafast and selective ion transport through atomic-scale filters to enable the human to sensitively detect thermal and mechanical stimuli from the ambient environment. However, the quest of artificial structures to mimic biological systems to realize comparable thermoelectric and mechanoelectric conversion efficiency has been hindered in achieving simultaneous ion selectivity, fast transport, and electrical gating at atomic scale. We will show that graphene nanofluidic membranes with channel size around 3 angstroms can achieve simultaneously ultrafast and highly selective ion transport controlled by electrostatic gating. The underlying mechanism is attributed to the highly dense packing of ions and their concerted movement inside the graphene channels. Inspired by biological ion channels, boosted thermoelectric and mechanoelectric responses in voltage-gated graphene nanofluidic membranes will also be discussed. The findings here pave the way for the development of high-performance nanofiltration membranes for low-grade thermal and mechanical energy harvesting.

July 16, 2026 | 9:50 AM

Defect and Strain Engineered Room-Temperature Ferromagnetism in Few-Layered MoS2 Films

Dr. Aswin kumar Anbalagan[1,2], Prof. Yu-Lun Chueh[3], Prof. Sheng-Yun Wu[4], Prof. Hsin-Yi Tiffany Chen[2,3], Dr. Andrew L. Walter[1], Prof. Chih-Hao Lee[2]

[1]National Synchrotron Light Source II, Brookhaven National Laboratory, Upton, United States, [2]Department of Engineering and System Science, National Tsing Hua University, , Taiwan, [3]Department of Materials Science and Engineering, National Tsing Hua University, , Taiwan, [4]Department of Physics, National Dong Hwa University, , Taiwan

Session 07 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 8:30 AM - 10:20 AM

Two-dimensional transition metal dichalcogenides (TMDs) offer a promising materials platform for spintronic technologies due to their strong spin-orbit coupling and tunable electronic structure; however, realizing stable room-temperature ferromagnetism remains a key challenge. Here, we demonstrate three complementary routes to induce robust ferromagnetism in sputtered few-layered MoS2 thin films through strain engineering, rare-earth magnetic doping, and defect engineering through gamma-ray irradiation. Structural and spectroscopic characterization (such as XRD, HRTEM, Raman, and XPS) confirms preservation of layered crystallinity alongside controlled lattice distortion and defect formation. Magnetic measurements such as SQUID and VSM reveal persistent ferromagnetic ordering well above room temperature across all engineered systems. Strain-induced lattice modification enhances exchange interactions through altered orbital hybridization, while Gd incorporation introduces localized magnetic moments coupled via bound magnetic polaron formation. Raman spectroscopy shows pronounced phonon linewidth evolution and signatures of spin-phonon coupling, supporting defect-mediated magnetic ordering mechanisms. Furthermore, gamma-ray irradiation generates controlled defect states that promote carrier localization and strengthen magnetic exchange without secondary phase formation.

These results establish a unified framework linking lattice strain, defects, and spin interactions in MoS2, demonstrating scalable pathways toward dilute magnetic 2D semiconductors and highlighting their potential for future spin-based electronic and quantum-functional devices.

Choices of Gas Phase Precursors for 2D Materials

Kalaiarasan Meganathan[1], Prof. Zdeněk Sofer[1], Prof Senthil Kumar Eswaran[2]
[1]Department of Inorganic Chemistry, University Of Chemistry And Technology, Technická 5, 166 28 , Czech Republic, [2]Department of Physics and Technology, SRM Insitute of Science and Technology, Chennai, SRM Nagar, Potheri, Chennai, India
Session 07 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 8:30 AM - 10:20 AM

Artificial Intelligence (AI) expansion requires more fast devices, memory devices, latency less devices, low power devices, low thermal dissipating devices both in electrical and optical devices. AI requires extraordinary and cheaper devices and long-lasting devices with zero failure are required. Current semiconductor industry has bottlenecks in Moore's law, low standby current and various other issues, which could not be sustainable for future. This pushes other materials to be replace the current silicon semiconductor technology, which provides the low short channel current, fast switching speed and subthreshold swing current. Above mentioned electronic characteristics of a material. Looking into exotic material, scientists found new avenues of the materials, i.e., 2D materials, which can take over the current semiconductor industry from where current silicon semiconductors break out.

As future electronics, heavily depends on the 2D materials, it's important to have desired form, which semiconductor industries are requiring. Thin films are the best performing form in the semiconductor industry. Obtaining 2D materials in the thin film form with desired thickness, requiring bottom-up approach, which is consists of chemical vapor deposition (CVD), atomic layer deposition (ALD) and molecular beam epitaxy. Among these thin film synthesis route, MOCVD and ALD is using bubbler precursor outside the growth chamber to have more precious control then other counterparts. In this talk, we will demonstrate that influence of growth conditions in the flake size, continuous film, quality of the film of the 2D material with case of MoS2 and WS2. With this narrow window the growth conditions for the specific precursors allowed us to establish reproducible growth condition for desired 2D materials.

Thin Films Meet Photonics: Nanostructured Optical Fiber Platforms for Ultra-Sensitive Gas Detection

BOON HOONG ONG[1]

[1]University of Malaya, Nanotechnology and Catalysis Research Centre, Malaysia

Session 08 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 10:45 AM - 12:30 PM

Advances in thin-film science are increasingly driven by the ability to precisely engineer structure–property relationships at the nanoscale, enabling new functionalities beyond conventional planar devices. In this context, this talk explores the synthesis and functional integration of nanostructured metal oxide thin films, such as MoO_3, ZnO, and MnO_2, on non-planar photonic substrates, specifically tapered optical fibers, for high-performance gas sensing applications. Scalable deposition approaches, including chemical bath deposition and controlled nanogranule growth, are employed to tailor film morphology, crystallinity, and surface chemistry. Particular emphasis is placed on Pd-functionalization, which introduces catalytic activity and promotes efficient gas–surface interactions. These structural and compositional modifications directly influence optical transduction via evanescent field coupling, providing a sensitive probe of surface adsorption phenomena. The interplay between thin-film architecture and optical field confinement enables significant enhancement in sensing performance, including rapid response, improved sensitivity, and operation at or near room temperature for gases such as hydrogen and ammonia. Mechanistic insights into adsorption kinetics, charge transfer, and catalytic dissociation are discussed to establish clear correlations between processing conditions, film nanostructure, and functional response. Importantly, this work addresses key challenges in extending thin-film technologies to curved and miniaturized platforms, including uniform coating, adhesion, and long-term stability. By bridging thin-film materials engineering with photonic device integration, the presented approach highlights a versatile pathway toward next-generation functional thin films for sensing and beyond, aligned with emerging demands in energy, environmental monitoring, and smart infrastructure.

July 16, 2026 | 11:05 AM

Biosensing membrane for dynamic blood separation and monitoring

Prof. Zhenyu Chu[1]

[1]Nanjing Tech University, 30 South Puzhu Road, China

Session 08 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 10:45 AM - 12:30 PM

Dynamic and on-site analysis of serum from human blood is crucial especially for making decisions during clinical surgery and emergency treatments. However, state-of-the-art blood assay methods can only collect single or discrete data of physiological analytes; thus, remaining a great challenge in the online reports of the dynamic fluctuation of key analytes. In order to address above issue, we have proposed a new-concept membrane to integrate principles of membrane separation and electrochemical biosensor together, achieving the serum collection and analysis from whole blood simultaneously. Relying on our developed various methods of nanostructure control, the membrane material can be exactly built to form porous separation layer and electroanalytic biosensing layer which realizes the blood sieving and key indices detection. This membrane achieved accurate and online glucose and lactate monitoring in patients with a variety of medical conditions within 1 min, which is one order of magnitude faster than the state-of-the-art techniques. Furthermore, this technique has been successfully transferred to commercial products which have already been applied in more than 10 fermentation companies.

July 16, 2026 | 11:25 AM

Angstrofluidics in 2D MoS2 Multichannels

Prof Hyung Gyu Park[1]

[1]POSTECH, Cheongam-ro 77, Nam-gu, South Korea

Session 08 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 10:45 AM - 12:30 PM

A single-angstrom-scale space provides a fundamental basis for the efficacy and efficiency of transmembrane protein channels, thereby creating a prime area of study in nanofluidics. We present the kinetics of water and ions in a two-dimensional (2D) molybdenum disulfide multichannel with a height of 3.1 Å. Water in tight 2D confinement can crystallize and exhibit structure-induced dynamics. Although the angstrom-level entrance incurs a severe energy penalty, such as dehydration, the surface charge enables ion passage, exhibiting a Hillian isotherm similar to that observed in biochannels. Our findings on molecular conduction in a 2D confined environment reveal new insights and the potential that Angstrofluidics promises to unlock.

Center-concave 2D nanosheets based handheld microchip-devices for ultrasensitive lysine determination

Huaiyu Song[1]

[1]Nanjing Tech University, No.30 Puzhu South Road, Nanjing, Jiangsu, China

Session 08 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 10:45 AM - 12:30 PM

Lysine is an essential amino acid for the human body, and its imbalance is a major cause of anemia, the aging process, leukemia cell proliferation, and tumor growth. Therefore, monitoring lysine levels is crucial for preventing disease progression and guiding clinical treatment. However, traditional in-hospital detection methods, such as colorimetry and fluorometry, often suffer from high costs and long turnaround times. These drawbacks pose difficulties for home-based and daily monitoring of lysine regulation in the body.

In this presentation, we propose an ultrasensitive microchip-based portable device that enables on-site and precise determination of lysine within just 10 seconds. The microchip was functionalized by constructing a center-concave nanosheet with a core–shell structure of WO_3@Prussian blue (WO_3@PB), which significantly enhances the generation and transfer of the detection signal. In this unique architecture, the core WO_3 nanosheet is exposed at the center region of the nanocomposite, effectively promoting enzymatic oxidation, while the PB shell enables strong reduction of the H_2O_2 produced by the enzymatic reaction. Leveraging these synergistic effects, we designed a handheld device that supports the plug-and-play microchip, achieving outstanding accuracy for lysine detection in blood.

July 16, 2026 | 12:00 PM

Medium and high entropy alloy coatings fabricated by co-sputter deposition of common engineering alloys

Jhen-De You[1], Shih-Yung Tsai[2], **Dr. Pak-Man Yiu**[1,3]

[1]Ming Chi University Of Technology, 84 Gungjuan Rd., Taishan Dist., Taiwan, [2]National Taiwan University of Science and Technology, No. 43, Sec. 4, Keelung Rd., Da'an Dist., Taiwan, [3]Center for Plasma and Thin Film Technologies, 84 Gungjuan Rd., Taishan Dist., Taiwan

Session 08 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 10:45 AM - 12:30 PM

High-entropy alloys (HEAs) are promising in protective coatings applications owing to their hardness, strength, and resistance to corrosion etc. However, popular high performance HEAs, such as FeCrMnNiCo and AlCoCrCuFeNi, are difficult to deposit by magnetron sputtering due to their complex chemical composition. The high cost and low utility rate of using hot isostatic, powder pressed sputtering taret is a big challenge in large-scale industrial applications. Therefore in our work, we chose inconel 718, which has a chemical composition closely resembles an HEA, as a subject of study. In the two attempts, we co-sputtered inconel 718 with Ti-6Al-4V or Pure Fe target to deposit a HEA/MEA coating. All these targets were cut from commercially available stock materials. At optimal composition, resultant coatings may exhibit excellent wear resistance ($K_0 < 3x10^{-4}$), High hardness (~9 GPa) and low friction coefficient (COF < 0.1).

July 16, 2026 | 12:15 PM

Asymmetric spin valve based on Fe3GaTe2/Fe3GaTe2 via the synergy of the anomalous Hall effect and spin-dependent scattering

Ms. Zhuoqing Gao[1], Prof. Xiaozhi Wang[1]
[1]Zhejiang University, ,

Session 08 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 10:45 AM - 12:30 PM

Two-dimensional ferromagnetic van der Waals heterostructures provide a promising platform for spintronic devices with tailorable interfacial transport. Here, we report tunable multi-state magnetoresistance (MR) in Fe3GaTe2/Fe3GaTe2 van der Waals junctions. Unlike conventional spin valves that usually exhibit only two resistance states, these junctions show multiple MR states arising from the coexistence of asymmetric and symmetric MR components. We attribute the asymmetric component to an anomalous-Hall-effect-induced loop current formed in the antiparallel magnetic configuration, where opposite transverse charge distributions in the two ferromagnetic electrodes generate an additional potential drop during readout. The symmetric component originates from spin-dependent scattering across the interface. By modulating the interfacial barrier height, the relative contributions of these two components can be continuously tuned, enabling controllable resistance-state evolution in a single device platform. Our results reveal an effective route to engineer multi-level spin transport in 2D magnetic junctions and highlight the potential of van der Waals interface design for high-density spintronic memory and other reconfigurable magnetic devices.

July 16, 2026 | 1:30 PM

Accurate controlling of the transport channels in 2D nanosheet membranes for efficient H2 purification

Yanying Wei[1]

[1]South China University of Technology, , China

Session 09 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 1:30 PM - 2:55 PM

Hydrogen is widely regarded as one of the most promising next-generation energy sources for reducing carbon emissions. However, H2 production is often accompanied by CO2, which poses a major challenge for efficient hydrogen purification. Developing green and energy-efficient separation technologies, particularly membrane-based processes, is therefore of great importance for hydrogen utilization and carbon-neutral development. Nevertheless, conventional polymer membranes are limited by the trade-off between permeability and selectivity. Two-dimensional nanosheet membranes, with atomic thickness and tunable in-plane and interlayer channels, provide a promising platform for high-performance H2 purification. However, precise control over their transport channels and understanding its influence on separation performance remains unrevealed and challenging. Here, we systematically investigate the precise regulation of transport pathways in two-dimensional (2D) nanosheet membranes through solvent droplet dynamic control, linker polarity tuning and the construction of uniformly distributed in-plane nanopores. Among these strategies, solvent droplet dynamic control effectively regulates the stacking of 2D metal-organic framework (MOF) nanosheets, where the dynamic behavior of solvent droplets at different drop-coating temperatures promotes mixed AA/AB stacking and thereby broadens gas transport pathways. More importantly, beyond tuning AA/AB stacking, linker polarity is proposed for accurately continuous regulation of stacking mode of MOF nanosheets. Higher linker polarity increases steric hindrance between neighboring nanosheets and promotes them toward a maximum AB stacking, leading to a controlled effective pore size of the membrane and consequently to improved H2 molecular sieving. Beyond 2D nanosheets with intrinsic in-plane pores, originally nonporous MXene nanosheets are engineered by O3 treatment to construct controllable in-plane nanopores, allowing precise balancing of in-plane and interlayer sieving channels for efficient H2/CO2 separation. These works represent an in-depth investigation into the precise regulation of transport channels in 2D nanosheet membranes and establish general strategies for the rational design of high-performance H2 purification membranes.

Interplay of Dehydration and Electronic Polarization Governs Ion Transport through Carbon Nanopores

Prof. Rahul Prasanna Misra[1]

[1]National University Of Singapore, Department of Chemical and Biomolecular Engineering, 4 Engineering Drive, #02-09 Blk E5, Singapore 117585, Singapore

Session 09 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 1:30 PM - 2:55 PM

Understanding salt ion transport through narrow channels is crucial for the rational design of nanoscale devices and membranes for applications such as energy storage and seawater desalination. It is commonly assumed that ion transport through uncharged pores is governed primarily by dehydration, where ions shed part of their hydration shell, making narrow pores unfavorable for permeation under strong confinement.

In this work, we employ polarizable force fields derived from quantum chemical simulations to investigate sodium (Na^+) ion transport through carbon nanotubes (CNTs) and graphene nanopores of comparable size using molecular dynamics (MD) simulations. Our approach explicitly accounts for the salt ion electric field–induced electronic polarization of the carbon atoms in both systems. We find that the screening of the ion's electric field by water differs markedly between CNTs and graphene nanopores. In CNTs, weaker screening leads to strong ion–CNT polarization interactions which offset the dehydration penalty, enabling ion permeation even in sub-nanometer pores. In contrast, graphene nanopores exhibit stronger screening by interfacial water on the basal plane of graphene, enhancing dehydration effects and promoting salt rejection. These results reveal that ion transport is governed not only by pore size but also by confinement geometry and dimensionality, which control the interplay between dehydration and polarization. Overall, this study provides molecular-level design rules for tuning ion transport in next-generation nanofluidic membranes.

Keywords | Nanofluidics; Simulations; Graphene Nanopores; Carbon Nanotubes; Electronic Polarization; Ion Dehydration

July 16, 2026 | 2:10 PM

Bioinspired Multi-modal Electronic Skin Based on Thin-Film Organic Electrochemical Transistors

Mr. Tianyi Ji[1], Mr. Yongsheng Liu[2], Mr. Chenhong Zhang[2], Mr. Wei Gong[2], Mr. Yuqing Tian[2], Mr. Jie Gu[2], Mr. Wenjie Zhao[2], Prof. Kerui Li[2], Prof. Qinghong Zhang[2], Prof. Yaogang Li[2], Prof. Chengyi Hou[2], Prof. Hongzhi Wang[2], Prof. Qing Zhang[1], Mr. Jiayi Sun[1]
[1]Nanyang Technological University, 50 Nanyang Avenue, Singapore, [2]Donghua University, 2999 North Renmin Road, Songjiang District, China
Session 09 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 1:30 PM - 2:55 PM

Future humanoid robotics and smart wearable systems have a demand on highly integrated electronic skins capable of multi-modal perception and efficient signal processing within a flexible form factor. Traditional e-skin architectures often encounter struggle with the mismatch between high-impedance self-powered sensors and the driving requirements of signal processing modules, or they rely on rigid silicon-based electronics that compromise mechanical compatibility with biological tissues. In this work, we present a bioinspired, fully flexible thin-film system that integrates a PVDF-TrFE dual-mode triboelectric/pyroelectric sensor with an array of organic electrochemical transistors (OECTs). By engineering the channel material through the incorporation of graphene into poly(benzimidazobenzophenanthroline) (BBL) thin films, we successfully modulate the thin-film's electronic energy levels and ion-electron coupling efficiency. This optimization significantly reduces the threshold voltage and accelerates the response time, enabling the direct processing of transient, weak analog signals from the thin-film sensors into stable digital outputs. The system leverages the flexibility of PET thin-film substrates and a double-network hydrogel electrolyte to maintain high performance under repeated mechanical deformation. Furthermore, we demonstrate logic-level decoupling of tactile and thermal stimuli by utilizing OECT thin-film devices with differentiated threshold voltages. This device-level discrimination allows the e-skin to function as a self-contained platform without the need for external silicon-based circuitry. This study establishes a robust strategy for developing next-generation, bio-compatible thin-film electronics with complex sensing and analysis functionalities.

Bifunctional CuS/rGO separation-sensing membrane for online monitoring of whole-blood lactate

Shaoqi Zhang[1]

[1]State Key Laboratory Of Materials-oriented Chemical Engineering, College Of Chemical Engineering, Nanjing Tech Universit, , China

Session 09 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 1:30 PM - 2:55 PM

Abstract: Lactate monitoring plays a critical role in evaluating metabolic homeostasis and predicting life-threatening clinical conditions, particularly under acute pathological states. For instance, in septic shock, blood lactate levels exceeding 2.2 mM are closely associated with metabolic acidosis and multiple organ failure. At present, lactate detection primarily relies on clinical instruments such as biochemical analyzers and immunoassay systems. However, these platforms involve complex procedures including whole blood collection, separation, and analysis, and are characterized by bulky instrumentation and prolonged detection cycles. As a result, they can only provide discrete and delayed data, which fails to reflect the dynamic physiological status of patients in real time. Furthermore, the separation between blood processing and analytical procedures, together with the limitations of existing devices, constitutes a major bottleneck for achieving continuous lactate monitoring in operating rooms and intensive care units.

In this work, a bifunctional separation-sensing membrane is proposed to integrate whole blood filtration with biosensing functionality, enabling online lactate monitoring during surgical procedures and intensive care. The membrane features a heterogeneous three-dimensional architecture, consisting of a reduced graphene oxide layer on the surface and CuS nanosheet layers within the internal channels. Under vacuum-driven conditions, blood cells and fibrinogen are effectively excluded by the reduced graphene oxide layer, allowing only serum to penetrate into the internal channels. Meanwhile, lactate molecules in the serum are rapidly recognized and accurately quantified through the electrocatalytic activity of CuS nanosheets. The membrane exhibits excellent cytocompatibility and electrochemical stability, ensuring high detection accuracy while preventing cellular damage. Validation using patient blood samples demonstrates that this membrane enables real-time lactate monitoring in whole blood without any pre-treatment.

Keywords: Blood separation; Lactate detection; Separation sensing; Dynamic monitoring

July 16, 2026 | 2:40 PM

Interlayer Engineering of MXene Nanofiltration Membranes via Cyclodextrin Crosslinking for Stable and Selective Ion Transport

Ms. YANAN Li[1], Mr. Junzhi Li[2], Professor Yibin Wei[2], Associate Professor Jie Shen[1]
[1]Nanyang Technological University, Nanyang Technological University, Singapore, [2]Ningxia University, , China
Session 09 - S01: 2D Materials (2DM), Changi - Level 4, July 16, 2026, 1:30 PM - 2:55 PM

Selective separation of monovalent and divalent ions is crucial for desalination and water purification, but remains challenging because high permeability, ion selectivity, and structural stability are difficult to achieve simultaneously in conventional nanofiltration membranes. Two-dimensional Ti_3C_2Tx MXene membranes are attractive for ion sieving owing to their lamellar structure and fast transport channels, yet their practical performance is often restricted by swelling in aqueous environments and insufficient ion selectivity.

In this work, a cyclodextrin-crosslinked MXene membrane was constructed through a TMC-assisted interfacial molecular engineering strategy. Cyclodextrin molecules were introduced into the interlayer of Ti_3C_2Tx MXene nanosheets, and a polyester network was further formed by reaction with TMC, yielding stabilized lamellar nanochannels. This crosslinked structure suppressed interlayer swelling, improved membrane stability, and provided a more favorable microenvironment for ion transport.

Theoretical calculations and molecular dynamics simulations further indicate that the polyester-crosslinked interlayer structure is energetically feasible and that divalent ions experience a much higher dehydration barrier than monovalent ions during transport. As a result, the membrane achieves enhanced mono-/divalent ion separation through the combined effects of steric confinement, Donnan exclusion, and dehydration-energy regulation. This work offers an effective strategy for designing high-performance two-dimensional nanofiltration membranes for desalination and selective ion transport.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Unveiling LiF-Driven Schottky Hybrid Architecture: Ti3C2Tx/ZnO for Ultrasensitive and Selective NH3 Detection at Ambient Temperature

Ms Gowri Shonali N[1], Dr Veera Prabu K[2], Dr Sridharan M[1,3]

[1]Functional Nanomaterials & Devices Lab, Centre for Nanotechnology & Advanced Biomaterials, School of Electrical & Electronics Engineering , SASTRA Deemed to be University,, India, [2]Department of Metallurgical and Materials Engineering, Indian Institute of Technology,, India, [3]School of Arts, Sciences, Humanities & Education, SASTRA Deemed to be University,, India

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The development of ammonia (NH3) sensors to apparent high selectivity and sensitivity, ability of detecting sub ppm concentrations, is foremost for mitigating workplace dangers, ecological concerns, and medical difficulties. However, MXene (Ti3C2Tx) based sensors often encounter characteristics limitations due to persisting Al impurities originating from the MAX (Ti3AlC2) phase, which impede charge transport and reduce surface reactivity. In this study, we fabricated a high-performance of Ti3C2Tx/ZnO hybrid sensor via novel LiF–HCl assisted Minimally Intensive Layer Delamination (MILD) etching strategy, avoiding the need for hazardous HF. Optimization of the LiF concentration improved surface functionalization, and yielded high-purity, entire delaminated Ti3C2Tx nanosheets with plenty of active area for gas interaction and redox process. A Ti3C2Tx/ZnO was fabricated via DC reactive magnetron sputtering and drop-casting, promoting a Schottky junction to access charge transfer. The resultant L3-Ti3C2Tx/ZnO sensor indicated a 50-fold augmented in NH3 sensitivity, a 4.5-fold rapidity in response at 5 ppm compared to pristine ZnO, and an ultra-low detection threshold of 0.1 ppm (4.52 ± 1.1). It indicated fast response (44 s) and recovery (26 s) periods, high selectivity, good reliability over 60 days, and strong resistance to humidity variations at 300 K. The remarkable sensing feature was ascribed to the synergistic interaction, elevated charge disruption, surface redox linkages at the interface, and hastened adsorption–desorption rates. The L3-Ti3C2Tx/ZnO hybrid Schottky junction that has been suggested represents a major breakthrough in environmental monitoring, industrial safety, and hazardous gas screening.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

HYBRID COMPOSITE ELECTRODES BASED ON TI_3C_2 TWO-DIMENSIONAL MATERIALS FOR SMART SOFT SYSTEMS

Syed Sheraz Ali[1]

[1]King Fahd University of Petroleum & Minerals (KFUPM), , Saudi Arabia

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Hybrid composite materials incorporating two-dimensional (2D) structures are emerging as key enablers for smart and adaptive material systems. In this work, a Ti_3C_2-based hybrid composite electrode is developed using a green and environmentally friendly synthesis route, avoiding hazardous chemical treatments typically associated with 2D material processing. The hybrid architecture integrates layered Ti_3C_2 with a metallic component as shown in figure 1 (a), resulting in a multifunctional composite that combines electrical conductivity, surface activity, and mechanical integrity. Structural and morphological characterization confirms the formation of an interconnected hybrid network with improved interfacial interactions. When employed in soft electroactive systems, the hybrid composite exhibits stable electrical response and repeatable deformation behavior under low-voltage operation (≈1 V), delivering a displacement on the order of ~10 mm. These results demonstrate the potential of green-processed Ti_3C_2 hybrid composites for smart materials, soft actuators, and next-generation functional devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Broadband Photodetector Based on Bismuth Telluride/p-Type Silicon Nanowire Array Heterostructures

Hsun Feng Hsu[1], Yong Da Zeng[1]

[1]National Chung Hsing University, 145 Xingda Rd., Taiwan

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Bismuth telluride (Bi_2Te_3) and silicon nanowires (SiNWs) offer significant advantages for optoelectronic applications. Bi_2Te_3 is an excellent thermoelectric material and topological insulator with a bandgap of 0.24 eV, exhibiting outstanding photoelectric properties, particularly high sensitivity in the infrared region. SiNWs possess a high specific surface area and excellent electronic transport properties, making them highly effective for photoconversion and light-trapping applications. In this study, the advantages of these two materials were combined to fabricate a Bi_2Te_3/SiNWs heterostructure aimed at achieving broadband photodetection performance from visible to mid-infrared wavelengths.

Silicon nanowire (SiNW) arrays were first prepared using metal-assisted chemical etching, followed by the growth of Bi_2Te_3 nanosheets via chemical vapor deposition (CVD). The optoelectronic performance of the devices was evaluated in terms of photocurrent, sensitivity, and responsivity at wavelengths of 660 nm, 940 nm, 1300 nm, and 5500 nm. The I–V and I–T characteristics were measured to analyze the current response under illumination at different wavelengths.

The results demonstrate that the Bi_2Te_3 nanosheet/SiNWs heterostructure broadband photodetector exhibits a rapid response across the visible to mid-infrared spectral range (660–5500 nm). With increasing deposition of Bi_2Te_3 nanosheets on silicon nanowires, the photocurrent under visible and near-infrared illumination (660 and 940 nm) gradually decreases, which is likely attributed to the increased optical reflectance induced by the higher coverage of Bi_2Te_3 nanosheets. In contrast, under infrared illumination at 1300 and 5500 nm, the photocurrent increases with increasing Bi_2Te_3 nanosheet coverage, suggesting enhanced photon absorption in this wavelength region. This study provides an important theoretical basis and technical support for the further development of broadband photodetector technologies.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Bi2Te3/SiNWs Heterostructures Fabricated via Pulsed Electrophoretic Deposition for Broadband Photodetectors

Min Huang Chang[1], Qi Yue Fu[1], Chih Hsun Lu[1], Hsun Feng Hsu[1]
[1]National Chung Hsing University, 145 Xingda Rd., South Dist., Taiwan
Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Topological insulator bismuth telluride (Bi_2Te_3), characterized by its narrow bandgap and high carrier mobility, together with silicon nanowire (SiNW) arrays featuring strong light absorption capability, provides a promising platform for constructing broadband and fast-response heterostructure devices. In this study, Bi_2Te_3 nanosheets with an average diameter of approximately 500 nm were synthesized via a hydrothermal method. An electrophoretic deposition (EPD) suspension was prepared using acetone as the solvent and triethanolamine (TEA) as a dispersant. An optimized EPD process was subsequently developed to deposit Bi_2Te_3 nanosheets onto SiNWs, resulting in a uniform thin-film coverage.

The results indicate that the SiNW array structure exhibits a pronounced tip-field effect, which directs nanosheets to preferentially attach to nanowire tips, yielding significantly improved film uniformity compared to planar substrates. To mitigate the electric field concentration at sample edges (edge effect), pulsed-voltage modulation was employed. The voltage off-period facilitated particle redistribution, effectively suppressing excessive deposition at edge regions. Consequently, a uniform and continuous Bi_2Te_3 thin film with a thickness below 100 nm was successfully fabricated over large-area SiNW arrays. The fabricated Bi_2Te_3 thin film/SiNW arrays heterostructure demonstrates the feasibility of developing broadband photodetectors with fast response characteristics, providing a promising approach for high-performance optoelectronic device applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

PMAA-FUNCTIONALIZED Ti3C2Tx MXENE THIN FILM FOR INTERFACIAL ENGINEERING AND DISPERSION STABILIZATION

THEJA SREE K[1]

[1]Sri Sairam Engineering College, West Tambaram, Chennai., Sai Leo Nagar, Poonthandalam Village, Dharkast Post, West Tambaram, Chennai - 600044, India

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Two-dimensional Ti3C2Tx MXene has attracted significant attention for thin-film and interfacial engineering applications owing to its high surface area, layered structure and tunable surface terminations. However, strong intersheet interactions often lead to aggregation and restacking, which hinder uniform film formation and limit processability. In this work, poly(methacrylic acid) (PMAA), a carboxyl-rich polymer, is employed as an interfacial modifier to fabricate PMAA-functionalized Ti3C2Tx hybrid thin films. The incorporation of PMAA promotes interfacial interactions with MXene sheets, improves dispersion stability and suppresses restacking during film formation. The hybrid system is investigated using structural, spectroscopic, thermal and microscopic characterization techniques to examine polymer incorporation, morphological evolution, surface chemical interactions and film integrity. This study presents a simple polymer-assisted strategy for transforming Ti3C2Tx MXene into a stable, processable and homogeneous thin-film material with potential for advanced functional applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Colossal Infrared Third-Harmonic Anisotropy in a Two-Dimensional Charge-Transfer Mott Insulator

Dr. Ruihuan Duan[1], Prof. Zheng Liu[1]

[1]Nanyang Technological University, 50 Nanyang Avenue, Singapore

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Colossal Infrared Third-Harmonic Anisotropy in a Two-Dimensional Charge-Transfer Mott Insulator

Ruihuan Duan1, Zheng Liu1

1School of Materials Science and Engineering, Nanyang Technological University, Singapore

Email: ruihuan.duan@ntu.edu.sg, z.liu@nttu.edu.sg

Strongly correlated two-dimensional materials offer a promising route toward compact nonlinear photonic devices, yet achieving large and spectrally tunable optical anisotropy remains a central challenge. Here, we investigate vanadium oxychloride (VOCl), a two-dimensional antiferromagnetic charge-transfer Mott insulator, as a platform for anisotropic nonlinear optics. Structural and electronic analyses identify VOCl as a correlated charge-transfer system with a nearly thickness-independent bandgap of ~2.0 eV, indicating extremely weak interlayer electronic coupling.

Polarization-resolved nonlinear optical measurements reveal a strong third-harmonic generation (THG) response in exfoliated VOCl flakes. Because electric-dipole second-harmonic generation is symmetry forbidden in VOCl, the nonlinear optical behavior is dominated by third-order processes. The material exhibits a third-order susceptibility on the order of 10-19 m2/V2 with minimal thickness dependence. More importantly, VOCl shows pronounced in-plane anisotropy, with photoluminescence and THG anisotropy ratios reaching 6.8 and 187, respectively. Across the infrared excitation range from 2028 to 1280 nm, the THG anisotropy increases from 2.6 to 187, corresponding to a 72-fold enhancement.

First-principles analysis attributes this giant nonlinear anisotropy to the combined effects of correlated charge-transfer excitations and intrinsic in-plane symmetry breaking. These results establish VOCl as a compelling material for polarization-sensitive nanophotonic and optoelectronic applications, and more broadly highlight charge-transfer Mott insulators as an emergent materials class for nonlinear optical engineering.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Emerging 15–16 group Xenes: structures, properties, preparation methods, and catalytic applications

Cong Ma[1], Kai Bao[1], Dr. Qiyuan He[1]

[1]City University Of Hong Kong, Tat Chee Avenue, Hong Kong

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Elemental two-dimensional (2D) materials, or ‘Xenes’, have attracted recent attention due to their unique physicochemical properties. These materials hold immense promise for diverse applications, ranging from energy storage and conversion to optoelectronics and biomedicine. Beyond graphene and phosphorene, a new class of Xenes has emerged, with particular attention directed toward antimonene, arsenene, tellurene, and selenene. These nascent Xenes exhibit diverse allotropes and highly tunable, layer-dependent characteristics, offering a versatile platform for precision engineering and catalytic applications. This review provides a comprehensive overview of recent advancements in the structures, inherent properties, and degradation behavior of Xenes. We systematically categorize synthesis strategies into bottom-up and top-down approaches. Particular emphasis is placed on the synergy between structural engineering and theoretical frameworks to enhance performance across a broad spectrum of catalytic reactions. Finally, we provide a forward-looking perspective on the challenges and opportunities essential for translating Xene research into scalable, high-performance technologies.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

NiCo-LDH@Mo_2CT_x Hybrid Electrode with Improved Charge Transfer for Efficient Oxygen Evolution Reaction

Soojin Kwon[1], Komal Patil[1], Yujin Choi[1], Daim Choe[1], Jiwon Choe[1], Jongsung Park[1]
[1]Gyeongsang National University, , South Korea

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Hydrogen is widely recognized as a promising clean energy carrier due to its high energy density and environmentally friendly characteristics. The development of efficient electrocatalysts for the oxygen evolution reaction (OER) in alkaline electrolytes is crucial for improving the performance of water electrolysis systems for sustainable hydrogen production. However, the sluggish OER at the anode limits the overall electrolysis efficiency, necessitating the development of highly active electrocatalysts. In this study, a three-dimensional NiCo-LDH@Mo2CTx composite was directly grown on nickel foam (NF) via an in-situ hydrothermal process. The highly conductive Mo2CTx MXene sheets were simultaneously integrated with NiCo-LDH nanosheets, forming an interconnected three-dimensional architecture on the NF substrate. The resulting NiCo-LDH@Mo2CTx was evaluated in both a three-electrode configuration and an AEM electrolyzer system. In 1.0 M KOH, NiCo-LDH@Mo2CTx required an overpotential of 393 mV to reach a current density of 100 mA cm^{-2} for the OER. The enhanced catalytic activity is attributed to the synergistic interaction between NiCo-LDHand the conductive Mo2CTx framework, which promotes charge transfer and exposes abundant active sites. Furthermore, in the AEM electrolysis system, the NiCo-LDH@Mo2CTx structure delivered a current density of 115 mA cm^{-2} at 2.0 V. The electrode also exhibited excellent durability during prolonged operation, maintaining stable current density over 50 h without significant degradation. These results highlight the effectiveness of integrating MXene with transition-metal hydroxides for the development of high-performance and cost-effective electrocatalysts for alkaline water splitting.

Engineering of the spectroscopic properties of 2D TMDs monolayer and their heterostructure for optoelectronic devices

Mandeep Chahal[1], Engineering of the spectroscopic properties of 2D TMDs monolayer and their heterostructure for optoelectronic devices Jitendra Singh[2], Engineering of the spectroscopic properties of 2D TMDs monolayer and their heterostructure for optoelectronic devices Meng-Lin Tsai[3], Engineering of the spectroscopic properties of 2D TMDs monolayer and their heterostructure for optoelectronic devices Fouran Singh[4]

[1]Inter-university Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India, Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India, India, [2]Netaji Subhas University of Technology, Dwarka, New Delhi- 110078, India, Netaji Subhas University of Technology, Dwarka, New Delhi- 110078, India, India, [3]National Taiwan University of Science and Technology, Taipei 106335, Taiwan, National Taiwan University of Science and Technology, Taipei 106335, Taiwan, Taiwan, [4]Inter-university Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India, Inter-university Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India, India

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Engineering of the spectroscopic properties of 2D TMDs monolayer and their heterostructure for optoelectronic devices

Mandeep Chahala**, Jitendra Singhb, Meng-Lin Tsaic, Fouran Singha*

a Material Science Group, Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India

b Department of Physics, Netaji Subhas University of Technology, Dwarka, New Delhi-110078, India

c Department of Materials Science and Engineering, National Taiwan University of Science and Technology, Taipei 106335, Taiwan

*Corresponding authors: fouran@gmail.com /mandeepchahal294@gmail.com

Abstract: Recently, 2-D TMDs monolayers, mainly MoS2, WS2, have gained significant attention from the industrial and scientific community due to their unique features, such as high exciton binding energy, low charge screening, prominent quantum confinement effect, direct band gap nature, strong light-matter interaction, and thermal stability, which enables novel quantum phenomena like triexciton formation, single photon emission, Valleytronics making them a perfect fit for future quantum optoelectronic devices. Vertical sta nolayers, held tighter by weak van

der Waals forces, leads to the formation of type-II two-dimensional (2D) van der Waals heterostructures. The physical properties of these 2-D TMD heterostructures depend on band alignment and interactions at the interface; hence, type-II vertically aligned heterostructures provide charge separation, leading to several important phenomena, such as interlayer exciton formation, efficient exciton dissociation, ultrafast charge transfer, and longer lifetimes of indirect interlayer excitons, making them the most reliable source for highly efficient quantum optoelectronic devices. 2-D TMDs monolayers and their heterostructures are highly sensitive to nanometre-scale thickness variation, dielectric environment, and the type of substrates. Therefore, in our studies, we have deposited WS2, MoS2 monolayers and their heterostructure on different substrates (SiO2, Al2O3), and observed that A1g mode shows red shift while E12g shows blue shift. Similarly, shifts of a few eV are also observed in the excitonic peaks of MoS2 & WS2 monolayers in the PL spectrum.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Temperature Effect for van der Waals Epitaxial Growth of h-BN on WS2 via Molecular Beam Epitaxy

Master Student Peng Tung-Yen[1], Master Student Hao Liu[1], Doctor of Philosophy Yen-Teng Ho[2], Professor Ing-Song Yu[1]

[1]Department of Materials Science and Engineering/National Dong Hwa University., No. 1, Sec. 2, Da Hsueh Rd. Shoufeng,, Taiwan, [2]Advanced 2D Materials Co.Ltd., 2 F., No. 96, Xinhe Rd., Xinfeng Township, Taiwan

Poster Session - S01: 2D Materials (2DM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Tungsten disulfide (WS_2) is a two-dimensional (2D) material with high potential for next-generation electronic and optoelectronic devices, while boron nitride (BN), owing to its wide energy bandgap, is well suited for use as a passivation or dielectric layer in electronic components. In this study, hexagonal boron nitride (h-BN) was grown on WS_2/sapphire substrates using the technique of low-temperature molecular beam epitaxy (MBE), and successfully fabricated h-BN/WS_2 van der Waals heterostructures. The experiments included three growth temperatures: 700, 750, and 785 °C, respectively. According to various characterization analyses, it was found that higher growth temperatures (750 and 785 °C) significantly improved the crystalline quality of the boron nitride films, which was evidenced by the more pronounced h-BN characteristic peak at 1360 cm^{-1} in Raman spectroscopy. Transmission electron microscopy (TEM) images confirmed the formation of the h-BN/WS_2 heterostructure. Photoluminescence (PL) spectra further revealed that the h-BN capping layer effectively enhanced the emission intensity of WS_2 at the wavelength of 719 nm, as well as higher growth temperatures resulted in stronger luminescence signals. X-ray photoelectron spectroscopy (XPS) and Fourier-transform infrared spectroscopy (FTIR) were also employed to confirm the film composition after the growth. Finally, post-annealing process will be conducted to enhance the crystal quality of h-BN.

Keywords: Tungsten disulfide; Boron nitride; Molecular beam epitaxy

July 14, 2026 | 10:50 AM

Electroactive PVTF coatings with heterogeneous microdomain potentials for osteogenesis application

Professor Kui Cheng[1], Ms Yutong Che[2]

[1]Zhejiang University, 866 Yuhangtang Road, China, [2]University of Science and Technology Beijing, 30 Xuyuan Road, China

Session 01 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 10:50 AM - 12:00 PM

The electrophysiological microenvironment of native bone tissue plays an indispensable role in regulating bone homeostasis, injury repair, and regeneration. Endogenous bioelectric signals in bone are spatially highly heterogeneous. This study employed electroactive materials with subcellular-scale microdomain potentials to emulate complex physiological bioelectric interfaces and enhance osteogenic responsiveness. A stable microdomain potential coating was established using the ferroelectric polymer poly(vinylidene fluoride–trifluoroethylene) (PVTF) to assess effects on stem cell osteogenic differentiation and macrophage polarization. Through dual-solvent phase separation, spin coating, and thermal treatment, PVTF nanoparticle coatings with high β-phase content were obtained. Corona poling induced oriented alignment of internal dipoles, enabling gradient regulation of surface microdomain potentials: the potential difference between PVTF regions and the exposed substrate increased from 80 mV to 267 mV, generating micrometer-scale low-potential microdomains on the substrate. In vitro, the topology of PVTF nanoparticles, together with low-potential microdomains, synergistically promoted bone marrow–derived macrophages toward the anti-inflammatory M2 phenotype. The surface topology favored adhesion and proliferation of bone marrow mesenchymal stem cells, upon which low-potential microdomains significantly enhanced osteogenic differentiation and matrix mineralization. Transcriptomic analysis and qPCR validation confirmed that low-potential microdomains on PVTF nanoparticle coating activated the PI3K–Akt signaling pathway, regulating multiple biological processes—cell adhesion, proliferation, osteogenic differentiation, and matrix mineralization—and thereby markedly promoting BMSC osteogenesis.

July 14, 2026 | 11:10 AM

Hydrophilization of nickel-titanium alloy surfaces through pulse anodization for biomedical application

Dr. Naofumi Ohtsu[1], Mr. Amon Kitayama[1], Ms. Rino Takada[1], Mr. Yoshiyuki Yamashita[1], Dr. Mitsuhiro Hirano[1]

[1]Kitami Institute of Technology, 165 Koen-cho, Japan

Session 01 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 10:50 AM - 12:00 PM

An almost equiatomic nickel–titanium (NiTi) alloy with unique superelasticity is widely used in medical devices in fields such as cardiology and dentistry. However, its poor biocompatibility often limits its clinical application. Forming a TiO_2 layer is an effective strategy to overcome this drawback, and our research group has focused on developing anodization processes for producing such layers. Conventional anodization cannot readily form TiO_2 because nickel inhibits oxide layer growth. In contrast, modifying the applied voltage from a continuous mode to a pulsed mode promotes the removal of surface Ni, thereby enabling TiO_2 formation. In this study, the optimization of pulsed anodization parameters was investigated to obtain TiO_2 layers with enhanced hydrophilicity and improved surface properties.

Aqueous solutions of 100 mM HNO_3 and H_2SO_4 were used as electrolytes for anodization. A pulsed voltage between 3.5 V and 0 V was applied with a pulse width of 100 ms and a duty ratio of 50% for durations of up to 120 minutes under controlled conditions.

With HNO_3, short-duration anodization caused little change in surface properties, whereas longer durations gradually decreased the contact angle to approximately 50°, after which no further decrease was observed. In contrast, H_2SO_4 effectively reduced the contact angle below 30° even at short anodization times. XPS analysis confirmed the formation of TiO_2 regardless of electrolyte type and anodization duration. The NiO concentration correlated with wettability, with lower NiO levels associated with lower contact angles, approximately 0.1 at.% for H_2SO_4 and approximately 0.4 at.% for HNO_3 treated surfaces. These results demonstrate that optimized pulsed anodization effectively removes surface Ni and enables the formation of stable hydrophilic TiO_2 layers on NiTi alloys.

Biomimetic Engineering of Robust Gradient Antibacterial Coatings using Hollow Nanoframes of Prussian Blue Analogues

Xiaodong He[1]

[1]Southwest University, , China

Session 01 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 10:50 AM - 12:00 PM

Abstract

Photothermal therapy for bacterial infections poses a significant challenge due to the high temperatures required for effective bacterial eradication, which can also harm surrounding healthy tissues. Determining the minimal effective temperature for bacterial destruction is therefore critical. In this study, we develop artificial reef-like manganese-doped Prussian blue (PBMn) nanoframes as photothermal agents and physical cross-linkers to reinforce a phytic acid and cationic polymer network coating. By optimizing the synergistic interaction between the PC network and PBMn nanoframes, along with precise deposition parameters, the resulting PC-PBM coating can be applied to diverse material surfaces and complex geometries while offering adjustable photothermal performance and antibacterial activity. Furthermore, the PC-PBM coating demonstrates biocompatibility and antibacterial efficacy both in vitro and in vivo when applied to polyurethane (PU) surfaces.

Keywords: Gradient coating; prussian blue analogue; biomimetic design; phytic acid; antibacterial photothermal therapy.

Cell activity on pulsed-anodized NiTi alloy surfaces with enhanced hydrophilicity

Mr. Amon Kitayama[1], Rino Takada[1], Yoshiyuki Yamashita[1], Mitsuhiro Hirano[1], Naofumi Ohtsu[1]

[1]Kitami Institute of Technology, 165 Koen-cho, Japan

Session 01 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 10:50 AM - 12:00 PM

NiTi alloys exhibit excellent superelasticity; however, anodization as a surface modification process is generally inapplicable because Ni, as the alloying element, makes it an obstacle for layer growth. In recent years, our group found out that anodized layer growth on NiTi alloy becomes possible by changing voltage mode to pulsed operation. The resultant anodized layer is almost Ni-free TiO_2 layer with enhanced hydrophilicity. Additionally, degree of hydrophilicity can be controlled by the anodization parameters such as electrolyte type and treatment duration. NiTi alloys are key material for biomaterial devices in cardiology and dentistry. Hydrophilic surface is beneficial for cell activation, and hence, the pulsed anodized technology is expected to improve the biocompatibility of NiTi alloy. To verify this hypothesis, in this study, cell activity on anodized NiTi alloy surface with varying hydrophilicity were investigated to demonstrate the potential for biomaterial applications.

Anodization was conducted on a mirror-polished NiTi alloy (55 at.% Ni) disk (φ15 mm) using 100 mM HNO_3 as the electrolyte. A square-shaped pulse voltage of 3.5 V as the upper and 0 V as the lower voltages was anodically applied for 15-120 min to obtain surface with varying hydrophilicity. Vascular endothelial cells (EA.hy926) were then seeded onto the sterilized samples surface, and their morphological changes and migration behavior were evaluated.

The water contact angle on the anodized alloy surface drastically decreased from approximately 70° to 30° with increasing treatment duration, yet. In contrast, the surface roughness change was hardly observed. Endothelial cells seeded on enhanced hydrophilic surface migrates vigorously, but those on less hydrophilic were inactive. Further, cell size and elongation were pronounced on enhanced hydrophilic surface, indicating high cell activity.

Pulsed anodization technology enables to convert NiTi alloy surface into hydrophilic, thereby improving cell activity, and hence, it has the potential for biomaterial applications.

July 14, 2026 | 1:20 PM

Flexible optoelectronic devices for wearable and implantable photodynamic therapy

Professor Peng LI[1,2]

[1]Northwestern Polytechnical University, 127 West Youyi Road, China, [2]Henan Institute of Flexible Electronics, 379 Mingli Road, China

Session 02 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Photodynamic therapy (PDT) is a highly selective noninvasive treatment, but its clinical use is often hindered by bulky optical equipment. To enable personalized PDT, we developed a suite of lightweight, flexible, and implantable optoelectronic devices. We created flexible wearable light sources using electroluminescence technology. These devices effectively eliminate drug-resistant bacteria and accelerate chronic wound healing. By adapting to the body's contours, they enhance patient comfort and shift treatment from hospital settings to daily life, increasing treatment accessibility. We also designed a wireless, minimally invasive biophotonic system for deep-tissue PDT. Powered by an adjustable electromagnetic field, this device delivers controllable illumination to generate reactive oxygen species. It demonstrated over 99% antibacterial activity and inhibited more than 90% of osteosarcoma cell growth, overcoming the tissue-penetration limits of rigid conventional instruments. We developed a flexible implantable device integrating sO2 sensing, Bluetooth, and wireless power. This system identifies micro-tumors by monitoring hypoxic environments. Its μ-LEDs provide in situ therapy while simultaneously tracking oxygen consumption to monitor treatment progression in real time. Together, these innovations provide a user-friendly, next-generation PDT platform capable of precise tumor discrimination, modulable treatment, and real-time efficacy optimization for both surface and internal diseases.

Pinpoint On-Demand Deposition of Self-Assembled Monolayers from Vapor Precursors

Dr. Gregory McGraw[1], Mr. Jiafan Li[1], Ms. Srikari Burra[1], Mr. Deepak Burra[1], Ms. Julie Liong[1], Dr. William Quinn[1], Mr. Chandran Nair[1]
[1]Universal Vapor Jet Corp., #8-18, 163 Kallang Way, Singapore
Session 02 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

A spatially selective vapor phase technique for surface energy modification can be used to fabricate components with novel functionalities for lab-on-a-chip systems (Ueda et al. 2012), cell culture (Horowitz et al. 2021), high-performance coatings (Li et al. 2023), and advanced manufacturing. Universal Vapor Jet Printing (UVJP) achieves surface energy modification on substrates by printing self-assembled monolayers from vapor phase precursors. UVJP combines the high-quality film growth of a vapor phase process with the precision, on-demand patterning of techniques like inkjet printing without the limitations of liquid-surface interactions. It can passivate or activate selected areas of the substrate surface while leaving surfaces beyond the print area undisturbed.

Printed monolayer patterns that direct the flow of water on planar substrates and capture micro-arrays of droplets are demonstrated. Hydrophobic features separating wetted regions may be as narrow as 30 μm. Regions of glass substrate treated with OTS had a contact angle of 106.1° compared with untreated regions that had a contact angle of 25.7°.

Works Cited:

Horowitz, J. A., Zhong, X., DePalma, S. J., Ward Rashidi, M. R., Baker, B. M., Lahann, J., & Forrest, S. R. (2021). Printable Organic Electronic Materials for Precisely Positioned Cell Attachment. Langmuir, 37(5), 1874–1881. https://doi.org/10.1021/acs.langmuir.0c03319

Li, C., Kim, B., Yoon, J., Soumyadip Sett, & Oh, J. (2023). Advances in Directional Wetting Surfaces for Enhanced Fluid Control: A Comprehensive Review. Advanced Functional Materials, 34(9). https://doi.org/10.1002/adfm.202308265

Ueda, E., Geyer, F. L., Nedashkivska, V., & Levkin, P. A. (2012). DropletMicroarray: facile formation of arrays of microdroplets and hydrogel micropads for cell screening applications. Lab on a Chip, 12(24), 5218. https://doi.org/10.1039/c2lc40921f

July 14, 2026 | 2:00 PM

Hydrogel-Based Ultrasonic Sensor for Long-term Wireless Monitoring

Yueying Yang[1]

[1]Northwestern Polytechnical University, , China

Session 02 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Implantable medical devices, designed for temporary or permanent residence in the body, enable disease diagnosis, physiological monitoring, and therapy. Hydrogels are increasingly used as core components due to their clinical adaptability and responsive properties. They serve as low-trauma assistive elements during device placement and removal, or as functional substrates that facilitate tissue repair, drug delivery, infection control, and monitoring of biomarkers. Inspired by biological tissues, hydrogel interfaces also show promise as sensing platforms that detect physiological signals through diverse interaction modes. Capitalizing on the excellent ultrasound transparency, we designed a smart hydrogel-based metamaterial system that responds to stimuli such as intracranial pressure, temperature, pH, and flow rate without electronic components. The fully implantable metagel structure enables wireless, accurate sensing of intracranial signals via ultrasonics, allowing noninvasive and stable bio-sensing without the need for secondary extraction surgery.

July 14, 2026 | 2:20 PM

Design and Fabrication of a Non-Invasive Sweat Glucose Sensor Using Graphene Oxide

Christina Daniel[1]

[1]COEP Technological University , Wellesley Rd, Shivajinagar, Pune, Maharashtra 411005, India

Session 02 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Diabetes mellitus affects over 500 million people worldwide, with conventional invasive glucometers hindering compliance due to pain and inconvenience. This work presents a disposable, paper-based electrochemical biosensor leveraging graphene oxide (GO) thin films for non-invasive sweat glucose detection, enabling continuous, pain-free monitoring.

We fabricated flexible 1×1 cm sensors on filter paper substrates using a scalable drop-casting process: GO synthesized via modified Hummers' method, functionalized with glucose oxidase (GOx) via glutaraldehyde crosslinking, and integrated with copper tape electrodes and silver interconnects for low-impedance contacts. Devices operate at a 3-3.5 V bias using a simple multimeter readout, bypassing costly potentiostats.

In artificial sweat, GO-GOx sensors exhibited superior sensitivity (15.2 μA mM^{-1} cm^{-2}), linearity (R^2=0.98) over 0.01-1 mM glucose, and a low LOD of 8.2 μM, outperforming unmodified GO by enhancing reproducibility and low-concentration response. Calibration curves and box plots confirmed dose-dependent microampere currents with tight interquartile ranges (<15% of median).

At <$0.10/unit, this thin-film platform advances biomedical thin-film sensors for wearable glucose monitoring, addressing accessibility gaps in diabetes management with potential for multiplexed, continuous health wearables.

July 14, 2026 | 2:35 PM

Self-Powered Bioelectronic Hydrogel Patches for Tissue Repair Enabled by Nanogenerators

Chuanrui Chen[1,2], Jiaqi Lu[1,2], Kaihang Zhang[4], Zhe Zhang[5], Jikui Luo[1,2,3]

[1]College of Information Science and Electronic Engineering, Zhejiang University, , China, [2]International Research Center for Information Science and Electronic Engineering, Zhejiang University, , China, [3]Key Lab of CS&AUS of Zhejiang Province, Zhejiang University, , China, [4]College of Biological Science and Medical Engineering, Donghua University, , China, [5] The Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University, , China

Session 02 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Triboelectric nanogenerators (TENGs) have attracted significant attention for harvesting biomechanical energy and enabling self-powered systems. MoS_2-doped electrospun polyvinyl alcohol (PVA) nanofiber films are developed for high-performance TENGs, achieving enhanced electrical output through synergistic effects of nanofiber morphology, surface potential modulation, and nanosheet-induced polarization. The optimized device delivers an output voltage approaching 1000 V, representing a ~3–4-fold enhancement compared to pristine PVA-based devices. The system further demonstrates capabilities in biomechanical energy harvesting, self-powered sensing, and wireless signal transmission, highlighting its potential for wearable and bio-integrated electronics.

Building on this foundation, we extend nanogenerator-enabled energy harvesting toward bioelectronic applications for tissue repair. Electrical stimulation has been widely shown to promote cell migration, proliferation, and angiogenesis; however, most existing approaches rely on external power sources, limiting their applicability in soft and dynamic biological environments. To address this challenge, we design a multifunctional bioelectronic hydrogel patch integrating a piezoelectric nanogenerator (PENG), a spiral electrode architecture, and a drug-loaded hydrogel matrix. Compared with TENGs, PENGs provide more stable and controllable electrical stimulation in soft biological environments. This system enables the conversion of physiological motion into localized electrical stimulation while simultaneously supporting controlled drug release, thereby offering a synergistic electromechanical and biochemical therapeutic strategy.

The results demonstrate the feasibility of integrating piezoelectric functionality with hydrogel-based platforms, including effective material coupling, structural optimization, and robust wet-tissue [illegible] proposed system exhibits promising

electromechanical responsiveness and potential biological functionality, indicating its suitability for self-powered and minimally invasive therapeutic applications. This platform provides a viable pathway toward clinically relevant bioelectronic systems for applications such as diabetic wound healing and gastrointestinal tissue repair.

July 14, 2026 | 2:50 PM

Design and Extreme Environment Adaptation of a Portable Wearable Multimodal Physiological Acquisition and Neuromodulation Closed-Loop System

Doctor HuiQing Zhang

[1]Northwestern Polytechnical University, 127 West Youyi Road, Beilin District, 710072, China

Session 02 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Commercial wearable physiological acquisition devices face significant limitations in extreme environments, where structural stability and data durability decline under severe cold, humidity, or heat, hindering their use in special operations, outdoor exploration, and emergency rescue. Additionally, current mental health assessments remain rudimentary, often limited to basic emotion recognition and lacking refined quantification of stress-related states (e.g., anxiety, fear) and load-related states (e.g., fatigue, alertness). Furthermore, there is a lack of a non-invasive closed-loop solution integrating data acquisition, state assessment, and active intervention, preventing comprehensive health management.

To address these challenges, this study conducts multidimensional technological research in three core areas. First, we optimize vital sign acquisition by developing diverse wearable terminals—such as health wristbands, smart rings, flexible patches, medical-grade bandages, smart clothing, and AI glasses—for precise, real-time monitoring of heart rate, blood oxygen, skin conductance, and EEG. Second, we construct refined mental health assessment models focusing on stress and load states, utilizing multi-source physiological signal features for quantitative analysis and accurate classification. Third, we employ transcutaneous auricular vagus nerve stimulation to achieve safe, efficient non-invasive neuromodulation for abnormal mental states.

Based on these advancements, we aim to develop an integrated portable closed-loop system for vital sign acquisition, mental health assessment, and neuromodulation intervention. By incorporating flexible packaging technology for structural optimization and environmental protection, the system ensures stable, reliable operation under extreme conditions. This research provides an intelligent, integrated solution for human health monitoring and mental state regulation in demanding scenarios.

July 14, 2026 | 3:30 PM

Synergistic Antibacterial Strategies and Surface/Interface Engineering of Biomaterials for Infection Control

Dr. Liqun Xu[1]

[1]Southwest University, No. 2 Tiansheng Road, Beibei District, China

Session 03 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Bacterial adhesion and subsequent biofilm formation on biomedical material surfaces remain major challenges that hinder the clinical translation of implantable medical devices, leading to compromised therapeutic outcomes and increased risks of implant-associated infections. Herein, we propose a synergistic antibacterial strategy integrating “passive defense” and “active elimination” based on surface/interface engineering. Specifically, by tuning interfacial wettability, surface charge, and micro-/nano-topographical features, an effective anti-adhesion barrier is constructed to suppress bacterial colonization. In parallel, active antibacterial modalities, including photothermal/photodynamic therapy, sustained metal-ion release, and controlled antibiotic delivery, are incorporated to efficiently eradicate adhered planktonic bacteria and established biofilms. Moreover, the regulation mechanisms of surface/interface composition (e.g., metal sulfide nanoparticles and cationic/zwitterionic polymers), structural designs (gradient coatings and porous structures), and stimuli-responsive properties (near-infrared, wound-exudate, and pH responsiveness) are systematically discussed, highlighting their roles in inhibiting bacterial attachment, enhancing bactericidal activity, and improving long-term durability. Experimental evidence indicates that this synergistic approach enhances broad-spectrum antibacterial efficacy and mitigates antimicrobial resistance via multiple mechanisms, including membrane disruption, metabolic interference, and virulence gene downregulation. Importantly, precise surface/interface modulation enables a favorable balance between antibacterial performance and biocompatibility, thereby supporting cell proliferation, angiogenesis, and tissue regeneration while preventing infection. This work provides design principles and technical insights for developing advanced antibacterial biomaterials and offers promising solutions for infection prevention in implantable medical devices.

July 14, 2026 | 3:50 PM

Antimicrobial Polymers for Combating Multidrug Resistant Bacterial Infections

Zhangyong Si[1]

[1]Ningbo Institute Of Materials Technology And Engineering, Chinese Academy Of Sciences, ,

Session 03 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Antibiotic resistance has escalated into a critical global health threat, with multidrug-resistant pathogens undermining the efficacy of conventional antibiotics. Traditional antimicrobial development has stagnated, as no new antibiotic class has been discovered in over three decades, while bacteria continuously evolve resistance. Consequently, there is an urgent need for innovative antimicrobial materials with distinct mechanisms of action.

Antimicrobial polymers represent a versatile class of next-generation agents, offering modular structures, tunable physicochemical properties, and multi-target activity. In this work, we present advances in two promising polymer platforms: (i) β-peptides, which display unique in vivo antibacterial and antibiofilm activities due to their structural diversity and proteolytic stability, and (ii) main-chain cationic polymers, exemplified by fully biodegradable poly(carbonate-imidazolium) (MCOP-1), which combine broad-spectrum efficacy with environmental sustainability.

For β-peptides, three candidates were identified: PDGu(7)-b-PBLK(13) effectively eradicates Staphylococcus aureus biofilms; PAS8-b-PDM12 enhances outer membrane permeability in ESKAPE Gram-negative bacteria, reversing intrinsic resistance; and a tapered blocky co-β-peptide selectively targets resistant Gram-negative pathogens through electrostatic and hydrogen bonding with lipopolysaccharides. For main-chain cationic polymers, MCOP-1 demonstrates potent activity against Gram-positive, Gram-negative, and Mycobacterium abscessus while degrading into non-toxic byproducts, thus minimizing long-term toxicity and resistance buildup.

These findings underscore the broad potential of antimicrobial polymers in tackling antibiotic resistance. Their ability to disrupt membranes, penetrate biofilms, and access intracellular targets highlights their superiority over traditional antibiotics and natural antimicrobial peptides. Antimicrobial polymers thus represent a promising platform for clinical translation, offering structural diversity, efficacy, and biodegradability as key solutions to the antimicrobial resistance crisis.

July 14, 2026 | 4:10 PM

Bacterial Adhesion-Based Antibiotic-Free Dressings for Infected Wound Healing

Prof. Lu Zhentan[1]

[1]Wuhan Textile University, No.1 Sunshine Avenue,Jiangxia District, China

Session 03 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Traditional bactericidal wound dressings cause bacterial resistance, biotoxicity, and inflammation from dead bacterial toxins, hindering infected wound healing. This study introduces a new strategy: physically adhering and removing viable bacteria instead of killing them, to achieve safe anti-infection and accelerated healing. We developed different fiber based wound dressing with high bacterial adhesion ability. And, we found that surface roughness dominates bacterial adhesion in heterogeneous materials, while matched surface free energy and hydrophilicity govern adhesion in homogeneous systems. The optimized dressings show high bacterial capture capacity, excellent biocompatibility, and low wound adhesion. In vivo results confirm they clear pathogens, reduce inflammation, boost growth factor expression, and speed healing without releasing bacterial toxins. This work establishes a novel antibiotic-free design paradigm for anti-infective wound dressings.

Synergistic Photothermal and Photodynamic Nanocoatings on Titanium Implants for Rapid Bactericidal Action and Enhanced Osseointegration

Jingjing Huo[1], **Ms. Yihan Liu**[1], Professor Peng LI[1]
[1]Northwestern Polytechnical University, Xi'an, China
Session 03 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

The clinical success of titanium (Ti) implants in dental and orthopedic applications is severely compromised by implant-associated infections and inadequate osseointegration. The emergence of antibiotic-resistant pathogens, coupled with the inherent bioinertness of Ti surfaces, demands multifunctional coatings capable of concurrent antibacterial and osteoinductive activities. In this study, we develop a synergistic photothermal and photodynamic nanocoating by co-immobilizing polydopamine (PDA) and Rose Bengal (RB) onto titanium dioxide nanotube (TNT) arrays via mussel-inspired chemistry and amide coupling. This TNT-PDA-RB platform integrates PDA as a photothermal agent and RB as a photosensitizer, enabling dual-modal bacterial inactivation through the combined effects of localized hyperthermia and reactive oxygen species. Under dual-wavelength irradiation (808 nm + 532 nm) for only 3 minutes, the coating achieves exceptional bactericidal efficacy of >99.99% against both Gram-negative Escherichia coli and Gram-positive methicillin-resistant Staphylococcus aureus (MRSA) in vitro. In a rat subcutaneous
infection model, the bacterial burden on TNT-PDA-RB is reduced by 2.49 log (>99%) compared with pristine Ti implants. Moreover, the nanocoating exhibits excellent cytocompatibility with MC3T3-E1 preosteoblasts and negligible hemotoxicity against red blood cells. Beyond antibacterial performance, the coating significantly enhances osteogenic differentiation, as evidenced by upregulated alkaline phosphatase activity
and increased extracellular matrix mineralization. This work presents a novel dual-modal synergistic strategy that overcomes the limitations of monomodal photothermal or photodynamic therapies, achieving rapid bactericidal action with minimized risk of thermal damage while ensuring robust biocompatibility. The combination of efficient light-triggered antibacterial activity and enhanced osteoinduction positions this TNT-PDA-RB nanocoating as a robust and versatile platform for next-generation anti-infective and osseointegrated Ti implants, addressing critical challenges in clinical implantology.
Keywords: Ti implants; antibacterial property; photothermal therapy; photodynamic therapy; osteoinduction

July 14, 2026 | 4:45 PM

A Multilayered Responsive Dressing for Programmable Exudate Control and Regenerative Therapy of Infected Wounds

Zhicheng Zhang

[1]Southwest University, , China

Session 03 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

To ensure effective management of wound exudate and optimize a conducive healing environment for wounds at various stages, a responsive dressing has been designed to effectively regulate the moisture at the wound site upon exudate absorption. Not only that, it involves the controlled release of therapeutic agents and bioactive substances, which serve to achieve anti-bacterial and anti-inflammatory effects, ultimately facilitating wound healing.

July 15, 2026 | 10:50 AM

Self-Assembled Nanoparticles for Antibacterial Applications

Qiao Jin[1]

[1]Zhejiang University, , China

Session 04 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Bacterial infection is considered as a big threat to public health in human history. Antibiotic resistance has become one of the biggest threats to public health worldwide. It is urgently needly to develop non-antibiotic therapeutic strategies for combating bacterial infections. Transition metal ions such as Ag^{+}, Cu^{2+}, and Zn^{2+} are utilized as sterile agents thousands of years ago. Unfortunately, these metal ions in the form of traditional metal or metal oxide nanoparticles cannot be directly medicated into human body due to the potential toxicity. Taking advantage of the dynamic metal-polyphenol coordination self-assembly, we fabricated a series of Zn^{2+}-polyphenol nanoparticles. The Zn^{2+}-polyphenol nanoparticles were stable in aqueous solution while could be easily decomposed and release Zn^{2+} in acidic bacterial infection microenvironment. The in vivo therapeutic efficacy of Zn^{2+}-polyphenol nanoparticles was investigated on a lung infection model and a keratitis model. The excellent bactericidal ability and negligible toxicity made Zn^{2+}-polyphenol nanoparticles a promising non-antibiotic agent for dealing with internal infection in the future.

July 15, 2026 | 11:10 AM

Synthesis and Characterization of “all-in-one” Nanomedicine Platform Applied for Rheumatoid Arthritis

Professor San-Yuan Chen[1], Student Ching-Hong Chung[1]

[1]National Yang Ming Chiao Tung University, 1001 University Road, Taiwan

Session 04 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Rheumatoid Arthritis (RA) involves complex vicious cycles of inflammation, excessive ROS accumulation, and hypoxia, rendering traditional monotherapies ineffective. This study develops a UCNP@GQDs-Cur/MSN@CeO2@Fu nanoplatform for multi-stage synergistic therapy. The system integrates an Upconversion Nanoparticle (UCNP) core within a Mesoporous Silica Nanoparticle (MSN) reservoir, utilizing the π−π stacking interaction of Graphene Quantum Dots (GQDs) to efficiently load hydrophobic Curcumin (Cur). The surface is further functionalized with enzyme-mimicking Cerium Oxide (CeO2) and P-selectin-targeting Fucoidan. The core strategy focuses on spatiotemporal modulation, ranging from microenvironment remodeling to precision therapy. First, the outer Fucoidan(Fu) layer targets P-selectin on inflamed endothelial cells to block leukocyte infiltration. Second, the CeO2 shell functions as a dual purpose gatekeeper and nanozyme, preventing premature drug leakage while scavenging ROS and generating oxygen to alleviate hypoxia. Upon entering acidic lysosomes, the shell degrades to release Curcumin, thereby inhibiting inflammatory cytokines and bone erosion. Simultaneously, CeO2 exhibits peroxidase (POD) activity. UCNPs convert 980 nm NIR to UV light, activating CeO2 to generate toxic hydroxyl radicals (·OH) and exciting GQDs for photothermal therapy (PTT). Collectively, this work presents a comprehensive “all-in-one” nanomedicine, providing a promising paradigm for the precise management of RA.

July 15, 2026 | 11:30 AM

Hydrogen Selenide Releasing Micelles for Antibacterial Therapy

Dr. Tengjiao Wang[1]

[1]Northwestern Polytechnical University, 127 West Youyi Road, China

Session 04 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Introduction: Bacterial pneumonia remains a leading cause of infection-related deaths worldwide, largely due to the persistence of antibiotic-resistant bacteria within cells. By hijacking macrophages as immune-privileged intracellular compartments, intracellular bacteria evade antibiotic exposure and attenuate host bactericidal programs through stress-induced dormancy and immune reprogramming. The inducible nitric oxide synthase (iNOS) axis is central to macrophage antibacterial defense yet is frequently suppressed during intracellular infection. Intracellular hydrogen selenide (H2Se) delivery strategies that reactivate iNOS expression and promote nitric oxide (NO) generation may represent a promising approach for enhancing macrophage-mediated clearance of intracellular bacteria.

Materials & Methods: A macrophage-targeting H2Se-releasing polymeric micelle (SeHM) was developed through living polymerization. By precisely tuning the ratio between the hydrophilic block and the organic H2Se donor block, accurate control over intracellular H2Se exposure was achieved, providing a chemically defined and controllable strategy for modulating macrophage immune function.

Results & Discussion: SeHM is selectively internalized by macrophages, and intracellular H2Se release can be directly visualized in living cells, confirming effective delivery and release from the polymeric carrier. Importantly, varying block ratios results in significant differences in intracellular H2Se exposure levels, leading to divergent immunological and antibacterial outcomes, including a marked promotion of macrophage transition toward a pro-inflammatory phenotype. SeHM treatment enhances endogenous NO production in macrophages, while inhibition of iNOS expression markedly attenuates SeHM mediated elimination of intracellularly persistent MRSA, thereby establishing a functional link between intracellular H2Se release and NO-dependent host defense behavior. In a mouse model of pulmonary MRSA infection, SeHM treatment reduces bacterial burden while alleviating lung pathological damage.

Conclusions: SeHM serves as a chemically defined platform that couples controlled intracellular H2Se delivery with restoration of NO-mediated immune effector functions, providing a chemically controllable strategy to overcome intracellular persistence of MRSA.

Self-assembled bioactive protein/HA/CUR-based amyloidogenic nanohydrogel dressing for rapid

infected diabetic wound healing via enhanced angiogenesis and anti-inflammation

Mr Saurabh Kumar Srivastava[1]

[1]Iit(bhu), Department of physics, India

Session 04 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Infected diabetic wounds present a significant clinical challenge due to impaired healing,
persistent inflammation, and heightened risk of infection. In this study, we report a novel self-assembled
hybrid nanohydrogel composed of Bovine Serum Albumin (BSA)-based amyloid fibrils, hyaluronic acid (HA),
and the natural anti-inflammatory agent curcumin, designed as a 3D-printed dressing for effective treatment
of infected diabetic wounds. The incorporation of curcumin enhances the antimicrobial and antioxidant
properties of the hydrogel, while HA contributes to moisture retention, angiogenesis, and anti-inflammatory
response. BSA amyloid fibrils offer structural integrity and self-assembly behavior, forming a mechanically
stable yet tunable scaffold. The resultant BSA–HA–Curcumin hydrogel demonstrates excellent water
retention, shear-thinning behavior, and biocompatibility, providing a moist healing microenvironment. In vitro
assays reveal significant reduction in bacterial burden and enhanced NIH-3T3 fibroblast migration. In vivo
diabetic wound models confirm accelerated wound closure, reduced inflammation, enhanced collagen
deposition, and neovascularization in infected sites. These findings suggest that the BSA–HA–Curcumin
composite hydrogel holds substantial promise as a multifunctional, translational dressing for managing
infected diabetic wounds.

Design of Highly Selective Sulfonium Polypeptides and Their Antibacterial Performance

Dr. Zhenyan Zhang[1], Dr. Peng Li

[1]Northwestern Polytechnical University, , China

Session 04 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Antibiotic misuse has driven bacterial resistance, posing a grave global public-health challenge. Polyamino acid–based antimicrobials, with non-antibiotic bactericidal mechanisms, show promise for addressing resistance, yet toxicity has limited clinical translation. In this study, through molecular design and structural optimization, we developed novel onium-salt antimicrobial polyamino acids and their functionalized composites, achieving dual breakthroughs in efficient selective antibacterial activity and bacterial clearance.

First, via amine-driven NCA ring-opening polymerization, we constructed star-shaped onium-salt polyamino acids with a defined topology, achieving an ultra-high selectivity index (HC_{10}/MIC > 16,000). These antimicrobial polyamino acids kill bacteria through multiple concurrent mechanisms, including disruption of membrane transport, DNA binding, reactive oxygen species generation, and attack on bacterial ribosomes, without inducing resistance. By precisely tuning the cationic fraction, we achieved selectivity toward Gram-positive vs Gram-negative bacteria: when the cationic degree exceeds 90%, Gram-positive targeting is dominant; when it is below 50%, Gram-negative targeting is favored.

In a second study, leveraging the high charge density of sulfonium groups, we developed a sulfonium-salt–based composite adsorbent with rapid adsorption and bactericidal activity. This material displays MRSA adsorption rates of 0.41×10^8 CFU/(mg·min), bilirubin adsorption capacity, and excellent blood compatibility. Notably, the adsorbent can completely eradicate adsorbed MRSA within 1 h and retains >90% adsorption efficiency after five cycles. This approach could enable rapid early clearance of MRSA in patient infections, potentially interrupting septic progression and mitigating excessive inflammatory organ injury.

July 15, 2026 | 1:20 PM

Phytic Acid-Enabled Hydrogel Sensors for Biomedical and Healthcare Monitoring

Dr Rong Wang[1]

[1]Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, No. 1219 West Zhongguan Road, Zhenhai District, China, [2]Ningbo Cixi Institute of Biomedical Engineering, No. 99 Xuelin Road, Cixi, China

Session 05 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Flexible hydrogel-based sensors are emerging as transformative tools in wearable health monitoring and smart medical systems, yet simultaneously achieving high sensitivity, broad detection range, mechanical robustness, and signal fidelity remains a persistent challenge. This work presents a series of studies on phytic acid (PA)-composite hydrogels, demonstrating that PA's versatile interfacial chemistry provides a generalizable strategy for engineering multifunctional sensing materials for biomedical applications.

By exploiting PA's differential interactions with various polymer matrices, we construct hydrogels with programmable mechanical and ionic properties. PA-induced plasticization and microphase separation enable gradient-modulus ion-conductive hydrogels with high pressure sensitivity (9.00 kPa^{-1}) and an ultrawide detection range (3.7 Pa to 1.2 MPa), reliably capturing physiological signals including pulse, muscle vibrations, and plantar pressure distribution. Integrating PA-mediated phase separation with dynamic hydrogen bonding yields hydrogels combining high toughness (≈3.4 MJ m^{-3}) and ultralow hysteresis (2.9% at 400% strain), enabling stable, drift-free strain sensing (GF = 3.32; range 0.1%–850%) under repetitive loading. Additionally, systematic investigation of PA in PVA systems uncovers competing "good-solvent" and "physical association" effects switchable by temperature and solvent environment, which is harnessed in wet spinning to produce PVA/PA hydrogel fibers with tensile strength exceeding 20 MPa and ionic conductivity of 3.72 S/m.

Collectively, this series of works establishes PA-mediated microstructure engineering as a versatile and promising materials strategy for flexible sensors capable of continuous, reliable monitoring of diverse physiological and biomechanical signals in healthcare applications.

Angle-Optimized TiO_2/CaF_2 One-Dimensional Photonic Crystal Biosensor for High-Sensitivity Label-Free Uric Acid Detection

Dr Kathiresan K[1], Mrs Karolourdhina K[2], Dr Poovendran K[3], Dr Ramanujam N R[4]
[1]PSNA COLLEGE OF ENGINEERING AND TECHNOLOGY, Kothandaraman Nagar, India, [2]PSNA COLLEGE OF ENGINEERING AND TECHNOLOGY , Kothandaraman Nagar, India, [3]SRM Madurai College for Engineering and Technology,, Pottapalayam, , India, [4]KLN College of Engineering, Pottapalayam, , India

Session 05 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

The precise determination of the concentration of uric acid in blood samples is critical in the early diagnosis and treatment of various metabolic conditions such as hyperuricemia, gout, and renal disease. In this study, the application of a one-dimensional photonic crystal biosensor with an optimized design consisting of TiO_2/CaF_2 layers with a central cavity is proposed for the detection of uric acid in real time. The most important contribution of this study is the optimized design of the biosensor that allows for the enhancement of the biosensing capability without increasing the biosensor's structural complexity. Unlike conventional one-dimensional biosensors that utilize normally incident light, the proposed biosensing structure exploits the advantage of the higher incident angles to maximize the biosensing capability. The sensor can detect the refractive index in the range of 1.333 to 1.3336 RIU, which covers the concentration of uric acid in clinical samples. The analysis of the sensor using the transfer matrix method confirms that the sensor can detect the increase in concentration with an increase in the resonance wavelength in the incident angle range of 0 to 85 degrees. Moreover, the optimized sensor design can attain a maximum sensitivity of 905 nm/RIU, a high quality factor of 4358, and a low detection limit of 1.5×10^{-5} RIU. The significant reduction in the linewidth of the sensor at higher incident angles confirms the minimized divergence of the beam, thus enhancing the resolution of the sensor. Moreover, the improved signal-to-noise ratio confirms the efficient excitation of the incident light in the defect mode. Thus, the proposed biosensor design possesses excellent linearity, sensitivity, and compactness, making it suitable for various portable, real-time, lab-on-chip technologies for advanced biomedical sensing.

Translational Collagen–MXene Hybrid Surgical Thin Film for Diabetic Wound Management

Dr PRAKASH JAYABAL[1]

[1]Translational Health Science And Technology Institute, NCR Biotech Science Cluster, PO box #04, Faridabad- 121001, India

Session 05 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

The global healthcare system faces a significant challenge from chronic and diabetic wounds, which require innovative therapeutic systems to improve tissue repair. The study was conducted using a composite comprising chitosan (Cs), fish collagen (FC), MXene, Zirconium oxide (ZrO_2), and Cu. In this study, the nanocomposite was incorporated into wound dressing patches using an environmentally friendly gel-casting method. In particular, the combination of MXene nanosheets with bioactive metal-ion-incorporated patches exhibited enhanced mechanical strength, moisture retention, and tensile stability. Moreover, the Cs/FC/MXene/ZrO_2+Cu showed excellent cytocompatibility and hemocompatibility in in vitro conditions. The in vivo studies were performed using streptozotocin-induced diabetic mice with full-thickness wounds. Furthermore, the histopathological examination showed that the treated wounds developed thick collagen networks, exhibited granulation tissue, increased neovascularization, and decreased inflammation compared to the control groups. Collectively, the combination of MXene with bioactive metal ions produced enhanced wound-healing outcomes through synergistic effects. Therefore, the collagen- and nanocomposite-incorporated patch has the potential to reduce global health effects associated with diabetic and chronic ulcers.

July 15, 2026 | 2:20 PM

Salt-Triggered Electroactive Dressing with Controlled Drug Release for Enhanced Healing of Exudative Wounds

Huajun Wu[1]

[1]Southwest University, , China

Session 05 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Excessive wound exudate is a key factor that exacerbates wound condition, and conventional treatments typically involve its physical removal. However, the components of exudate, such as enzymes, and salts, present valuable resources that can be utilized for therapeutic purposes. To harness the potential of wound exudate, this study developed a novel exudate-responsive electrotherapy system by integrating salt-responsive polymer coatings with a yarn-based battery. Specifically, zwitterionic polymers (PVBIPS) were grafted onto the cotton yarn, which was then embedded with the antibacterial drug carvacrol. The modified yarn was further woven with anode and cathode materials to create a self-powered electric fabric dressing. The salt ions in the wound exudate triggered the dissociation of PVBIPS, enhancing the dressing's moisture retention and enabling the release of carvacrol. Furthermore, Mg(OH)2 generated during the discharge of the yarn-based battery synergistically enhanced the antibacterial effects of carvacrol. The electric field generated by the dressing promoted macrophage polarization, guided fibroblast migration and proliferation, and accelerating tissue regeneration. In both rat and porcine wound models, this electric fabric dressing significantly enhanced healing outcomes. This electric fabric dressing not only effectively utilizes wound exudate to support therapeutic functions, but also offers an alternative approach to developing multifunctional wound care systems.

July 15, 2026 | 2:35 PM

Laser-Induced Graphene Coated Wearable Smart Textile Electrodes for Biopotential Signal Monitoring

Miss Vidhya C M[1], Dr. Sakshi Kapoor[1], Dr. Yogita Maithani[1], Dr. Jitendra Pratap Singh[1]
[1]Indian Institute Of Technology Delhi, India, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, 110016, India

Session 05 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

This work describes the fabrication of an e-textile using laser-induced graphene (LIG) and its application in biopotential monitoring, including electrocardiogram (ECG) and electromyogram (EMG). The major challenges associated with textile-based electrodes are their higher skin-electrode impedance and surface stability, and the fabrication technique should be scalable and low-cost. To address these issues, laser-induced graphene was used as the conducting material. It was manufactured using a low-cost single-step process, laser ablation of a commercial polyimide. The formation of LIG on PI sheets and other carbonaceous materials has been widely explored for the laser-induced graphene's characteristics; however, its ability to form a stable dispersion has been less explored. In this work, the ability of the LIG to form a stable dispersion in a low-boiling, nontoxic, environmentally friendly solvent was investigated. The dispersion obtained showed better conductivity than reduced graphene oxide and was comparable to that of graphene. After successive coating of the LIG dispersion on the cotton fabric to make it conductive, the sheet resistance of the resulting fabric dropped to 3% of its initial value. The laser-induced graphene (LIG) cotton dry electrodes thus manufactured are comparable to Ag/AgCl wet electrodes in terms of the skin-to-electrode impedance, measuring between 78.0 and 7.2 kΩ for the frequency between 40 Hz and 1 kHz. The LIG cotton electrode displayed a signal-to-noise ratio of 20.17 dB. Due to its comfort, simplicity, and good performance over a longer period of time, the textile electrode coated with the functional material appears suited for wearable applications.

July 15, 2026 | 2:50 PM

Biodegradable Scaffolds for Electrical Stimulation Enhanced Tissue Repair

Xi Yang[1], Liang Zhang[2], Yufan Zhong[3], Xiaozhi Wang[1]
[1]College of Information Science & Electronic Engineering, Zhejiang University, , China, [2]Research Center for Computing Sensing, Zhejiang Lab, , China, [3]Department of Plastic Surgery, Sir Run Run Shaw Hospital, Zhejiang University School of Medicine, Hangzhou, China

Session 05 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Electrical stimulation (ES) is a widely used clinical therapeutic approach that enhances endogenous electric field effects and thereby promotes tissue repair. In this study, we develop a tissue engineering scaffold–based ES system using conductive graphene–PLGA ink and insulating boron nitride (BN)-PLGA ink, which provides both a stable electrical stimulation environment and mechanical support for damaged tissues. The scaffold is fabricated via extrusion-based 3D printing using a biodegradable PLGA matrix incorporated with conductive graphene or insulating BN. In the ES system, the implanted scaffold serves as the cathode, while a ring-shaped electrode placed on the surrounding skin acts as the anode, establishing a centrally directed electric field at the defect site.

By tuning the composition of the polymer matrix and two-dimensional nanomaterials, the mechanical and electrical properties of the scaffold can be synergistically regulated to better match the physiological characteristics of different tissues. Comprehensive material characterization demonstrates that the scaffold exhibits favorable mechanical properties, electrical conductivity, electrochemical performance, hydrophilicity, biocompatibility, and biodegradability.

In vivo experiments using rat skin wound and abdominal wall defect models show that the scaffold combined with ES significantly accelerates tissue healing. Histological analysis reveals no evident inflammatory response in hematoxylin and eosin staining, indicating good biocompatibility. Masson’s trichrome staining further demonstrates that ES promotes the ordered deposition and alignment of collagen fibers, facilitating tissue remodeling. In addition, immunohistochemical results show significantly increased expression of α-SMA, collagen I, and Ki-67 in the ES group, further confirming the enhanced tissue regeneration capability.

In summary, the biodegradable implantable scaffold developed in this study shows strong potential for application in ES-based therapies, providing a promising strategy for accelerating tissue repair and enhancing regenerative outcomes.

July 16, 2026 | 8:30 AM

Fabrication of Main-Chain Betulin-based Polymer Nanofibers as Antibacterial Surface Coatings

Zhiyuan Ma[1]

[1]Donghua University, 2999 North Renmin Road, Songjiang, China

Session 07 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Betulin, a naturally abundant pentacyclic triterpene isolated from birch bark (30 wt%), offers significant potential as a sustainable building block for advanced surface coatings due to its inherent antibacterial properties and exceptional biocompatibility. This study presents the rational design and controlled synthesis of main-chain betulin-based polymers via two complementary polymerization strategies: acyclic diene metathesis (ADMET) utilizing Grubbs catalysts and thiol-ene click chemistry under UV irradiation. α,ω-Diene betulin derivatives bearing phosphate, urea, or ester functional groups with varying methylene spacer lengths were successfully polymerized, yielding polyolefins, polysulfides, and polysulfoxides with controllable molecular weights (ranging from 3,300 to 38,900 g/mol) and excellent thermal stability (Td > 300°C). These biobased polymers were fabricated into uniform nanofibrous thin films and surface coatings through electrospinning technology, displaying average fiber diameters of 3–4 μm, high surface porosity, and tunable hydrophobicity (water contact angles 126–132°). Comprehensive biological evaluations demonstrated outstanding cytocompatibility with mammalian cells (viability >80%) and significant broad-spectrum antibacterial efficacy against both Gram-positive (S. aureus , B. subtilis) and Gram-negative (E. coli , A. baumannii) pathogens. Furthermore, the polysulfoxide fiber coatings demonstrated remarkable potential in active food packaging applications, effectively extending strawberry shelf life at room temperature while significantly reducing weight loss through synergistic antimicrobial activity and moisture barrier effects. This research establishes a versatile strategy for converting natural triterpenoids into high-performance bioactive thin films applicable in food packaging, wound dressing, and antimicrobial surfaces.

July 16, 2026 | 8:50 AM

Metal-enhanced ZIF-8 nanohybrid for advancing metastatic breast cancer treatment

Dr. Swati Singh[1]

[1]Indian Institute of Technology Ropar, Department of Chemistry, Indian Institute of Technology Ropar, Rupnagar, 140001, Punjab, India., India, [2]Tokyo University of Science, Tokyo, Japan, Faculty of Pharmaceutical Sciences, Tokyo University of Science, 6-3-1 Niijuku, Katsushika, Tokyo, Japan, Japan

Session 07 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Metastatic breast cancer remains a critical clinical challenge due to therapeutic resistance and poor prognosis, highlighting the need for precise and multifunctional treatment strategies. In this work, we developed a metal-enhanced ZIF-8 nanohybrid that integrates targeted delivery, mitochondrial disruption, and chemodynamic therapy (CDT) to improve therapeutic outcomes. The engineered nanoplatform, HA-Au@ZIF-8@TPP-DOX, incorporates gold nanoparticles within the ZIF-8 framework to enhance catalytic generation of reactive oxygen species (ROS), thereby intensifying oxidative stress in cancer cells. Triphenylphosphonium (TPP) moieties enable efficient mitochondrial targeting, allowing direct interference with cellular energy metabolism and apoptosis regulation. Surface functionalization with hyaluronic acid (HA) promotes selective uptake via CD44 receptor-mediated endocytosis, improving tumor specificity. Additionally, the system exhibits pH-responsive release of doxorubicin (DOX) within the acidic tumor microenvironment, ensuring controlled and localized drug action. Collectively, the nanohybrid induces synergistic anticancer effects through elevated ROS production, mitochondrial dysfunction, and enhanced apoptotic signaling. This multifunctional platform not only improves therapeutic precision but also has the potential to integrate with immunomodulatory approaches, offering a promising strategy for advancing metastatic breast cancer treatment.

July 16, 2026 | 9:10 AM

Study of Antimicrobial OIMS (oligo-imidazoliums) Internalization Mechanism, Structure-activity Relationship and Toxicity Property

Chongyun Tan[1]

[1]Ningbo Institute of Materials Technology and Engineering, Ningbo, China

Session 07 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Antimicrobial resistance (AMR) poses a major global health challenge, driving the need for new antibacterial agents with distinct mechanisms of action. This work investigates oligo-imidazoliums (OIMs), a class of main-chain cationic antimicrobials with unique membrane-translocating properties.

Mechanistic studies reveal that OIMs utilize transient N-heterocyclic carbene (NHC) formation to facilitate bacterial membrane translocation without inducing membrane lysis. Carbene-mediated hydrophobic switching enables these highly hydrophilic polycations to penetrate bacterial membranes and target intracellular DNA. Structure–activity relationship studies further demonstrate that balancing carbene stabilization and overall hydrophilicity is critical for optimizing bacterial uptake and antibacterial efficacy.

To improve in vivo safety, a dual-degradable nanoparticle system, PM251-NP, was developed to shield polycationic charges and enable pH-responsive release at infection sites. PM251-NP exhibited potent antibacterial activity against multidrug-resistant pathogens with improved biocompatibility and demonstrated strong therapeutic efficacy in multiple murine infection models caused by carbapenem-resistant Carbapenem-resistant Acinetobacter baumannii.

These findings establish OIMs as a promising antimicrobial platform and provide a potential translational strategy for combating multidrug-resistant bacterial infections.

Antioxidant PDA/CeO2 coating on PLLA stent for intestinal ROS scavenging

Shangyong Zuo[1], Prof. Kui Cheng[1]

[1]Zhejiang University School of Materials Science and Engineering, 866 Yuhangtang Road, Xihu District, China

Session 07 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Inflammatory bowel disease (IBD), especially Crohn's disease, is often marked by persistent inflammation, oxidative stress, and aberrant tissue remodeling, which together create a microenvironment hostile to intestinal repair. The stent-based diverting technique (SDT) can achieve temporary fecal diversion, shield lesions or anastomotic sites, and thereby facilitate healing. However, metallic devices are constrained by chronic foreign-body irritation and the need for secondary removal, whereas biodegradable polymeric materials generally lack bioactivity for local microenvironmental regulation. Therefore, developing functionalized intestinal diversion stent materials integrating diversion, biodegradability, and antioxidant activity is of considerable significance. In this study, a PLLA substrate was first prepared by hot pressing, followed by dopamine self-polymerization to construct a polydopamine (PDA) interlayer and subsequent in situ growth of CeO2 under alkaline conditions at 90 °C, thereby generating an antioxidant PDA/CeO2 functional coating on PLLA. This coating strategy uses PDA as a stable interfacial layer and reactive platform, enabling CeO2 to be in situ immobilized on the substrate surface with smaller particle size and more homogeneous dispersion. Compared with conventional direct particle loading, the in situ constructed functional coating is expected to deliver higher catalytic efficiency with lower rare-earth metal usage, while improving interfacial stability and biosafety. The resulting composite exhibited high mechanical strength, a certain degree of degradability, and good biocompatibility. The in situ generated CeO2 endowed the material with excellent antioxidant activity, enabling effective reactive oxygen species (ROS) scavenging to alleviate local oxidative stress and thereby improve the unfavorable microenvironment at intestinal lesion sites. The PDA interlayer enhanced the interfacial bonding and stability between the functional coating and the PLLA substrate. This material is expected to relieve local oxidative stress while providing mechanical support, offering a biodegradable antioxidant surface-coating strategy for intestinal diversion.

July 16, 2026 | 9:45 AM

Heterostructured metal/metal oxide thin films for electrochemical biosensing applications

Mr Muralidharan Lakshmi Narayanan[1], Dr C Viswanathan[1]

[1]Bharathiar University, Department of Nanoscience and Technology, India

Session 07 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Integrating distinct metal oxides and metal/metal oxide systems at the nanoscale enables the formation of functional interfaces that enhance charge transfer and significantly increase the electrochemically active surface area. However, achieving an optimal balance between sensitivity and durability in immunosensor platforms remains a key challenge. In this study, a robust label-free immunosensing platform for the detection of Interleukin-6 (IL-6) a crucial biomarker associated with viral and microbial infections, tumors, and cancers has been successfully developed. The sensor was fabricated by depositing Cu/WO_3 thin films onto carbon-based substrate using RF magnetron sputtering, enabling highly sensitive IL-6 detection. The interplay between substrate temperature and electrochemical performance was systematically examined. The fabricated electrode exhibited a linear current response across a wide IL-6 concentration range from 1 fg/mL to 1 µg/mL with a sensitivity of 22.49 µA/(µg/mL). Furthermore, the uniformly deposited Cu/WO_3 thin films demonstrated excellent stability, repeatability, and reproducibility. These results underscore the potential of such thin-film architectures as reliable electrode materials for developing high-performance, label-free immunosensors for the early detection of critical diseases.

3D printable/injectable personalized amyloidgenic hydrogel for accelerated wound healing and tissue regeneration

Ms. Shikha Tripathi[1], Prof. Avanish Singh Parmar[1]

[1]Indian Institute Of Technology, BHU, Varanasi, Varanasi, India

Session 07 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Personalized biomaterials with multifunctional healing capabilities are essential for addressing complex and diverse tissue injuries. In this work, we present a novel 3D printable and injectable amyloidogenic hydrogel, derived from self-assembling protein fibrils, designed to accelerate healing in renal abscesses, internal organ injuries, deep muscle wounds, and burn wounds. The hydrogel mimics the extracellular matrix (ECM), forming a biocompatible, structurally stable scaffold that supports cell survival, proliferation, and migration. Unlike conventional hydrogels limited by weak mechanical properties, high cost, and poor reproducibility, our hybrid formulation offers enhanced mechanical resilience, scaffold stability, and cost-effectiveness while maintaining high biodegradability and biocompatibility. Tunable porosity and adhesive properties further support cellular infiltration and integration. Inherent antimicrobial, antioxidant, and anti-inflammatory properties facilitate faster tissue regeneration through neovascularization and collagen remodeling. The dual-mode delivery injectable for internal applications like kidney abscesses and printable for surface wounds ensures versatility and site-specific adaptation. In vivo studies on rat models confirm the hydrogel's effectiveness in reducing inflammation, enhancing tissue integration, and significantly accelerating healing outcomes in both soft and complex tissues. This personalized, ECM-inspired hydrogel system addresses current limitations in tissue engineering and wound management, offering a promising, patient-adaptable solution for acute and chronic injuries. It represents a transformative platform in regenerative medicine, capable of meeting the multifaceted demands of modern wound care through its multifunctional healing capabilities.

Enhanced corrosion resistance and osteogenic activity of PEO-coated Ti-Mg composites

Si Rui Tian[1], Enhanced corrosion resistance and osteogenic activity of PEO-coated Ti-Mg composites Qiang Wang[2], Enhanced corrosion resistance and osteogenic activity of PEO-coated Ti-Mg composites Bao Hong Zhao[3]

[1]School and Hospital of Stomatology,China Medical University,, 117 North Nanjing Street, Heping District, China, [2]School and Hospital of Stomatology,China Medical University,, 117 North Nanjing Street, Heping District, China, [3]School and Hospital of Stomatology,China Medical University,, 117 North Nanjing Street, Heping District, China

Session 08 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 10:45 AM - 12:05 PM

Titanium (Ti) and magnesium (Mg) have garnered considerable attention as bone implant materials owing to their superior mechanical properties and excellent biocompatibility, respectively. However, traditional single-phase materials often exhibit limitations in synergizing biological responses with degradation behaviors. To overcome these limitations, Ti-Mg composites with a three-dimensionally (3D) interconnected structure were designed and fabricated by combining selective laser melting (SLM) and pressureless infiltration techniques. In this composite, a porous Ti scaffold with a triply periodic minimal surface (TPMS) architecture serves as the continuous skeleton, while Mg is introduced as a degradable phase to effectively compensate for the deficiencies of the individual materials. Furthermore, to optimize the surface properties and regulate the degradation behavior, a plasma electrolytic oxidation (PEO) coating was fabricated on the composite surface. The composition, microstructure, coating characteristics, corrosion behavior, and biological performance of the composites were systematically evaluated. The results indicated that the PEO-coated Ti-Mg composites exhibit not only significantly enhanced corrosion resistance but also superior biocompatibility and improved osteogenic capacity, demonstrating the immense potential of this novel composite as an advanced implant for bone defect repair.

July 16, 2026 | 11:05 AM

Multi-functional nanofibrous membrane with antibacterial abilities for infected diabetic wound healing and long-lasting air filtration

Prof. Junwei Ye[1], Dr Lanling Xiu[1], Miss Ziran Wang[1], Dr Yueguang Fang[1]

[1]Dalian University Of Technology, 2 Linggong Road, High Technology Zone, Dalian 116024, P.R. China, China

Session 08 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 10:45 AM - 12:05 PM

To address the increasingly severe problem of bacterial resistance, the development of new and highly effective antibacterial materials is urgently needed. Organic-inorganic composite nanomembrane materials, with their adjustable structure and multi-functional synergy, demonstrate outstanding antibacterial and wound healing-promoting potential and have become a current research hotspot. Precise structural design is the key to achieving the efficient, broad-spectrum and intelligent antibacterial properties of organic-inorganic composite nanomaterials. This article introduces the design and preparation of composite nanomembranes with pH, light and infection microenvironment stimulus-responsive properties, studies the effects of interfacial interactions such as covalent bonds, coordination bonds and electrostatic attractions on the stability and dispersion of the composite materials, and reveals the mechanism of their multi-mode synergistic enhancement of antibacterial activity. The prepared composite materials can be used in wound antibacterial dressings, air filtration film materials and other fields.

Improving durability of stainless steel nanopillar surface structure to prevent antibacterial activity deterioration induced by abrasion

Dr. Mitsuhiro Hirano[1], Mr. Keita Kitazawa[1], Mr. Kai Kojima[1], Mr. Nozomu Kuraoka[1], Prof. Naofumi Ohtsu[1]

[1]Kitami Institute of Technology, 165 Koen-cho, Japan

Session 08 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 10:45 AM - 12:05 PM

Ar plasma etching with direct current (DC) discharge for AISI 316 stainless steel (316SS) can fabricate an antibacterial nanopillar surface, yet such unique structure is damaged by the abrasion such touching gently. To maintain the structure, dimension and strength of nanopillars need to be improved. The deformation of nanopillars is caused by bending stress induced with contact, which depends on their height and diameter. Furthermore, the modification of nanopillar is also one of effective approaches for enhancing their strength. Thus, in this study, we attempt to improve the durability of nanopillar surface by optimizing the dimension and performing plasma nitriding as post-treatment. Using an instrument built in our laboratory, 316SS substrates etched by Ar plasma DC-discharged with a constant current ranging from 0.05 to 0.15 A for 60 min to fabricate various nanopillar. Subsequently, etched surfaces were plasma-nitrided using gas mixture composed N_2 and H_2. Finally, antibacterial activity against Staphylococcus epidermidis was evaluated on the surfaces damaged by the abrasion, and the effect of these approaches on durability and function was discussed.

Nanopillars with various dimensions were fabricated on the entire surface via Ar plasma etching, of which height and diameter increased with increasing the current. Especially, on the surface etched at 0.15 A, maximum current in this study, a part of higher pillars was deformed and broken after abrasion test, whereas smaller that were maintained. When such structure was plasma-nitrided, nanopillars were modified to expanded austenite phase via interfacial solution of nitrogen atoms, resulting in preventing their deformation. Furthermore, nitrided nanopillar surface exhibited antibacterial activity even if it was damaged by abrasion. These results indicated that the improvement of durability and the sustention of antibacterial activity on nanopillar surface was achieved by strengthening the higher nanopillars which protect smaller that through post plasma nitriding.

July 16, 2026 | 11:45 AM

Interfacial Behavior of Functionalized Short Quartz Fibers for Dental Resin Composites

Assoc. Prof. Ruili Wang[1]

[1]Donghua University, 2999 North Renmin Road, China

Session 08 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 10:45 AM - 12:05 PM

The development of dental resin composites (DRCs) with high mechanical performance remains a significant challenge due to the weak filler-matrix interfacial bonding. Herein, we proposed a rational strategy for interfacial reinforcement by grafting methacrylate-polyhedral oligomeric silsesquioxane (MA-POSS) onto the thiolated short quartz fibers (SQFs-SH) via thiol-ene click chemistry. The resulting surface-functionalized fibers (PxSQFs) exhibited tunable grafted layer thickness by controlling the thiol concentration, where P0.33SQFs showed the roughest surface (Ra = 17.92 nm) and optimal grafted thickness (0.86 μm). All PxSQFs were incorporated into the Bis-GMA-based matrix and photopolymerized by visible light to fabricate dental composites. Among all materials, the developed P0.33SQFs-filled DRCs (P0.33SQFs-DRCs) exhibited highest flexural strength and modulus, fracture toughness, and fracture work, which were increased by 64.8, 123.3, 51.2, and 118.7%, respectively, over the unmodified SQFs-filled composite. Meanwhile, the molecular dynamics (MD) simulations were performed to elucidate the mechanical performance and interfacial behavior of PxSQFs-DRCs from a molecular-level perspective, where P0.33SQFs-DRCs exhibited the strongest interfacial adhesion, the highest resistance during the fiber pull-out process, and the maximum stress response under both longitudinal and transverse uniaxial tension models. In vitro and in vivo cytocompatibility assessments confirmed that this P0.33SQFs-DRCs material showed no adverse effects. This work provides a multiscale construction strategy for fiber surface functionalization and combines experimental and simulation studies on the interfacial behaviors of dental composites, which can offer a design guidance for the next-generation of dental materials with enhanced mechanical reliability and clinical safety.

July 16, 2026 | 1:30 PM

Ultrasound-responsive PVTF coated GaIn Microspheres for biomedical application

Xin Xin[1], Professor Kui Cheng[2]
[1]Zhejiang University, , China, [2]Zhejiang University, , China
Session 09 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 1:30 PM - 2:30 PM

Recently, room-temperature liquid metals have attracted increasing attention due to their excellent material properties. However, their intrinsically low melting point causes them to reaggregate at body temperature, which severely limits their application in biomedical environments. In this work, we focus on designing a functional coating to stabilize liquid metals and endow them with bioactive and responsive properties. Polyvinylidene fluoride-based polymers are widely used in biomedical fields due to their excellent piezoelectric effect. Here, we develop an injectable microsphere system (GaIn@PVTF) in which polyvinylidene fluoride trifluoroethylene (PVTF) serves as a conformal coating on GaIn droplets, forming core–shell structured microspheres with self-polarizing properties for the treatment of bone tissue injury and inflammation regulation.GaIn@PVTF microspheres are prepared via a phase-separation method, during which the PVTF coating is formed in situ on the surface of GaIn. The PVTF coating markedly improves the colloidal and morphological stability of the liquid metal in aqueous media and physiological environments. Furthermore, by tuning the polarity of the solvent system, the coating thickness and integrity of the PVTF shell can be effectively regulated, thus enabling precise control over the microsphere structure and functional response.During the microsphere formation process, the electrostatic coupling between the inherently negative surface potential of the liquid metal core and the PVTF molecular chains, together with hydrogen bonding between the hydroxyl groups of the outer solvent and PVTF chains, induces spontaneous orientation of the polar phase in the PVTF coating. Under external ultrasound, the coated microspheres efficiently convert acoustic energy into localized electrical stimulation, allowing on-demand activation and regulation of their biofunction.Biological evaluation shows that GaIn@PVTF microspheres possess good biocompatibility. In addition, the high negative surface potential arising mainly from the PVTF-coated interface, combined with the intrinsic imaging capabilities of the GaIn core, enables passive targeting of inflammatory sites and supports multimodal imaging.

July 16, 2026 | 1:45 PM

Amyloid-like Protein-Metal Sulfide Nanocoatings for Synergistic Photothermal and Antibacterial Implant Surface Protection

Kexin Li[1]

[1]Southwest University, Beibei Campus: No. 2, Tiansheng Road, Beibei District, China

Session 09 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 1:30 PM - 2:30 PM

Preventing bacterial adhesion and biofilm formation is essential for the long-term success of biomedical implants. Implant-associated infections remain a significant clinical challenge, underscoring the urgent need for effective and durable antimicrobial surface strategies. This study develops a nanocoating with dual antibacterial adhesion and photothermal antibacterial properties for biomedical surface modification. Bovine serum albumin-templated metal sulfide (MS@BSA) nanocomposites are synthesized and converted into a stable nanofilm via phase-transitioned BSA (PTB) self-assembly. The MS@PTB coating adheres to various substrates and demonstrates broad-spectrum antibacterial activity. In vitro assays show that the copper sulfide@PTB (CuS@PTB) coating significantly reduces bacterial attachment and suppresses biofilm development upon 808 nm near-infrared irradiation. RNA sequencing identifies differentially expressed genes in common pathogens, indicating disrupted respiration, energy metabolism, and virulence pathways, as well as stress responses to heat and copper ions. In vivo experiments using rat subcutaneous infection and abdominal wall defect models demonstrate that CuS@PTB markedly reduces bacterial load and inflammatory responses, while accelerating tissue regeneration and maintaining excellent biocompatibility. The results demonstrate the synergistic antibacterial effects of photothermal heating and Cu ion release, supporting CuS@PTB as a promising antimicrobial surface coating for implantable biomaterials.

Self-Assembled Mechanochromic Nano Thin-Film Structures for Wearable Health Monitoring

Ms. Srijeeta Biswas[1], Dr. Tapajyoti Das Gupta[1]
[1]Indian Institute of Science, CV Raman road, IISc, Bengaluru 560012, India
Session 09 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 1:30 PM - 2:30 PM

Mechanochromic nano thin-films that exhibit reversible color changes under mechanical deformation provide an intuitive, power-free approach for real-time visualization of strain and curvature, making them highly attractive for wearable healthcare and biomedical sensing. However, most existing curvature sensors either require large deformations to produce detectable optical responses or suffer from mechanical fatigue and hysteresis, and often depend on complex lithographic or multistep fabrication processes that limit scalability and clinical translation.

Here, we present a simple, lithography-free thermal self-assembly strategy to fabricate large-area, ordered one-dimensional sinusoidal wrinkle structures in silver thin films supported on elastomeric PDMS substrates. The method exploits controlled thermomechanical instability arising from thermal expansion mismatch between metal and polymer layers, enabling spontaneous formation of periodic wrinkle patterns with tunable wavelengths. These nano-engineered wrinkled bilayers function as self-assembled diffraction gratings, producing vivid structural colors that vary sensitively and reversibly with applied curvature. The mechanochromic response spans a broad color gamut in CIE space, enabling direct optical readout of bending and strain without external power or electronics.

The thin-film curvature sensors exhibit minimal hysteresis, high repeatability over hundreds of deformation cycles, and robust mechanical and environmental stability under variations in temperature and solvent exposure. Owing to their conformal flexibility and dynamic optical tunability, the structures can be seamlessly integrated into wearable biomedical platforms, including flexible curvature sensors and smart bandages. When applied as smart bandages, the wrinkled metal–elastomer films visually report tissue swelling or deformation through distinct, reversible color changes correlated with local curvature, allowing qualitative assessment of healing progress or inflammatory conditions, supporting timely medical decision-making in resource-limited or remote locations.

Overall, this work establishes self-assembled mechanochromic thin-film nanomaterials as a scalable and sensitive platform for power-free biomedical sensing, bridging nanomaterials design with practical applications in wearable healthcare monitoring and personalized biomedical engineering.

July 16, 2026 | 2:15 PM

Shikonin-loaded porous graphdiyne nanofilm on titanium surface for enhanced antibacterial activity and osseointegration

Xiaojing Zhang[1]

[1]Southwest University, Beibei Campus: No. 2, Tiansheng Road, Beibei District, China

Session 09 - S02: Biomedical and Healthcare (BHC), Seletar1 - Level 3, July 16, 2026, 1:30 PM - 2:30 PM

Bacterial infection, peri-implant inflammation, and poor osseointegration are primary causes of failure in titanium (Ti)-based implants. Surface functionalization provides a simple and effective strategy to overcome these challenges. In this study, we developed a multifunctional coating based on porous graphdiyne (GDY) nanofilm loaded with shikonin (Skn). GDY was synthesized on Ti surfaces via a copper-catalyzed reaction to form a porous nanostructure. Following Skn loading, a composite layer of tannic acid (TA) and poly (N-isopropylacrylamide) (pNIPAM) was applied, resulting in the Ti-GDY@Skn-TP system. Upon near-infrared (NIR) irradiation, the GDY coating induced localized photothermal effects sufficient to eradicate bacteria. Concurrently, the thermoresponsive release of Skn suppressed early inflammation and promoted osseointegration by regulating macrophage polarization and inflammatory cytokine secretion. In vivo studies confirmed that Ti-GDY@Skn-TP implants effectively eliminated bacterial infections, attenuated acute inflammation, and enhanced bone tissue regeneration and implant integration. This multifunctional approach offers a promising strategy for the surface modification of Ti-based biomedical implants.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A Novel Strategy for Achieving Immunomodulation and Osseointegration of Titanium Alloys: Boron-Doped Porous Coating Modification

Yan Li[1,2], **Xinwei Ming**[1,2]

[1]School of Materials Science and Engineering, Beihang University, 37 Xueyuan Road, Haidian District, Beijing, China, [2]Hangzhou International Innovation Institute, Beihang University, No.166, Shuanghongqiao Street, Yuhang District, Hangzhou, China

Poster Session - S02: Biomedical and Healthcare (BHC), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Durable performance of metallic implants in the research fields of biofunctional materials hinges on robust osseointegration and controlled immunomodulation at the bone-implant interface. Steering macrophage polarization and osteoblast proliferation via surface topography and chemistry has become an effective strategy for titanium alloy implants. This work fabricated an innovative boron-doped, hierarchical porous ceramic coatings on the low-modulus Ti-19Zr-10Nb-1Fe alloy using a one-step micro-arc oxidation process, achieving adjustable pore topography, roughness, wettability, and boron release rate by the setting of voltages. M300V coatings have higher adhesion and improved corrosion resistance. In vitro, osteoblast proliferation and differentiation were enhanced on these coatings, and macrophages were polarized toward an anti-inflammatory M2 phenotype. Conditioned medium from M2 macrophages further promoted osteoblast differentiation. These effects are likely mediated by activation of key osteogenic pathways involving RUNX2, COL1, and OCN. In a rat femoral condyle model, early inflammatory responses were reduced, osteoclast activity was suppressed, and osseointegration was improved by the M300V coating. These findings show that the MAO hierarchical porous coatings synergize osteogenesis and immune regulation caused by the addition of boron and hierarchical porous microstructures, offering a promising surface strategy for orthopedic and dental implants.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Ice Regulation of Magnetic Ionic Liquids Self-Assemblies

Professor Lixia Ren[1], Jie Yang[1], Xiaoyan Yuan[1]

[1]Tianjin University, Tianjin, China

Poster Session - S02: Biomedical and Healthcare (BHC), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Ice regulation is crucial for applications in cryopreservation, food science, and materials engineering. Inspired by the structure-function relationship of antifreeze proteins (AFPs), we designed and synthesized a series of magnetic ionic liquids (MILs) with different linker and counter ions to investigate the role of MIL structure on the self-assembly structures and the ice regulation property. It is noted that MILs with [$FeCl_4^-$] as counter ion are self-assembled into spindle shape nanosheet. And, the MIL with terphenyl linker with smallest size shows the most active ice regulation property, which reduces the mean largest grain size (MLGS) by 19.7 ± 3.2% at 1.28 mM compared with DI water. The ice regulation property is closely related to the self-assembly structure and size, which is important in design of ice regulation materials.

References:

[1] Yuan, L.; Chen, B.; Zhu, K.; Ren, L.; Yuan, X. Development of Macromolecular Cryoprotectants for Cryopreservation of Cells. Macromol. Rapid Commun. 2024, 45, 2400309.

[2] Murray, K. A.; Gibson, M. I. Chemical Approaches to Cryopreservation. Nat. Rev. Chem. 2022, 6, 579-593.

[3] Yang, J.; Zhang, X.; Zhu, K.; Yuan, X.; Shi, W.; Ren, T.; Ren, L. Self-Assembled Nanostructures of 3ph-Imi[Fecl4] as a Strong Ice Recrystallization Inhibitor. J. Colloid Interface Sci. 2026, 710, 140021.

Acknowledgements:

This work was financially supported by the National Natural Science Foundation of China (No. 52073201 and 52373152).

SYMPOSIUM S3 | ABSTRACT #739

July 14, 2026 | Invited | 10:50 AM - 11:10 AM | Boardroom - Level 3

Breaking Mobility Limits in Flexible Transparent Conductive InOx Thin Films: Precursor Engineering and Crystallization Control

Junichi NOMOTO 1,2

National Institute of Advanced Industrial Science and Technology (AIST)
Japan Society of Vacuum & Surface Science (JVSS)

Invited - S3: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3

Indium oxide-based transparent conductive films are emerging as indispensable materials for next-generation flexible optoelectronics, including solar cells and near-infrared devices. Among them, hydrogenated In2O3 (IO:H) and Ce-H co-doped In2O3 (ICO:H) have demonstrated extraordinary electron mobilities exceeding 100-130 cm2/Vs, far surpassing conventional ITO. However, their practical implementation on flexible substrates has been hampered by the lack of a unified understanding of precursor design and crystallization pathways.

In this talk, we will present a comprehensive framework that directly links deposition conditions, precursor structure, crystallization dynamics, and electronic transport properties, establishing a clear design principle for achieving high-mobility InOx thin films. By integrating RF magnetron sputtering (RF-MS) and reactive plasma deposition (RPD) with advanced surface-sensitive techniques, including HAXPES, TDS, SIM, and EBSD, we elucidate the fundamental mechanisms governing solid-phase crystallization and defect formation.

For IO:H films, we reveal that the microcrystal density embedded in the amorphous precursor precisely controlled by water vapor partial pressure (PH2O), RF power (PRF), and oxygen flow ratio (fO2) plays a decisive role in determining crystallization behavior. Remarkably, precursors prepared under low PRF (20 - 60 W) and optimized fO2 (0.1 - 0.5%) enable growth-limited solid-phase crystallization at temperatures below 200 °C, initiated from sparsely distributed microcrystalline seeds. This unique growth mode yields micrometer-scale grains, as confirmed by SIM/EBSD and 3D FIBSEM, while HAXPES and TDS analyses reveal substantial reduction of defect states and hydrogenrelated species. These synergistic effects underpin electron mobilities exceeding 100 cm2/Vs. [1]

For ICO:H films, we further demonstrate a breakthrough approach to overcome thermal limitations of polymer substrates. By employing KrF excimer laser irradiation, transient photothermal effects enable rapid crystallization processes otherwise unattainable under conventional thermal budgets. The evolution from amorphous phase to nucleation, grain growth, and grain coalescence is clearly visualized, leading to polycrystalline films with grain sizes of 2-3 μm even on PET substrates. As a result, a Hall mobility of 133 cm2/Vs and a sheet resistance of 14.2 ·/sq. are achieved-among

the highest performances ever reported for flexible transparent conductors. [2]

These findings converge to a unifying concept: high-mobility InOx films are realized by designing low microcrystal-density precursors and driving defect-minimized solid-phase crystallization. The combined use of multi-modal surface analyses provides direct, quantitative evidence of the causal relationships between processing, structure, and electronic properties.

This work not only establishes a reproducible pathway toward high-performance transparent electrodes on flexible substrates but also offers a broadly applicable strategy for precursor engineering in functional oxide thin films.

[1] J. Nomoto et.al., ACS Appl. Mater. Interfaces 16, 64113 (2024).

[2] J. Nomoto et.al., NPG Asia Materials 14, 76 (2022).

July 14, 2026 | 11:10 AM

Synergetic Reactions between HF adsorption and Plasmas enabling atomic-layer processes

Shih-nan Hsiao[1], Che-Ya Wu, Makoto Sekine, Masaru Hori
[1]Nagoya University, ES building 425, Furo, Chikusa, Japan

Session 01 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

To meet the stringent demands of device scaling in semiconductor fabrication, achieving atomic-scale precision in both deposition and etching processes—specifically, atomic-layer deposition (ALD) and atomic-layer etching (ALE)—is imperative for high-fidelity pattern transfer. Non-equilibrium low temperature plasma facilitate ALD at reduced thermal budgets and enable anisotropic ALE through directional ion bombardment and the high reactivity of plasma-generated radicals. These radicals engage in gas-phase reactions and surface-interface physiochemical reactions, driving the overall deposition and etching kinetics.
Beyond radical-driven chemisorption, cryogenic-assisted ALE and reactive ion etching—which leverage the physisorption of neutral species—offer superior process characteristics compared to conventional process. Consequently, these methods have emerged as promising candidates for the fabrication of next-generation semiconductor devices. Specifically, it utilizes surface-adsorbed HF/H2O as etching catalysts in conjunction with plasma species, significantly enhancing the etching performance for SiO2 [1-2]. This study elucidates the mechanisms of cryogenic plasma etching for SiO2 and SiN using HF-containing precursors. By exploiting the synergistic surface reactions between HF physisorption and plasma exposure, this technique enables plasma-assisted atomic layer processing at cryogenic temperatures [3].

[1] S. N. Hsiao, et al., Small Methods, 8, 2400090 (2024).
[2] S. N. Hsiao, et al., Chem. Eng. J. 522, 167517 (2025).
[3] S. N. Hsiao, et al., Small Methods, 10, 01744 (2026).

July 14, 2026 | 11:30 AM

Self-Consistent Fluid-Circuit Modeling of Impedance Matching for Ar/SiH4 PECVD

Lifen Zhao[1], Dehen Cao[2], Shimin Yu[2], Prof. Xiangmei Liu[3], Prof. Hongyu Wang[4], Wei Jiang[2], **Ya Zhang**[1]

[1]Wuhan University Of Technology, , China, [2]Huazhong University of Science and Technology, , China, [3]Qiqihar University, , China, [4]Anshan Normal University, , China

Session 01 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

In plasma-enhanced chemical vapor deposition (PECVD), the dynamic coupling between the radio-frequency (RF) capacitively coupled plasma (CCP) and the external impedance matching network is critical but often oversimplified. To address this, a fully self-consistent fluid-external circuit coupled model was developed to investigate the RF-CCP discharge evolution from initial electrical breakdown to steady-state operation.

During the transient breakdown phase in argon, the impedance matching state fundamentally dictates the ignition dynamics. While non-optimal matching can expedite breakdown at lower pressures (1 Torr), optimal matching maximizes the post-breakdown steady-state electron density and heating efficiency. For steady-state argon discharges, the system reliably converges to an optimal matching state independent of initial circuit parameters. However, as pressure increases, the real part of the plasma impedance exceeds standard source resistance, necessitating an alternate circuit topology (Topology II) to achieve effective matching.

Extending the model to Ar/SiH_{4} mixtures—essential for hydrogenated amorphous silicon (a-Si:H) deposition—reveals that iterative matching significantly enhances reactive species densities and power absorption. As silane concentration increases, plasma electronegativity and equivalent resistance rise monotonically. Crucially for high-quality film growth, higher silane concentrations combined with optimal impedance matching elevate the silyl-to-silylene radical flux ratio and the overall silicon deposition rate. These deposition metrics are consistently superior at the powered electrode, highlighting its strategic advantage as a substrate location. This comprehensive approach bridges the gap between external circuitry and plasma kinetics, offering systematic theoretical guidelines for optimizing PECVD processes.

Combined effect of MRSR mechanism and E×B drift in magnetized capacitively coupled plasma

Mr. Ze-Xuan Liu[1], Fang-Fang Ma[1], Quan-Zhi Zhang[1]
[1]Dalian University of Technology, No.2 Linggong Road, Ganjingzi District, , China
Session 01 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

Recently, magnetized capacitively coupled plasmas (MCCPs) have exhibited an emerging trend in semiconductor manufacturing, with increasing interest from industry and ongoing integration into advanced etching and thin-film deposition platforms. A resonance mechanism in MCCPs, known as the magnetized RF sheath resonance (MRSR), occurs when half of the electron cyclotron period matches the RF period. This mechanism has been shown to enhance electron–sheath interactions and increase the plasma density, but its interplay with coexisting multidimensional effects remains unexplored.

In this work, we employ an advanced 2D3V magnetized implicit PIC/MCC model to elucidate the combined effect of MRSR and E×B drift. Our results indicate that the E×B drift emerges simultaneously as electrons interact with the expanding sheath. Consequently, electrons do not resonate in a localized region but drift along the chamber periphery. The combination of these effects leads to an overall enhancement in plasma density, while also causing pronounced non-uniformity in the density distribution. The results also extend the investigation to a broader parameter space, where we examine how chamber geometry and electrical parameters influence this coupled effect. Moreover, the rotating magnetic field is found to have a good modulation effect on the density uniformity. The instantaneous plasma drift direction and the corresponding density shift vary dynamically with the magnetic-field direction and cancel out over one rotation period, leading to an axisymmetric density distribution.

The performed research provides valuable insights into the mechanism of magnetized RF plasmas and contributes to the optimal design of magnetized plasma reactors in semiconductor and thin-film processing.

References

[1] Q. Z. Zhang, J. Y. Sun et al., Phys. Rev. E 104, 045209 (2021).
[2] J. Y. Sun, Q. Z. Zhang et al., Plasma Sources Sci. Technol. 31, 085012 (2022).

Multiscale Simulation of Magnetron Sputtered Thin-Film Growth Based on Direct Simulation Monte Carlo and Kinetic Monte Carlo Methods

Dr Yating Huang[1], Mr Wenhao Zhao[1], Mr HongWei Lian[1], Mr Shuhao Zhang[1], Dr Nan Li, Dr Lifei Zhang[2]

[1]Beijing Technology And Business University, Fucheng Road 11#, Haidian District, China, [2]Tsinghua University, Tsinghua University, China

Session 01 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

Magnetron sputtering technology has been widely applied due to its advantages of low substrate temperature, high deposition rate, dense film structure, and strong adhesion to the substrate. In this study, a multiscale simulation framework was established to investigate the entire thin-film growth process on the inner surfaces of high-aspect-ratio cylindrical cavities, including magnetic field distribution, plasma discharge characteristics, sputtering processes, particle transport, and grain growth evolution. The effects of single-target and dual-target deposition configurations, as well as substrate surface roughness, on the thickness uniformity and structural compactness of deposited films were systematically analyzed.

The background magnetic field distribution was calculated using the finite element method (FEM). The plasma discharge and sputtering processes were simulated using the particle-in-cell/Monte Carlo collision (PIC/MCC) method. The transport behavior of sputtered particles and the subsequent thin-film growth process were modeled using Monte Carlo-based approaches, including the direct simulation Monte Carlo (DSMC) method and kinetic Monte Carlo (KMC) method, enabling multiscale analysis from plasma transport to microstructural evolution during film growth.

The simulation results showed that films deposited under single-target conditions exhibited relatively large surface roughness, reduced film thickness, and a significant number of vacancies and internal pores. In contrast, dual-target deposition effectively suppressed the formation of pores and lattice defects, reduced surface roughness, and increased film thickness. Furthermore, under dual-target deposition conditions, the surface roughness of the deposited film showed a positive correlation with the substrate surface roughness.

This study provides theoretical guidance and process references for defect regulation and surface quality optimization in PVD thin-film deposition within high-aspect-ratio structures and offers important support for expanding its applications in advanced manufacturing fields.

Simulation Study on Radio-Frequency Ion Source and Ion Extraction System for Thin-Film Deposition Processes

Prof. Quan-zhi Zhang[1]

[1]Dalian University Of Technology, Ganjingzi District, Linggong road, China

Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

Radio-frequency (RF) ion sources are widely employed in ion beam sputtering, ion source-assisted evaporation, and magnetron sputtering deposition. Accordingly, effectively optimizing the plasma power coupling efficiency to improve ion yield, and refining grid structures, aperture arrangements, and voltage configurations to enhance beam quality, has become a key research direction for advancing thin-film deposition quality. Nevertheless, simulations of RF inductive discharges and ion extraction systems face several critical challenges: first, the complex irregular geometry of extraction electrodes and multi-aperture arrays complicates boundary representation; second, large-scale grid arrays significantly expand the computational domain, imposing heavy computational burdens; third, the strong coupling between particle dynamics and electromagnetic fields demands extremely high simulation efficiency.

To address these issues, this study establishes an integrated PIC/MCC simulation framework covering the ion source and ion extraction system. On one hand, a two-dimensional implicit PIC/MCC model is specifically developed for low-pressure miniature RF inductively coupled plasma (ICP) discharges. Using this platform, numerical simulations of argon discharges under various operating parameters are performed to systematically analyze the spatial distribution, temporal evolution, and heating mechanisms of plasma characteristics. On the other hand, an efficient particle simulation method is proposed, featuring customized numerical algorithms for irregular geometries to achieve high-precision boundary modeling of electrodes and apertures. Particle dynamics simulations further optimize the focusing performance and current uniformity of the extracted ion beam.

Simulation results reveal that electrons exhibit strong nonlocal behavior at low pressures; high-energy electrons from the skin layer induce negative power absorption during diffusion, while the anomalous electric field distribution further modulates plasma properties. Additionally, the integrated framework clearly elucidates the modulation of ion trajectories by the electric field distortion region, providing theoretical support and scientific guidance for the structural design of high-current, low-divergence ion sources and the performance optimization of ion extraction systems.

July 14, 2026 | 1:40 PM

Microwave Remote Plasma Source in Semiconductor Manufacturing: Cleaning, Surface Modification, Post-Oxidation, and Atomic Layer Deposition

Mr Xingxing Huang[1], Mr Lang Hu[1], Mr Yuning Zhao[1], Doctor Li Wu[2], Doctor Zhenhuai Yang[1]

[1]Jihua Laboratory, Huandao South Road,Nanhai District, China, [2]Sichuan University, Wangjiang Road 24,Wuhou District, China

Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

Microwave remote plasma source (RPS) offers unique advantages including high-density active radicals, low ion damage, and electrode-less contamination, making it a promising technology in the field of surface engineering. This study systematically explores the multi-functional applications of microwave remote plasma source in semiconductor manufacturing, covering four key process areas: surface cleaning, surface modification, post-oxidation, and atomic layer deposition (ALD). A 2.45 GHz microwave remote plasma system was employed, achieving plasma conditions with an ion density of 1.1×10^{16} cm^{-3} and an electron density of 5.5×10^{14} cm^{-3} at a power of 300 W. For surface cleaning, oxygen plasma treatment was applied to remove carbon films on silicon wafers, resulting in a surface carbon content below 1% with no significant increase in surface roughness. For surface modification, oxygen plasma treatment of diamond-like carbon (DLC) films significantly improved hydro-philicity, as evidenced by a reduction in water contact angle from 96.6° to 42.9°, increased the film hardness by approximately 9%, and decreased the elastic modulus by about 17%. These changes indicate that the treated films possess enhanced adhesion, higher hardness, and better toughness. In post-oxidation applications, the microwave remote plasma utilizes highly active oxygen radicals to achieve low-temperature, high-efficiency oxidation, such as on SiC materials. In ALD applications, the remote plasma configuration separates the plasma generation zone from the deposition zone, exposing the substrate primarily to neutral radicals rather than high-energy ions, thereby effectively avoiding ion bombardment damage. In summary, microwave remote plasma technology integrates cleaning, modification, post-oxidation, and ALD into a single platform, providing a low-temperature, damage-free, high-purity surface treatment solution for semiconductor materials, and holds significant engineering application value in advanced semiconductor manufacturing.

Multi-Scale Modeling of HF Cryogenic Etching of SiO2 and Si3N4: From Plasma Kinetics to Surface Reactions

Xingyu Li[1], Prof. Jinda Wang[1], Junyi An[1], Quanzhi Zhang[1], Younian Wang[1]
[1]Dalian University Of Technology, No. 2, Lingong Road, Ganjingzi District, China
Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

Cryogenic etching has attracted considerable interest in 3D NAND manufacturing, where ultra-high aspect ratio structures demand precise profile control[1]. This study presents a multi-scale simulation framework for HF-based cryogenic etching (~ -20 °C) of SiO2 and Si3N4, integrating plasma kinetics, neutral transport, and surface chemistry. A Particle-in-Cell Monte Carlo Collision (PIC-MCC) model simulates HF discharge characteristics[2], while Direct Simulation Monte Carlo (DSMC) resolves neutral gas transport. Surface reactions are modeled using a cellular automata approach, complemented by density functional theory (DFT) calculations to determine reaction pathways and energy barriers[3].

The integrated multi-scale analysis reveals three key findings. First, under cryogenic conditions, HF co-adsorbs with H_2O on SiO2 surfaces, not only supplying reactants but also significantly reducing the activation energy of surface reactions. Second, the ultra-low temperature environment substantially modifies plasma discharge characteristics and neutral species transport, altering the flux and energy distribution of active species reaching the substrate. Third, the synergistic interplay between surface chemistry and gas-phase transport dictates etch anisotropy and selectivity. Collectively, these results demonstrate that cryogenic etching involves coupled mechanisms, highlighting the necessity of a multi-scale modeling approach for process optimization in advanced semiconductor manufacturing.

Keywords: Cryogenic etching, HF plasma, PIC-MCC, DSMC, DFT

Reference

[1] T. Lill et al., “Low-temperature etching of silicon oxide and silicon nitride with hydrogen fluoride,” JVSTA, vol. 42, no. 6, p. 063006, Nov. 2024.

[2] S. Takagi et al “Plasma simulation of HF plasma generated in dual-frequency chamber for high aspect ratio dielectric etching,” JJAP, vol. 63, no. 9, p. 09SP21, Sep. 2024.

[3] J.-E. Jung et al., “Highly selective Si3N4/SiO2 etching using an NF3/N2/O2/H2 remote plasma. II. Surface reaction mechanism,” JVSTA, vol. 38, no. 2, p. 023008, Jan. 2020.

July 14, 2026 | 2:15 PM

Influence of Bias Power on the Etching Behavior of Aluminum Alloy in ICP with an HBr/Cl2/N2/O2 Gas Mixture

Prof. Xianxiu Mei[1], Liyue Gong[1], Yongxin Liu[1], Fei Gao[1]

[1]Dalian University Of Technology, No. 2 Linggong Road, Ganjingzi District, China

Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

Aluminum alloys are widely used in the fabrication of semiconductor etching chambers because of their excellent thermal conductivity and mechanical properties. In this work, based on an inductively coupled HBr/Cl2/N2/O2 plasma etching process, the etching mechanisms of aluminum alloys under different bias powers were systematically investigated. In addition, some machined aluminum alloy samples (M-Al) were polished to examine the effect of surface morphology on the etching behavior. The results show that increasing the bias power mainly enhanced the ion bombardment energy on the aluminum alloy surface, while exerting only a minor influence on the electron density and radical density in the main plasma region. Meanwhile, the etching weight-loss rate of the aluminum alloy increased significantly with increasing bias power. For M-Al, the surface morphology remained essentially unchanged at low bias powers (0-200 W), whereas crater-like MgAl2O4 species formed on the surface at high bias powers (300-500 W), and their size increased with increasing bias power. On the initial surface of polished aluminum alloy (P-Al), a large number of flaky FeSi second-phase particles were exposed. At low bias powers (0-200 W), MgAl2O4 particles preferentially and selectively deposited on the surface of the FeSi second phase. When the bias power exceeded 300 W, the FeSi second phase began to fracture, and the deposited particles evolved from localized deposition to large-area coverage. XPS analysis showed that the Mg-O bond content on the etched M-Al surface was higher than that on P-Al, and weak Br 3d peaks were detected on the surfaces of both types of samples. This study reveals the etching mechanisms of aluminum alloys with different surface morphologies in inductively coupled HBr/Cl2/N2/O2 plasma under varying bias powers, and provides a theoretical basis and data support for process optimization of etching chamber materials.

In-situ post doping plasma process for improving electrical properties of ZrO2-TiN based capacitors

Sangwon Lee[1], Donghyun Kim[2], Jihwan An[1,2]
[1]Graduate School of Semiconductor Technology, POSTECH, 77 Cheongam-ro, Nam-gu, Republic of Korea, [2]Department of Mechanical Engineering, POSTECH, 77 Cheongam-ro, Nam-gu, Republic of Korea
Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

Owing to the continuous scaling of dynamic random-access memory (DRAM), the development of high-k dielectrics and the reduction of equivalent oxide thickness (EOT) in metal–insulator–metal capacitors have become increasingly critical. However, defect formation within the dielectric and unintended interfacial degradation, including oxidation of the TiN bottom electrode can significantly deteriorate electrical performance.

In this study, we propose an in-situ Ar plasma post-doping process integrated within the ALD cycle to improve the electrical properties of ZrO2-TiN capacitors while suppressing electrode degradation. The plasma treatment is performed immediately after Al dopant incorporation without breaking vacuum, enabling controlled modification of dopant distribution and film structure. Unlike reactive plasma processes, the inert Ar plasma induces ion-driven physical effects, including sub-surface atomic displacement and effectively reduces undesired oxidation of the TiN bottom electrode, preserving interface integrity.

The energetic Ar ion bombardment induces Al dopant redistribution from surface-localized regions into the dielectric bulk, leading to a more uniform dopant profile. Simultaneously, ion-driven energy transfer promotes structural relaxation, partial crystallization, and film densification. These effects collectively suppress defect-related trap states and improve interfacial quality.

Electrical characterization shows that the proposed process significantly enhances device performance. Under optimized conditions, the capacitance is substantially increased while the leakage current density is maintained at a comparable level. This behavior indicates effective suppression of the conventional trade-off between capacitance and leakage. The improvements are attributed to reduced trap-assisted conduction, enhanced crystallinity, and the preservation of the TiN interface.

July 14, 2026 | 2:45 PM

Key Scientific Issues in Plasma Interaction with Porous Complex Surfaces and Their Applications

Professor Ruobing Zhang[1], **Lan Li**[1]

[1]Tsinghua Shenzhen International Graduate School, Tsinghua University, No. 2279 Lishui Road, Nanshan District, China

Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

The interaction between low-temperature plasma and material surfaces constitutes the foundation and frontier of its applications. This study focuses on the interaction mechanisms of plasma jets with porous complex surfaces, exploring core scientific questions. Experiments reveal the penetration behavior of active plasma particles within porous inorganic materials and investigate influencing factors. Regulatory mechanisms and methods for surface hydrophobicity/hydrophilicity modulated by plasma dosage are elucidated. Finally, advances in applying this technology to power systems and biomedical fields are summarized.

July 14, 2026 | 3:00 PM

Mechanical and Tribological Performance of Magnetron-Sputtered MoS2/ZrN Composite Coatings: Influence of Composition and Ambient Conditions

Ahraf Gulzar[1], Dr. Shahid Saleem[1], Prof. M.F Wani[1]

[1]National Institute of Technology Srinagar, Dargah, Hazratbal, Srinagar, India

Session 02 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 1:20 PM - 3:15 PM

In this research, a comprehensive analysis of the mechanical, morphological, and tribological characteristics of MoS2/ZrN composite coatings deposited via direct current (DC) and radio frequency (RF) magnetron sputtering on AMS 5898 bearing steel is presented. Each coating begins with the development of a Chromium interlayer, and then a distinct single layer of MoS2/ZrN is deposited. The ZrN content was controlled by varying target power, which significantly influenced the coating's microstructure and performance. Among all coatings, the MoS2/20 at.% ZrN demonstrated superior mechanical properties (hardness: 5.83 GPa, elastic modulus: 87.04 GPa) and excellent tribological behavior under ambient conditions (Coefficient of friction: 0.091, wear rate: 2.41×10^{-7} mm^3/Nm), reflecting ~70% reduction in both coefficient of friction and wear rate compared to pure MoS_2. Post-testing wear track analysis revealed a combination of oxidative, delamination, adhesive, and abrasive wear mechanisms. These results highlight the MoS_2/ZrN composite coatings potential for solid lubrication in tribological systems.

Key words: Magnetron Sputtered MoS2/ZrN composite coatings, Surface Characterization, Mechanical Properties, Friction and Wear

July 14, 2026 | 3:15 PM

Flow-Field Reconstruction in Spin-Coating Chambers via Rectifying Plates for Uniform Coating on Square Substrates

Mr. Hongfu Zhang, Mr Zikeng Fang, Mr Jiaqi Wan, Mr Yuze Li, Mr Henan Li, **Prof. Ying Yan**[1], Mr Dongming Guo

[1]Dalian University Of Technology, State Key Laboratory of High-performance Precision Manufacturing, Department of Mechanical Engineering, Dalian University of Technology, Dalian 116024, China, China

Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

During spin coating, the airflow environment inside the chamber critically affects liquid film thinning and the final film thickness uniformity. For square substrates, geometric asymmetry during rotation generates strong edge-induced airflow disturbances and unsteady flow structures, which destabilize the chamber flow field and limit the application of spin coating to large-area or non-circular substrates.To address this issue, this study proposes an aerodynamic regulation strategy for spin-coating chambers using rectifying plates. By introducing rectifying structures into the chamber, the airflow path is guided and reconstructed, thereby improving flow stability during spin coating. Numerical simulations combined with experiments were conducted to systematically investigate the effects of rectifying structures on the spatiotemporal characteristics of the chamber airflow field. The results show that rectifying plates effectively weaken the periodic airflow disturbances caused by square-substrate rotation and suppress unsteady flow structures inside the chamber. Compared with a conventional chamber, fluctuations in airflow velocity, local angular velocity, and shear rate are reduced by 12.3%, 90.5%, and 89.6%, respectively, indicating a significant enhancement in airflow stability. Further optimization of the rectifying structure also improves airflow uniformity within the chamber. Spin-coating experiments using photoresist on square quartz substrates demonstrate that the optimized structure reduces film thickness non-uniformity from ±5.23% to ±2.06%. This improvement is mainly attributed to the reconstructed airflow field, which provides a more stable and uniform aerodynamic environment for liquid film thinning. These results confirm that aerodynamic regulation is an effective strategy for stabilizing the flow field and improving coating uniformity on non-circular substrates.

July 14, 2026 | 3:35 PM

Uniformity modulation of large-area very-high-frequency capacitively coupled plasmas driven by multi-frequency sources

Yu-Ru Zhang[1], Xin-Yang Li[1], You-Nian Wang[1]

[1]Dalian University of Technology, No.2 Linggong Road, Ganjingzi District,, China

Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

Capacitively coupled plasmas (CCPs) driven by very high frequency (VHF) sources are widely utilized in thin-film deposition and other surface treatments, due to their high ion flux and low ion energy. However, in VHF discharges, the electromagnetic effects, such as the standing wave effect (SWE) and skin effect, significantly degrade plasma uniformity, thereby imposing constraints on the broader application of VHF CCP sources. In this study, a fluid-analytical sheath hybrid model is employed to investigate the radial uniformity of VHF Ar/CF_4 discharges driven by dual- and triple-frequency sources. In dual-frequency regimes, increasing the high frequency (HF) induces a pronounced SWE, thus reducing the uniformity of species densities. Conversely, rising the low-frequency (LF) current improves uniformity, as the LF edge effect compensates for the HF SWE. Furthermore, introducing a third HF source strengthens the SWE, consequently reducing uniformity for most species except negative ions. Alternatively, adding a medium-frequency (MF) source effectively balances the SWE, evanescent wave skin effect and edge effect, thereby improving plasma radial uniformity. These findings elucidate the mechanisms underlying the electromagnetic effects and uniformity control in large-area VHF plasmas, providing valuable insights for the optimization of plasma technology and thin-film applications.

Simple and scalable large-scaled plasma plume generated via merged series-connected APPJ array

Dr. Dingyuan Peng[1], Prof. Ruobing Zhang[1], Ms. Jialu Duan[1], Dr. Lan Li[1]
[1]GuangDong Engineering Technology Research Center of High Voltage Discharge and Plasma Applications, Tsinghua Shenzhen International Graduate School, Shenzhen,China,518055,
Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

The achieving of the large-scale merge for atmospheric pressure plasma jet (APPJ) array has been an issue for APPJ application. In this work, based on an electrically series-connected APPJ array, a large-scale (3cm) merged APPJ array can be achieved. The discharge appears two different modes with different applied pulsed voltage waveform. For Mode1 with pulsed square wave, the APPJ plumes are merged only in the downstream, where the discharge is carried by transversely propagating plasma bullets. For Mode2 with strong damped oscillation waveform, the plumes are merged within the whole discharge area, with discharge intensity and uniformity increased but plume length decreased. Rather than plasma bullet, in Mode 2 the merged plume is carried by a significantly intense discharge channel spanning all APPJ units which elongates downstream with the gas flow. Moreover, with such series-connected configuration, the APPJ array is highly scalable and the achievable size of merged plume can be further expanded, up to 4.2cm in this work.
Key words: merged APPJ array; series-connected APPJ array; large-scale plasma; transverse plasma bullet; discharge bridging channel.

July 14, 2026 | 4:10 PM

Atmospheric Pressure Plasma Jet Synthesis and Deposition of Metal Organic Films

Miss Andrianne Thoma[1,3], Prof Daren Caruana[1], Dr Albertus Denny Handoko[3], Dr Riko Made[2]

[1]University College London, 20 Gordon St, London WC1H 0AJ, United Kingdom, United Kingdom, [2]A*STAR- Institute of Materials Research and engineering (IMRE), 2 Fusionopolis Wy, Singapore 138634, Singapore, [3]A*STAR- 3 Institute of Sustainability for chemicals, energy and environment (ISCE2), 1 Pesek Rd, 627833, SIngapore

Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

The tuneable physical and structural properties of metal coordinated polymers, and inorganic frameworks have generated intense interest due to their promise for energy storage, catalysis and beyond. The caveat of such materials is their translation into functional films, often hindered by lengthy synthesis and functionalisation processes. Atmospheric pressure plasma jets (APPJs), operating under ambient conditions offer great potential in complex thin film fabrication in a single step. With their high energy electrons providing unique redox pathways, APPJs enable single- step film deposition for a variety of otherwise slow growing materials.

In this work, we explore the use of APPJ to synthesise and simultaneously deposit metal-organic frameworks (MOFs) in situ. Zr based 2,5-dimercapto-1,4-benzenedicarboxylate (Zr-DMBD) MOF was used as an initial model structure due to straightforward synthesis route and robustness. In conjunction with this, pre synthesised Zr-DMBD was then deposited and functionalised with metals to create ready to use functional films. This contrasts traditional synthetic procedures, typically carried out at temperatures averaging 100 °C for at least 24 hours, with additional purification steps.

The plasma-mediated synthesis approach was extended to ferricyanide systems to evaluate the reducing capability of the plasma and probe potential structural transformation. Nickel, Iron and ferricyanide precursors were investigated to facilitate the formation of mixed metal-ferricyanide complexes, which are of interest for energy storage and biomolecule sensing applications.

The analysis of the formed films were carried out by Fourier-transform infrared spectroscopy -attenuated total reflectance (FTIR-ATR), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD). The deposits were then broadly probed using cyclic voltammetry with carbon paper and Ni foam substrates.

We conclude that APPJ's ability to synthesise an amorphous Zr-DMBD-like structures that can be decorated with metal and deposited on a surface. This approach may provide time and energy efficient pathways to create printable electrodes and sensors.

July 14, 2026 | 4:25 PM

CUSTOMIZING TRIBOLOGICAL INTERFACE STRUCTURE ON TC6 ALLOY BY PLASMA ELECTROLYTIC OXIDATION AND CATHODIC DEPOSITION

Yunhui Wang[1], **An Liu**[1], Ning Chen[1], Changming Zhang[1]
[1]Shaanxi Key Laboratory of Advanced Manufacturing and Health Management for Aviation Components, Shaanxi University of Technology, 陕西省, 中国, [2]School of Mechanical Engineering, Shaanxi University of Technology,, 陕西省, 中国
Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

Cathodic deposition (CD) is an electrochemically driven surface modification technique in which metallic, alloy, or compound layers are reduced and deposited onto a cathodic substrate. This process typically operates under relatively low voltages and is primarily applicable to non-valve metals. In contrast, plasma electrolytic oxidation (PEO) relies on high-voltage dielectric breakdown and micro-arc discharges to generate ceramic oxide coatings on valve metals, thereby markedly enhancing their mechanical strength and wear resistance.
To further improve the mechanical and tribological performance of titanium alloys, a wear-resistant and low-friction composite lubricating coating was successfully fabricated on TC6 alloy through a combined PEO pretreatment followed by CD processing. This synergistic strategy not only overcomes the intrinsic limitation of directly applying CD to titanium alloys but also effectively mitigates the relatively high friction coefficient commonly associated with PEO coatings. The proposed PEO–CD composite approach provides new insights into titanium alloy surface modification and the design of multifunctional tribological coatings.

July 14, 2026 | 4:40 PM

Unveiling 3D Plasma Dynamics in Magnetron Discharges: Implications for PVD and Thin-Film Processing

Mr. Pengze Xiao[1], Prof Wei Jiang[1], Prof Ya Zhang[2]

[1]School of Physics，Huazhong University of Science and Technology, Wuhan 430074, China, China, [2]School of Physics and Mechanics，Wuhan University of Technology, Wuhan 430070, China, China

Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

Magnetron sputtering is a cornerstone of physical vapor deposition (PVD), where plasma instabilities, particularly rotating spokes, critically influence film growth by modulating ion flux and energy. We present a 3D implicit PIC/MCC simulation study that resolves the complex topology of these instabilities, providing new insights into the plasma non-uniformities that dictate deposition rate and film microstructure. Our simulations confirm a sharp gradient in electron energy and ionization rate at the spoke front—a key region governing local flux towards the substrate. We systematically investigate the influence of magnetic field intensity and gas pressure on spoke dynamics, revealing transitions to higher azimuthal modes under stronger magnetic confinement and stabilization to a uniform plasma at higher pressures. A critical analysis of the early-stage discharge suggests that small-wavelength instabilities precede spoke formation, potentially seeding the initial perturbations that affect long-range deposition uniformity. Furthermore, we examine the fundamental mechanisms of anomalous electron heating, a process central to sustaining the discharge at low pressures relevant to high-quality film deposition. By linking mesoscale plasma structures to the flux of energy and ions at the substrate, this 3D framework offers predictive capabilities for tailoring plasma parameters to control film properties, paving the way for more uniform and precisely engineered thin films.

July 14, 2026 | 4:55 PM

Magnetic field effects on magnetized inductively coupled plasmas for thin film deposition: a PIC/MCC study

Minglun Tian[1], Pengze Xiao[1], Zhaoyu Chen[2], Zili Chen[2], Wei Jiang[1], Ya Zhang[3]
[1]School Of Physics, Huazhong University Of Science And Technology, , China, [2]School of Electrical and Electronic Engineering, Huazhong University of Science and Technology, , China, [3]School of Physics and Mechanics, Wuhan University of Technology, , China

Session 03 - S03: Plasma Technology and Application for Thin Films (PTA), Boardroom - Level 3, July 14, 2026, 3:30 PM - 5:05 PM

Magnetized inductively coupled plasmas (M-ICP) have attracted increasing attention in thin film deposition due to their potential for enhanced plasma confinement and precise control over ion bombardment, which are critical for high-quality film growth in physical vapor deposition (PVD) processes. In this work, a two-dimensional particle-in-cell/Monte Carlo collision (PIC/MCC) model is employed to systematically investigate the impact of magnetic field strength on plasma characteristics essential for thin film synthesis.

The results demonstrate that an external magnetic field significantly modulates electron heating mechanisms and spatial power deposition. As the magnetic field strength increases, electron heating becomes localized near the discharge regions, leading to a transition in the ionization structure. Consequently, the ion energy distribution function (IEDF) and ion flux—key drivers of film quality—are strongly affected. The IEDF exhibits a shift in peak energy and narrowed distribution, while the ion flux shows complex spatial variation due to enhanced plasma confinement.

These variations directly influence thin film growth mechanisms, including surface adatom mobility, film density, and microstructure evolution. Specifically, moderate magnetic fields enable fine-tuning of ion energy and flux, which is beneficial for tailoring the stoichiometric and mechanical properties of PVD films. However, excessive confinement may induce plasma non-uniformity, potentially degrading film thickness consistency. This study provides physical insights into the role of magnetic fields in M-ICP systems and offers a theoretical framework for optimizing plasma conditions to achieve superior thin film properties.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

XAS study of Zinc Ferrite Thin Films grown on Quartz substrate

Ms. Neha Neha[1], Prof (Dr.) Sandeep Kumar[1], Dr. Weon Cheol Lim[2], Mr. Byeong Hyeon Lee[2], Prof (Dr.) Sangsul Lee[3,4], Prof (Dr.) Keun Hwa Chae[2], Dr. Jitendra Pal Singh[1]
[1]Manav Rachna University, Sector - 46, Surajkund Road, Faridabad, Haryana, India, [2]Advanced Analysis and Data Centre, Korea Institute of Science and Technology (KIST), Seoul 02792, South Korea, South Korea, [3]Pohang Accelerator Laboratory, POSTECH, Pohang-37673, Republic of Korea, [4]Department of Semiconductor Engineering, POSTECH, Pohang-37673, Republic of Korea

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

For the present work, the local atomic structural evolution in zinc ferrite (ZF) thin films is systematically investigated using X-ray absorption spectroscopy (XAS). These thin films were deposited on a quartz substrate using radio frequency (RF) sputtering as a function of deposition time and subsequently annealed at 600 and 800°C. Rutherford backscattering spectrometry (RBS) confirms the stoichiometric Zn:Fe ratio. The thickness of deposited films increases with deposition time at both annealing temperatures, as confirmed by RBS and X-ray reflectivity (XRR) measurements. The increase in thickness occurs because longer deposition durations allow more atoms to accumulate onto the substrate. Slight variation in thickness between the two annealing temperatures indicates temperature-dependent densification of the films. X-ray diffraction (XRD) analysis further indicates that films deposited for shorter durations (2-15 min) are amorphous, while increasing deposition time (25-105 min) enhances crystallinity, shown by sharper diffraction peaks. Moreover, increasing the annealing temperature favours the formation of the spinel phase. O K-edge X-ray absorption near-edge spectroscopy (XANES) reveals a systematic evolution of the t2g and eg electronic states with increasing deposition time and corresponding film thickness. Fe K-edge spectra exhibit features centred at 7133, 7140, and 7147 eV. The Fe K-edge main edge energy at 7125 eV indicates Fe3+ oxidation states across all deposited thin films. Longer deposition sharpens edge features, reflecting the strengthening of local atomic structural order. The Zn K-edge evolves from broad features at shorter deposition duration (2-15 min) to well-defined peaks at 9665, 9669 and 9673 eV, consistent with Zn2+ coordination corresponding to $ZnFe_2O_4$. The increment in Zn K-edge step height with longer deposition time and post-annealing further suggests enhanced Zn2+ coordination. Thus, these results indicate significant changes in the local coordination and metal-oxygen interaction with deposition time and annealing temperature.

Keywords: RF-sputtering, Rutherford backscattering spectrometry, X-ray absorption near-edge spectroscopy (XANES)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Sacrificial Layer–Assisted Growth and Transfer of Hematite Thin Films for Ultrafast Pump–Probe Spectroscopy

Fatma Ali[1]

[1]Northwestern University, , United States

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The preparation of freestanding oxide thin film membranes remains a significant challenge for ultrafast optical characterization techniques, such as pump–probe spectroscopy, which require direct optical access to high-quality materials. In this work, we investigate a strategy for growing and transferring hematite (Fe_2O_3) thin films to enable such measurements.

A central difficulty lies in depositing hematite, a non-perovskite oxide, onto perovskite substrates, where lattice mismatch and structural differences can limit film quality and complicate the release process. To address this, we are exploring pulsed laser deposition (PLD) of hematite on $LaAlO_3$ substrates with intermediate sacrificial layers, including $Sr_3Al_2O_6$ (SAO) and $CaAl_2O_4$ (CAO). By employing (111)-oriented substrates and systematically varying sacrificial-layer compositions, we aim to improve lattice compatibility and investigate approaches to controlled film release.

Following growth, a poly(methyl methacrylate) (PMMA) layer is applied via spin coating to support the films during the release process. The sacrificial layer can then be dissolved in water to produce freestanding membranes, which are transferred onto silicon substrates. Subsequent thermal treatment and acetone processing are used to remove the PMMA layer, leaving hematite films on the target substrate.

This project focuses on developing a reproducible workflow for creating freestanding hematite thin films suitable for optical characterization. Current efforts involve optimizing substrate orientation, sacrificial layer composition, and transfer protocols to ensure the structural integrity of the membranes. Once transferred, these films will be used for pump–probe spectroscopy to investigate ultrafast carrier dynamics in hematite.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Microstructural Evolution and Crystallographic Characterization of Asymmetric Nickel-Based Superalloy Joints via Actively Modulated Micro-Offset Electron Beam Welding

Shunfeng Sang[1]

[1]季华实验室, 广东省佛山市南海区环岛南路, 中国

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Nickel-based superalloys are critical materials for capacitance diaphragm gauges (CDGs), where the reliable joining of 600 μm thin films to thick-walled cavities is essential for maintaining long-term zero-point stability. This study evaluates the effectiveness of an actively modulated micro-offset electron beam welding (EBW) technique to govern asymmetric thermal dissipation and examines the subsequent crystallographic evolution of the joints. A foundational study was conducted to quantify the impact of varied heat inputs on the fusion zone, utilizing specific beam currents (4, 5, and 8 mA) and precise spatial offsets (±0.01 mm) to tailor the interfacial thermodynamic boundaries. Electron Backscatter Diffraction (EBSD) test results confirmed the distinct correlation between localized thermal conditions and grain morphology transitions. Correspondingly, the varying degrees of microstructural heterogeneity are closely related to the dynamically altered temperature gradient and solidification rate. Areas subjected to excessive heat input (e.g., 8 mA) exhibited severe columnar grain coarsening and detrimental anisotropic epitaxial growth. Conversely, the optimized 4 mA process with a 0.01 mm offset successfully drove a Columnar-to-Equiaxed Transition (CET), forming a fine and dense equiaxed grain network in the central film region that minimized localized micro-strains. By elucidating the link between active spatial-energy modulation and microstructural homogeneity, this research offers a theoretical foundation for optimizing extreme asymmetric welding processes and ensuring the structural integrity of advanced precision sensors.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Unveiling 3D Plasma Dynamics in Magnetron Discharges: Implications for PVD and Thin-Film Processing

Mr. Pengze Xiao[1], Wei Jiang[1], Prof Ya Zhang[2]

[1]School of Physics，Huazhong University of Science and Technology,, Wuhan 430074, China, China, [2]School of Physics and Mechanics ， Wuhan University of Technology, Wuhan 430070, China, China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Magnetron sputtering is a cornerstone of physical vapor deposition (PVD), where plasma instabilities, particularly rotating spokes, critically influence film growth by modulating ion flux and energy. We present a 3D implicit PIC/MCC simulation study that resolves the complex topology of these instabilities, providing new insights into the plasma non-uniformities that dictate deposition rate and film microstructure. Our simulations confirm a sharp gradient in electron energy and ionization rate at the spoke front—a key region governing local flux towards the substrate. We systematically investigate the influence of magnetic field intensity and gas pressure on spoke dynamics, revealing transitions to higher azimuthal modes under stronger magnetic confinement and stabilization to a uniform plasma at higher pressures. A critical analysis of the early-stage discharge suggests that small-wavelength instabilities precede spoke formation, potentially seeding the initial perturbations that affect long-range deposition uniformity. Furthermore, we examine the fundamental mechanisms of anomalous electron heating, a process central to sustaining the discharge at low pressures relevant to high-quality film deposition. By linking mesoscale plasma structures to the flux of energy and ions at the substrate, this 3D framework offers predictive capabilities for tailoring plasma parameters to control film properties, paving the way for more uniform and precisely engineered thin films.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Investigation of the Etching Behavior of Aluminum Alloy in CCP with Ar, Ar/O2, NF3/Ar, and NF3/Ar/O2 Plasmas.

Liyue Gong[1], Yongxin Liu[1], Fei Gao[1], Xianxiu Mei[1]

[1]Dalian University of Technology, No. 2 Linggong Road, Ganjingzi District, China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Plasma-induced corrosion is a critical factor affecting the lifetime and operational stability of semiconductor etching equipment. As a substrate material for fluorine-resistant chamber coatings, 6061 aluminum alloy has been widely used, yet it is prone to corrosion under plasma exposure. In this work, the etching behavior of 6061 aluminum alloy was investigated in Ar, Ar/O2, NF3/Ar, and NF3/Ar/O2 plasmas. The results indicate that the etching rates in Ar and Ar/O2 plasmas are relatively low, mainly governed by physical sputtering and oxidation passivation, respectively. With the introduction of NF3, the etching rate increased by nearly one order of magnitude because of the synergistic effects of fluorination reactions and ion sputtering. In the NF3/Ar/O2 system, with a constant O2 flow rate, a moderate Ar concentration effectively disrupted metallic bonds and promoted the removal of AlF3, thereby enhancing the etching rate, whereas excessive Ar caused the etching rate to decline. In addition, etching products were preferentially enriched at grain boundaries and second-phase regions, while sputtering pits were mainly formed within the grains. After etching in NF3-containing plasmas, aluminum on the sample surface was found to exist predominantly in the form of AlF3. These findings clarify the plasma corrosion behavior and mechanisms of 6061 aluminum alloy under different gas atmospheres, and provide theoretical guidance for the optimized application of aluminum alloy materials in semiconductor manufacturing.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Customized modulation on plasma uniformity by non-uniform magnetic field in SiH4/NH3 capacitively coupled plasma

Mr. Sen Wang[1], Prof. Quan-zhi Zhang[1], Prof. You-nian Wang[1]

[1]School of Physics, Dalian University of Technology, No.2 Linggong Road, Ganjingzi District, Dalian City, Liaoning Province, China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

A two-dimensional fluid model based on COMSOL Multiphysics is developed to investigate the modulation of plasma homogeneity by a static magnetic field in a SiH_4/NH_3 Plasma Enhanced Chemical Vapor Deposition (PECVD) chamber. To generate a static magnetic field, direct current is applied to a circular coil located above the chamber. In the absence of a magnetic field, the radial plasma density within the chamber exhibits a nonuniform profile characterized by a high density at the center, a reduced density in the vicinity of the ceramic ring, and a pronounced peak at the edge of the grounded electrode. The reduced density near the ceramic ring is ascribed to the attenuation of the local bulk electric field induced by ring polarization, whereas the extreme density at the electrode edge is exclusively attributable to the edge effect. Upon application of the static magnetic field generated by the coil, the uniformity of the plasma density is substantially enhanced. The improvement is attributed to an increase in the electron–neutral collision frequency induced by the magnetic field, which results in a pronounced rise in plasma density adjacent to the coil. By varying the coil current and its position, the uniformity and overall density distribution of the plasma can be flexibly modulated. These findings demonstrate the feasibility of applying a static magnetic field to achieve uniform plasma density in industrial applications.

Keywords: COMSOL, plasma enhanced chemical vapor deposition (PECVD), plasma uniformity, magnetic field

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Design and electrochemical performance of flexibly detached 3D patterned boron-doped diamond electrodes

Shijie Huang[1]

[1]Jihua Laboratory, , China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Boron-doped diamond (BDD) has emerged as an ideal electrode material for wastewater treatment due to its wide potential window and extreme chemical stability. However, its degradation efficiency is highly dependent on the specific surface area and structural design of the material. This study proposes a simple and reproducible fabrication method for constructing microstructured BDD electrodes to increase their specific surface area. To fabricate the microstructured BDD materials, silicon substrates were first surface-treated using a laser. Multiple control groups were established by regulating the depth, size, and density of the laser-induced surface pits. Subsequently, BDD films were grown via microwave plasma chemical vapor deposition (MPCVD), after which they were flexibly detached from the silicon substrates and mounted onto receiving substrates. The grown microstructured BDD layers were characterized by scanning electron microscopy (SEM) and Raman spectroscopy. Furthermore, simulated wastewater treatment experiments were conducted to evaluate the water purification capacity of the BDD electrodes. The results revealed that the water purification performance of BDD electrodes with deep pits, large pits, and dense pits exhibited a 10% improvement compared to those with shallow pits, small pits, and sparse pits, respectively. This research provides a novel approach for increasing the specific surface area of microstructured BDD, thereby further enhancing its water purification capability.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Engineering Synergistic B-Sn Codoping in Diamond Thin Films for Enhanced Electrocatalytic Water Purification

Aixin Luo[1]

[1]Ji Hua Laboratory, Jihua Laboratory, No. 28 Huandao South Road, Guicheng Street, Nanhai District, Foshan, Guangdong Province,

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Addressing the challenges of low catalytic efficiency and insufficient stability in traditional electrode materials for organic wastewater treatment, this study innovatively proposes a boron-tin (B-Sn) synergistic doping strategy for diamond thin films (SnBDD). Through the integration of microwave plasma chemical vapor deposition (MPCVD) with in-situ laser activation technology, the stable incorporation of Sn atoms into the diamond lattice was successfully achieved. By employing first-principles calculations and multi-scale characterization techniques, the modulation mechanism of Sn doping on the electronic structure of diamond was systematically revealed: the introduction of Sn not only formed C-Sn covalent bonds but also significantly broadened the electrochemical potential window ($\Delta E \approx 1.2$ eV) via orbital hybridization effects, while simultaneously reducing charge transfer resistance. In simulated wastewater degradation experiments, the SnBDD electrode exhibited exceptional electrocatalytic performance, achieving a mineralization efficiency of 92.8% for Rhodamine B within 60 minutes, with only a 2.1% decay in activity after 30 cycle tests, far outperforming single-doped BDD electrodes. Mechanistic studies demonstrated that surface oxygen vacancies induced by Sn doping serve as active sites, significantly enhancing the generation efficiency of ·OH radicals. This work provides new insights into the band structure engineering design of high-performance functional thin films and holds significant application value in the field of environmental remediation.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

The pressure gradient-induced mechanism of edge effect in square substrate spin coating

Zikeng Fang[1], **Jiaqi Wan**[1], Prof. Ying Yan[1], Hongfu Zhang[1]
[1]Dalian University of Technology, Dalian University of Technology, China
Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Edge effects induced by geometric asymmetry critically limit film uniformity in spin coating of square substrates. In this work, the evolution of liquid films under non-axisymmetric boundary conditions is systematically investigated, with a particular focus on the role of fixture-induced confinement. Numerical simulations combined with experiments reveal that a radial pressure gradient emerging at the substrate–fixture interface governs the onset of film rupture and edge accumulation. By tailoring fixture geometry, a flow-restructuring strategy is proposed to modulate local pressure distribution and interfacial stability, enabling controlled positioning of rupture fronts and uniform film spreading. The results demonstrate that film uniformity is highly sensitive to geometric parameters, and an optimized configuration effectively suppresses pressure fluctuations and stabilizes the coating front. A mechanistic framework linking pressure gradient, flow restructuring, and film thickness evolution is established, providing new insights into non-axisymmetric spin coating and offering a practical pathway for precision coating on complex substrates.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Frequency-Dependent Sheath Dynamics and Interfacial Evolution of ta-C Films on Insulating Substrates by FCVA

Feng Tian[1,2], Chong Wei Tan[1,2], Professor Beng Kang Tay[1,2]

[1]Centre for Micro-&Nano-Electronics, School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore 639798, Singapore, [2]NTI-NTU Corporate Laboratory, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Tetrahedral amorphous carbon (ta-C) deposition on insulating substrates by filtered cathodic vacuum arc is limited by surface charging, which weakens the effective substrate bias and reduces energetic ion bombardment. In this work, ta-C films are deposited on quartz substrates under pulsed bias at different frequencies to examine their effects on film morphology, bonding structure, composition, and optical properties. To emphasize the early growth stage, an initial high-frequency treatment is introduced to facilitate the formation of the film-substrate interfacial region. Finite element simulation is employed to quantify the sheath duration at the substrate surface and to estimate the corresponding effective energetic particle input under different pulse frequencies. This study demonstrates how frequency-dependent sheath behavior dictates the effective ion energy reaching insulating substrates. The initial pulse-induced bombardment was linked to the degree of interfacial mixing during early-stage growth. These findings reveal that strategic pulse design can independently control interfacial stabilization and subsequent bulk growth, providing a novel approach for ta-C films on insulators.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Pristine 3D Vertical Graphene Arrays via 172 nm VUV Polymer-Free Lithography and MPCVD Selective Area Epitaxy

Hao Liu[1]

[1]Jihua Laboratory, foshan, China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Three-dimensional vertical graphene nanosheets (VGNs) hold immense potential for advanced micro-devices, including on-chip thermal management systems and micro-supercapacitors, owing to their non-stacking morphology, massive surface area, and abundant active edges. However, conventional top-down patterning techniques heavily rely on polymer photoresists and oxygen plasma etching, which inevitably induce irreversible deep-pore contamination, capillary-force-driven structural collapse, and severe degradation of intrinsic edge reactivities. To overcome these critical integration bottlenecks, we propose a novel bottom-up, polymer-free selective area epitaxy paradigm for fabricating highly customized 3D VGN arrays.

High-quality chemical vapor deposition (CVD) single-layer graphene (SLG) is first transferred onto an insulating SiO_2/Si substrate to serve as an initial nucleation seed layer. Subsequently, utilizing a 172 nm vacuum ultraviolet (VUV) excimer lamp coupled with a physical shadow mask, the SLG is selectively photo-etched under ambient conditions. The 7.2 eV VUV photons directly dissociate atmospheric oxygen and moisture into highly reactive oxygen species, achieving an atomic-layer precision "cold etching" that completely gasifies the exposed SLG while simultaneously eliminating polymer transfer residues. Finally, microwave plasma CVD (MPCVD) is employed to achieve highly selective vertical growth.

This exceptional selectivity originates from a dynamic competition mechanism: the low homoepitaxial nucleation barrier on the pristine SLG seeds facilitates rapid VGN growth, whereas the high heterogeneous nucleation barrier on the bare SiO_2, combined with strong in-situ etching by plasma-generated hydrogen radicals (H*), thoroughly suppresses parasitic amorphous carbon deposition. This fully dry, contamination-free approach completely bypasses the limitations of traditional wet lithography, providing a scalable and highly pristine manufacturing pathway for integrating next-generation 3D carbon architectures into high-performance microelectronics and aerospace systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Photochemical Film Formation-Vapor Deposition Hybrid Coating via 172 nm VUV Irradiation: Preparation and Corrosion Resistance

Bochun Li, Kesheng Guo, Lang Hu, Qimin Wang
[1]Ji Hua Laboratory, Foshan , china

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Photochemical film formation technology leverages the high photon nergy of vacuum ultraviolet (VUV) radiation to effectively cleave chemical bonds such as C=C and C=H, enabling the low-temperature photochemical deposition of metal precursors. Compared with conventional chemical vapor deposition (CVD) and physical vapor deposition (PVD), 172 nm VUV-assisted film formation exhibits distinct advantages of low processing temperature and excellent conformal coverage.This study reports, for the first time, the conversion of dimethyl silicone oil into solid silicon oxide (SiO_x) thin films via 172 nm VUV irradiation on carbon-based substrates (tetrahedral amorphous carbon, ta-C/diamond), forming composite coatings with enhanced overall corrosion resistance and plasma etching durability. X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS) analyses reveal that upon 172 nm irradiation of dimethyl silicone oil-coated silicon substrates, the majority of C–Si–O bonds are transformed into Si–O bonds, with the silicon-oxygen bond fraction increasing from 2.2% to 93.1%, resulting in the formation of amorphous silicon oxide films.The composite coating, comprising a high-density ta-C base layer combined with a dense SiO_x overlayer deposited under 172 nm irradiation, demonstrates significantly improved electrochemical performance. The corrosion current density is reduced from the 10^{-8} to 10^{-10} A cm^{-2} range, while the electrochemical impedance increases by one to two orders of magnitude, indicating substantially enhanced corrosion resistance. This photochemical-vapor deposition hybrid approach for composite coating fabrication advances the development of anti-corrosive performance and related applications, promotes the optimization of photocured thin-film technologies, and holds significant implications for extending the service life of semiconductor components and advancing protective coating

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Study on the Surface Activation Mechanism and Performance of PEEK by 172 nm Vacuum Ultraviolet Light

Zhouquan Liu[1]

[1]Jihua Laboratory, foshan, China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Polyetheretherketone (PEEK) is highly valued in aerospace for its lightweight and high-strength properties, but its extreme chemical inertness leads to poor interfacial bonding with structural adhesives like epoxy. Conventional surface pretreatments often degrade bulk properties or cause environmental issues. To address this, we propose a room-temperature, dry, and non-destructive photochemical activation process using 172 nm vacuum ultraviolet (VUV) light. We systematically investigated the effects of VUV irradiation on PEEK surfaces using water contact angle (WCA) measurements, X-ray photoelectron spectroscopy (XPS), and atomic force microscopy (AFM), and evaluated the macroscopic bonding strength via single lap shear tests.

Results demonstrate that 172 nm photons precisely cleave PEEK macromolecular chains, in-situ grafting polar oxygen-containing functional groups (-OH, C=O, -COOH) in ambient air. Under optimal conditions, the PEEK surface transitions from hydrophobic (~88°) to superhydrophilic without a significant increase in surface roughness, achieving atomic-level non-destructive activation. Consequently, the tensile shear strength of VUV-activated PEEK/epoxy joints increases exponentially, with the failure mode shifting from fragile adhesive failure to high-strength cohesive failure. This study elucidates the 172 nm VUV cold activation kinetics and provides an efficient, eco-friendly surface engineering solution for highly reliable heterogeneous bonding in extreme aerospace environments.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Multiphysics Simulation of Non-Uniform Magnetic Field Modulation for Tailoring Plasma Uniformity in Capacitively Coupled Plasmas

Ms. Yu-Meng Cui[1], Mr. Lei-Yu Zhang[1], Prof. Quan-Zhi Zhang[1]

[1]Dalian University of Technology, No.2 Linggong Road, Ganjingzi District, China

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Radio frequency (RF) capacitively coupled plasma (CCP) technology has been widely applied in the semiconductor manufacturing industry due to its simple geometry and ability to generate large area plasmas. Driven by the growing demand for high-precision plasma etching and deposition applications, achieving high radial uniformity in CCP has become critical to ensuring excellent process quality and favorable thin film properties. Although various structural optimization methods, such as lens-shaped electrodes, graded conductivity electrodes, structured electrodes with vertical trenches, can improve plasma uniformity, their high cost and structural complexity have significantly limited their practical applications. In contrast, the external static magnetic field approach is more flexible, low-cost, and can regulate plasma uniformity without modifying the original discharge structure or parameters. In this work, a two-dimensional multiphysics model is developed to investigate the coupled effect of temperature effects or magnetic field modulation. The model integrates thermal, magnetostatic, plasma fluid, and frequency-domain electric field models, implemented through a COMSOL and MATLAB co-simulation framework. The results show that a non-uniform magnetic field, generated by a single DC coil, can effectively tailor the plasma density profile by regulating electron transport and power absorption. Crucially, the efficacy of this magnetic control is strongly dependent on the electrode temperature. When the temperature-controlled region of the electrode is small, abrupt temperature changes occur at its boundaries, leading to remarkable variations in the distributions of neutral gas concentration and plasma density. This, in turn, complicates the modulation effect of the magnetic field. This phenomenon becomes even more pronounced with the increase in electrode temperature. Therefore, expanding the radial range of the temperature-controlled electrode is essential to realize uniform and effective magnetic field modulation of plasmas, thereby improving thin film quality.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Analyses of Metal Surface Reaction Induced by Laser-induced Plasma Toward Improved Nitride Layer Formation

Ms. Madoka Tachibana[1], Yoshifumi Kitadate[1], Eishi Hashiba[1], Mitsuhiro Hirano[1], Naofumi Ohtsu[1]

[1]Kitami Institute of Technology, 165 Koen-cho Kitami, Hokkaido, Japan

Poster Session - S03: Plasma Technology and Application for Thin Films (PTA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

A novel metal surface nitriding process based on laser-induced plasma (LIP) has been developed in our research group. LIP is microsecond-lifetime plasma generated on metal surface by irradiation with a focused pulsed laser beam. Nitriding process is initiated by melting the surface by LIP, then nitrogen is incorporated through convective currents and nitride layer is subsequently formed by rapid quenching. This series of processes can be completed in less than a millisecond, thus does not follow thermochemical principles, potentially enabling nitriding even in air. Here, the status of LIP is expected to dominate metal surface reaction. In this study, dynamics of metal surface reactions induced by various LIP status were evaluated for obtaining an improved nitride layer.

LIP was generated on Ti surface using a focused pulsed laser beam (wavelength: 1064 nm, pulse width: 6 ns, pulse energy: 300 mJ/pulse) under various lens-surface distances and atmospheres such as air and pure nitrogen. The generated LIP was observed on nanosecond timescale using the intensified CCD, and the molten pool temperature was measured using a pyrometer. Furthermore, the resulting Ti surface was characterized by SEM/EDS.

Nitride layer on Ti surface was formed only in a crater region induced by laser irradiation. Initial LIP was surface-densified plasma of which lifetime was several hundred nanoseconds, and its shape gradually expanded outward from the surface. Here, the size of crater agreed with that of densified LIP.

The surface melting is inferred to be triggered by the initial LIP, and therefore gas incorporation and quenching may complete within microsecond timescale. Such behavior was observed at every lens-surface distance, yet the nitrogen concentration in craters decreased with decreasing the lens-surface distance. Distribution of densified LIP varies depending on the lens-surface distance. Such variation may affect energy transfer from LIP to surface, thereby changing the efficiency of nitriding.

AI for crystal structure optimization

Dr Lei Shen[1]

[1]National University Of Singapore, 9 Engineering Drive 1, Singapore

Session 04 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

AI-driven crystal structure optimization

Lei Shen*,1,2

1Department of Mechanical Engineering, National University of Singapore, Singapore 117575, Singapore;
2National University of Singapore (Chongqing) Research InstituteChongqing Liang Jiang New Area, Chongqing 401120, China
*shenlei@nus.edu.sg

In the rapidly developing field of AI for Science, especially in computational materials, AI has attracted significant attention as a driving force for understanding the physical structure-property relationships and accelerating the discovery of new materials.
In this talk, I will begin my talk by discussing our early stage of developing feature engineering techniques used in predicting physical properties directly from material structures. The development of a materials database using high-throughput density functional theory (DFT) calculations represents the middle stage, enriching large quantities of material data as the foundation for training AI models[1]. Finally, I will introduce the concept of physics-integrated deep learning models. By incorporating the fundamental equivariant principle into the architecture of deep learning algorithms, one can enhance the model predictive power and interpretability for optimizating crystal structures[2] and the interatomic potentials[3]. This approach not only improves the accuracy of predictions but also ensures that the models adhere to the laws of physics.

References

1. Shen, L.; Zhou, J.; Yang, T.; Yang, M.; Feng, Y. P. Accounts of Materials Research, 3, 572 (2022).
2. Yang, Z.; Zhao, Y.-M.; Liu, X.; Zhang, X.; Li, Y.; Lv, Q.; Chen, Y. C.; Shen, L. Nature Communications 15, 8148 (2024).
3. Yang, Z.; Wang, X.; Li, Y.; Lv, Q.; Chen, Y. C.; Shen, L. npj Computational Materials 11, 49 (2025).

July 15, 2026 | 11:10 AM

Physics AI Empowers the New Paradigm of Digital Materials R&D

Dr. Kui Gong[1], Prof. Yin Wang[1]

[1]Hongzhiwei Technology (shanghai) Co., Ltd., 11th Floor, Building 2, 2777 Jinxiudong Road, Pudong Direct, China

Session 04 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

Artificial Intelligence-enhanced Materials Genome Engineering (AI+MGE) has emerged as a key driver for revolutionizing materials R&D. This report introduces Hongzhiwei's AI+MGE digital R&D platform, which integrates self-developed multi-scale simulation tools, high-throughput computing workflow engines, material databases, advanced AI algorithms, and full-process automated laboratory devices. The platform shifts traditional trial-and-error R&D model into an innovative paradigm of "data-driven exploration + AI-enabled prediction + target-oriented material design + automated experimentation + closed-loop data feedback iteration". It supports multi-scale computational simulation and Chinese substitution of core software. Driven by material large models and AI Agents, the platform enables end-to-end automated R&D from natural language instructions to robotic experiments execution. Applied across new energy, semiconductors, alloys, chemicals, and other industries, it has delivered outstanding results in screening and synthesis of electrolyte molecular materials. By significantly shortening R&D cycles, reducing costs, and improving innovation efficiency, the platform serves as core infrastructure for intelligent materials manufacturing.

July 15, 2026 | 11:30 AM

Introducing the High-Throughput Computational Platform of Chinese Materials Genome Engineering

Dr Xiangfei Meng[1], Mr Xiaodong Jian[1], Ms Dongjie Shi[1], **Dr Tianruo Shen**[1]
[1]National Supercomputer Center in Tianjin, 10 Xinhuan West Road, China
Session 04 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

The advancement of innovative materials continues to face several challenges, including long development cycles, high trial-and-error costs, and the complexity of cross-scale structure-property correlations. The conventional paradigm of experience-driven design followed by repeated experimental optimization is no longer sufficient for the rapid discovery and precise tailoring of high-performance materials. To this end, the High-Throughput Computational Platform of Chinese Materials Genome Engineering is established based on the Tianhe supercomputer at the National Supercomputer Center in Tianjin. Designed to support high-dimensional materials screening, multiscale simulation, and data-driven materials development, the platform integrates supercomputing, cloud computing, and big data technologies into a unified high-throughput computational environment. It incorporates a high-concurrency, cross-scale, and automated workflow-based system for large-scale materials computation and data management. Combined with machine learning methods, this platform enables sufficient screening, data mining, and performance prediction of advanced functional materials. In addition, a dedicated task-scheduling and workflow-management framework has been developed to support multi-user and multi-task high-throughput calculations. These capabilities substantially enhance the efficiency of materials development while effectively reducing associated costs.

July 15, 2026 | 11:50 AM

Revealing the effects of NbHx on the dehydrogenation of MgH2 from first-principles

Dr. Jianchuan Wang[1], Mr. Yukun Liu[1], Prof. Yong Du[1]

[1]Central South University, No.932 South Lushan Road, China

Session 04 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

The practical application of magnesium hydride (MgH2) for solid-state hydrogen storage is hindered by the high dehydrogenation temperatures and sluggish hydrogen absorption/desorption kinetics. Previous studies have demonstrated that pure niobium and its compounds can significantly enhance the hydrogen storage properties of MgH2, likely due to the formation of niobium hydrides during the hydrogen absorption/desorption process. In this study, interface models were constructed to provide insight into the influence of niobium hydrides on hydrogen desorption from MgH2. A first-principles approach was employed to investigate the structural, electronic, and energetic properties of the NbHx(110)/MgH2(110) (x=1, 2) interfaces. The results indicate that the disordered NbH(110)/MgH2(110) interface is more stable than the ordered NbH2(110)/MgH2(110) interface. For both interfaces, the dehydrogenation energy in the interface zone is significantly lower than that of bulk MgH2, facilitating hydrogen desorption from thermodynamics. Regarding dehydrogenation kinetics, the diffusion behavior of H atoms in MgH2 phase at the interface region was studied by the ab initio molecular dynamical simulations. By analyzing the mean square displacement and trajectories of H atoms, we found that niobium hydrides can directly promote hydrogen desorption from MgH2 and hydrogen diffusion in both interface systems predominantly occurs within the interface plane. Furthermore, the NbH(110)/MgH2(110) interface exhibits a notable enhancement in dehydrogenation compared to the NbH2(110)/MgH2(110) interface.

Hydrogen adsorption on group IV and III–V 2D honeycombs: Designing an electronegativity-based descriptor

Mr Yi Sheng Ng[1], Dr. Jin-Cheng Zheng[1,2]

[1]Xiamen University Malaysia, , Malaysia, [2]Xiamen University, , China

Session 04 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

Understanding and predicting hydrogen adsorption energy is key to designing effective electrocatalysts. In this study, we develop a physically interpretable descriptor within a framework that decomposes atomic hydrogen adsorption energy into intuitive contributions, applied to 22 group IV and III–V 2D honeycomb materials. The density functional theory (DFT) calculated adsorption energy is decomposed into two components: bond energy, approximated by the integrated crystal orbital Hamilton population (ICOHP), and the energy cost of forming the additional bond, termed distortion energy Ed. This decomposition facilitates analysis of adsorption trends beyond treating adsorption energy as a single quantity. We find that ICOHP correlates strongly with the adsorption site electronegativity ($R^2 = 0.86$), improving to $R^2 = 0.91$ when electronegativity differences and structural parameters are included. Ed shows moderate correlation with the unrelaxed vacancy energy Evac ($R^2 = 0.60$) and can be accurately modeled ($R^2 = 0.92$) using similar dependences on electronegativity and structural parameters. Notably, Evac can be expressed in terms of the sum of electronegativities, enabling a DFT-free formulation. Combining both components into an Eads descriptor, we achieve an R^2 score of 0.82 across both group IV and III–V systems. Further analysis reveals that increasing the adsorption site electronegativity weakens adsorption unless the lattice constant is sufficiently large.

July 15, 2026 | 1:20 PM

Computational and Data-Driven Design of Strong Physical Response Materials

Dr Yan Sun[1]

[1]Institute Of Metal Research, Chinese Academy of Sciences, , China

Session 05 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 1:20 PM - 3:10 PM

The combination of symmetry and electronic band structures has revealed various physical responses in materials, where quantized and enhanced physical responses are often accompanied with special band structures and Fermi surfaces. The Berry curvature associated with Weyl points and nodal-line band structures significantly enhances linear responses. Through studies of the linear responses in Weyl semimetals and nodal-line semimetals, we have discovered strong spin Hall effects, spin Nernst effects, anomalous Hall effects, and anomalous Nernst effects. Combining symmetry analysis with high-throughput calculations, we examine the dependence of the anomalous Hall effect on magnetization direction and demonstrate deviations from the commonly assumed expression J^{AHC}~M×E. Inspired by the theory of flat bands and narrow bands, we propose the concept of a flat Fermi surface and apply it to altermagnets, revealing the quantum limit of time-reversal-odd spin currents. In nonlinear optics, to identify good second-order photovoltaic materials, we combine bulk photovoltaic theory with solar radiation to propose the solar rectification vector, which can be considered analogous to the Shockley-Queisser model in p-n junction solar cells.

July 15, 2026 | 1:40 PM

Molecular dynamics and lattice dynamics for ion transport and thermal conduction in complex solid systems

Prof. Yongqing Cai[1]

[1]University Of Macau, ,

Session 05 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 1:20 PM - 3:10 PM

Solid compounds contain rigid lattice and mobile units play a key role in solid ionics and thermoelectric applications. By engineering the local environment of mobile ions and introducing structural disorder, these approaches can significantly improve ionic conductivity and phonon anharmonicity. Unfortunately, large-scale and accurate simulation of the dynamics of the atoms are difficult in such complex compounds. Here, based on machine learning potential, we reveal the function mechanism of the structural diversity and interplay of the mobile units and rigid backbone. We propose path entropy (S_p) as a descriptor to quantify the diversity of diffusion pathways, directly capturing the disorder associated with ion transport. Extending this path-informed S_p to high-throughput screening, we demonstrate its broad applicability in identifying and designing high-performance solid-state electrolytes. In another work, we demonstrate that CuInP2S6, a layered material, manifests as a unique system differing from both solid and fluid: It is solid but contains disconnected pathways of highly mobile Cu species. Each pathway comprises two main docking sites, facilitating rapid intersite hopping of Cu that disrupts lattice waves of the immobilized sulfur sublattice, thereby inducing strong phonon anharmonicity. This suppresses the virial contribution, a dominant heat conduction mechanism in conventional solids, while inducing a moderate liquid-like convective mode of heat transfer.

Determination of the embedded electronic states at nanoscale interface via the simulation based on surface-sensitive electron structure spectroscopies

Professor Hui-Qiong Wang[1], Dr. Yaping Li[1], Mr. Zi Cheng Tey[2], Mr. Yii Yat Chan[2], Professor Junyong Kang[1], Professor Jin-Cheng Zheng[1]

[1]Xiamen University, Department of Physics, China, [2]Xiamen University Malaysia, Department of New Energy Science and Engineering, Malaysia

Session 05 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 1:20 PM - 3:10 PM

The fabrication of miniaturized electronics often requires integrating different functional materials. Electronic states at nanoscale interfaces play a crucial role in device performance and exotic interfacial physics. Electronic structure spectroscopies —such as X-ray photoelectron spectroscopy, ultraviolet photoelectron spectroscopy, and X-ray absorption spectroscopy in total electron yield mode—are powerful tools for probing material electronic structures. However, as surface-sensitive techniques, they are generally unsuitable for investigating buried interface states due to the electron inelastic mean free path limitation.

In this work, we introduce a modeling method to extract buried interface states from film-thickness-dependent electronic structure spectra, acquired using an integrated system with in-situ growth and characterization capabilities. This method has been applied to several transition-metal oxide interfaces, including NiO/Fe_3O_4, CoO/Fe_3O_4, and NiO/ZnO. A more general modeling approach that accounts for different growth modes— layer-by-layer (Frank–Vander Merwe), island (Volmer–Weber), and hybrid (Stranski–Krastanov)—will also be discussed. This modeling strategy is expected to advance the understanding of interfacial electronic states between functional materials and aid in determining interface layer structures.

Related references:

1. Hui-Qiong Wang, Eric Altman, Christine Broadbridge, Yimei Zhu, Victor Henrich, Determination of electronic structure of oxide-oxide interfaces by photoemission spectroscopy, Advanced Materials 22, 2950 (2010).

2. Yaping Li, Hui-Qiong Wang*, Kurash Ibrahim*, Jia-Ou Wang, Rui Wu, Hai-Jie Qian, Huanhua Wang, Tao Lei, Zhiqiang Wang, Xiaojun Li, Meng Wu, Jin-Cheng Zheng, Junyong Kang, Lihua Zhang, Kim Wu*, and Yimei Zhu, Interfacial

electronic states of misfit heterostructure between hexagonal ZnO and cubic NiO, Physical Review Materials, 4, 124601 (2020).

3. Hui-Qiong Wang*, Jiayi Xu, Xiaoyuan Lin, Yaping Li, Junyong Kang and Jin-Cheng Zheng*, Determination of the embedded electronic states at nanoscale interface via surface-sensitive photoemission spectroscopy, Light: Science & Applications, 10:153 (2021).

July 15, 2026 | 2:20 PM

Tunable Magnonic Chern Insulators: Rational Design and Material Realization

Prof Chengwang Niu[1], Ying Dai[1]

[1]Shandong University, South of Shanda Road 27, China

Session 05 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 1:20 PM - 3:10 PM

The Chern insulator is an extremely important fundamental topological state in topological physics, achievable in both electronic and magnonic systems, with rich physical implications. We uncover that coupling nontrivial electronic bands with magnonic bands can realize the dual Chern insulator [1,2]. We also systematically investigate the regulatory effects of different stacking configurations in the two-dimensional material CrGeSe3 on magnetic exchange coupling and topological magnonic states, finding that adjusting interlayer stacking configurations can achieve two distinct topological magnon states: the magnon Chern insulator and the magnon spin Chern insulator [3]. Additionally, in two-dimensional ferromagnetic materials, we realize the higher-order topological magnon insulator and propose a novel mechanism for regulating topological magnon states driven by ferroelectric polarization [4]. By reversing the ferroelectric polarization direction, we achieve the non-volatile regulation of magnetic exchange interaction parameters in a breathing kagome lattice, enabling reversible switching between higher-order topological magnon insulators, magnon Chern insulators, and conventional magnon insulators within the same material system. This topological phase transition process is also accompanied by the reversal of spontaneous magnon valley polarization, exhibiting non-volatile regulation of valley-dependent magnon transport behavior.

[1] Y. Bai, L. Zhang, N. Mao, R. Li, Z. Chen, Y. Dai, B. Huang, and C. Niu, ACS Nano 2024, 18, 13377.

[2] Y. Bai, X. Zou, Z. Chen, R. Li, B. Yuan, Y. Dai, B. Huang, and C. Niu, ACS Nano 2025, 19, 9265.

[3] X. Feng, Y. Bai, B. Yuan, Y. Dai, B. Huang, C. Niu, X. Wang, Adv. Funct. Mater. 2026, doi: 10.1002/adfm.202525877.

[4] Y. Bai, B. Yuan, Z. Chen, Y. Dai, B. Huang, X. Wang, and C. Niu, Phys. Rev. Lett. 2026, 136, 046602.

July 15, 2026 | 2:40 PM

Ferroelectric-Engineered Valley Physics in Two-Dimensional Systems

Dr Xinru Li[1], Dr. Xinru Li[1]

[1]Shandong University, Shanda Nanlu No. 27, China

Session 05 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 1:20 PM - 3:10 PM

Efficient electrical control of the valley degree of freedom in two-dimensional (2D) materials is a central challenge in valleytronics. We present a systematic study showing that ferroelectric polarization provides a unifying mechanism to lock, create, and switch valley related properties across different 2D systems. The underlying physics is that ferroelectricity breaks spatial symmetry and modifies band structures, thereby coupling to the valley index. In the 2D multiferroic semiconductor TiCr2O4, ferroelectric polarization generates inequivalent potentials that reverse and annihilate nonsymmetric trigons, leading to electrical reversal of the valley index and electrical creation or annihilation of valley polarization. In nonmagnetic monolayer In2Se3, ferroelectricity hosts van Hove singularities that, under carrier doping, break time reversal symmetry and induce non equilibrium valley polarization, giving rise to an anomalous valley Hall effect without intrinsic magnetism. In the ferroelectric homobilayer Tl2NO2, ferroelectric polarization drives switching between antiferromagnetic and ferromagnetic interlayer orders. The antiferromagnetic phase supports coexisting layer polarized valley and spin Hall currents, whereas the ferromagnetic phase makes them mutually exclusive, enabling nonvolatile ferroelectric switching of both valley and spin degrees of freedom. These results establish ferroelectricity as a versatile knob for engineering valley physics in diverse 2D material platforms, including multiferroic semiconductors, nonmagnetic ferroelectrics, and ferroelectric homobilayers, offering a systematic framework for electrically tunable valleytronic devices.

July 15, 2026 | 2:55 PM

Excitonic Instability in Quantum Spin Hall Insulators

Professor Wei Wei[1], Professor Ying Dai[1]

[1]Shandong University, Shandananlu 27, China, [2]Shandong University, Shandananlu 27, China

Session 05 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 1:20 PM - 3:10 PM

Excitonic insulator (EI), a long-sought yet exceptionally scarce macroscopic quantum phase of matter, has remained elusive. We propose that quantum spin Hall insulators (QSHIs) can be promising candidates for realizing excitonic instability. This is enabled by the atypical inverse quasiparticle (QP) correction to the inverted bands of QSHIs, which decouples the synergy of the QP band gap (Eg) and exciton binding energy (Eb). Combining first-principles calculations with many-body perturbation theory, we verify our proposal in the QSHIs TlX (X = As, Sb, Bi) with Eb exceeding the QP Eg. In stark contrast to the previously proposed EI dominated by dark excitons, the EI state in this study is constituted by bright excitons with negative formation energy and large oscillator strength, providing an optically accessible signature for detecting the EI. In particular, the emergence of correlated EI accompanied by nontrivial band topology unveils a novel paradigm of (bright) topological EI.

July 15, 2026 | 3:30 PM

Enhanced erosion resistance of BaZrO3 mold against TiAl alloy melt during directional solidification through an in situ formed Y2O3 protective layer

Dr. Lu Mao[1], Dr. Haitao Li[1], Dr. Dongdong He[1], Dr. Qisheng Feng[1], Prof. Pengyue Gao[1], Prof. Guangyao Chen[1], **Prof. Chonghe Li**[1]

[1]School of Materials Science and Engineering, Shanghai University, 99 Shangda Road, Baoshan District, China

Session 06 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 3:30 PM - 5:05 PM

The interaction between highly reactive TiAl alloy melts and ceramic molds during directional solidification significantly contaminates the alloy microstructure, thereby greatly limiting the application of this high-temperature alloy. To address this issue, 0, 1, 1.5, and 2 wt.% Y were added to the TiAl alloy melts, and directional solidification was carried out in BaZrO3 molds. The results indicate that, in the absence of Y addition during directional solidification, BaZrO3 underwent significant dissolution and reacted with alloying elements to form BaAl2O4. The oxygen content in the alloy reached as high as 4600 ppm, and a erosion layer with a thickness of approximately 240 μm formed on the alloy surface. After the addition of Y to the alloy melt, the dissolution of BaZrO3 was markedly suppressed, and the oxygen content in the alloy decreased substantially. Moreover, the oxygen content further decreased with increasing Y addition. When 2 wt. % Y was added, no erosion layer was observed on the alloy surface. Meanwhile, a dense Y2O3 layer formed on the inner wall of the mold. This in situ formed Y2O3 protective layer effectively prevented direct contact between the alloy melt and the BaZrO3 mold, thereby inhibiting further dissolution. In addition, the strong affinity between Y and O facilitated the reduction of oxygen content in the alloy.

July 15, 2026 | 3:50 PM

Influence of Surface Defects on the Fatigue Behavior and Phase Transformation Mechanisms in NiTi Alloys Fabricated by Laser Powder Bed Fusion

Pengyue Gao[1], Pengyue Gao[1], Haitao Li[1], Jianzhou Huang[1], Tongbo Xue[1], Qisheng Feng[1], Guangyao Chen[1], Chonghe Li[1]

[1]Shanghai University, No. 99, Shangda Road, Baoshan District, China

Session 06 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 3:30 PM - 5:05 PM

Abstract: Laser Powder Bed Fusion (LPBF) has emerged as a promising manufacturing route for NiTi shape memory alloys. However, the impact of process-induced surface defects on fatigue performance remains insufficiently understood. In this study, cylindrical surface pores of 500 μm diameter were pre-introduced onto LPBF-fabricated NiTi alloy specimens to investigate the role of surface defects in governing tensile and fatigue behavior. Microstructural characterization was performed using scanning electron microscopy (SEM), electron backscatter diffraction (EBSD), and transmission electron microscopy (TEM) to track defect evolution under cyclic loading. The LPBF-fabricated NiTi alloy exhibited a tensile strength of 766.85 MPa and an elongation of 10.8%. Under cyclic loading, the regions surrounding surface pores progressively accumulated residual B19’ martensite, elevated dislocation densities, and increasing residual stresses with increasing fatigue cycles. These defect-driven microstructural changes suppressed the stress-induced martensitic transformation and its reverse transformation, degrading the superelastic response of the alloy. Consequently, surface defects act as preferential nucleation sites for functional fatigue, governing the fatigue crack initiation and damage accumulation mechanisms in LPBF-fabricated NiTi alloys. These findings provide critical insights for optimizing LPBF process parameters and surface post-processing strategies to enhance the fatigue life of NiTi components for biomedical and engineering applications.

Keywords: Laser powder bed fusion; NiTi alloy; Surface defect; Tensile properties; Fatigue properties

July 15, 2026 | 4:05 PM

Design, Synthesis, and Structural Characterization of Novel Sulfide Perovskite Materials BaCeS3 and SrCeS3

Haitao Li[1], Qisheng Feng[1], mao Lu[1], Dongdong He[1], Yunqi Guo[1], Rulin Zhang[1], Pengyue Gao[1,2,3], Guangyao Chen[1,2,3], Chonghe Li[1,2,3]

[1]State Key Laboratory of Advanced Special Steel & Shanghai Key Laboratory of Advanced Ferrometallurgy & School of Materials Science and Engineering, Shanghai University,, , China, [2]Shanghai Special Casting Engineering Technology Research Center, , China, [3]Zhejiang Institute of Advanced Materials Shanghai University, , China

Session 06 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 3:30 PM - 5:05 PM

Sulfide perovskites display excellent light absorption properties and show great potential in the photovoltaic field. However, compared to oxide perovskites, far fewer sulfide perovskite materials have been reported. Therefore, the development of additional ABS3 sulfide perovskite materials is urgently needed. This paper introduces two novel sulfide perovskites: BaCeS3 and SrCeS3. First, potential new sulfide perovskites, BaCeS3 and SrCeS3, were identified through composition screening using the t-μ structural map method. Subsequently, their crystal structures and formation energies were calculated using density functional theory (DFT), and their thermodynamic stability was verified in conjunction with thermodynamic data. Finally, these two novel sulfide perovskites, BaCeS3 and SrCeS3, were synthesized using an improved high-temperature solid-state method (involving vacuum sealing of raw materials with B and S in a quartz tube), and characterized by XRD and TEM.

July 15, 2026 | 4:20 PM

Erosion Behavior and Failure Mechanisms of Plasma-Sprayed YSZ Coatings Under Prolonged Aluminum alloy melts

Pengyue Gao[1], Dongdong He[1], Tongbo Xue[1], Jianzhou Huang[1], Zhen Zhang[1], Qisheng Feng[1], Guangyao Chen[1], Chonghe Li[1]

[1]Shanghai University, No. 99, Shangda Road, Baoshan District, China

Session 06 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 3:30 PM - 5:05 PM

Abstract: Yttria-stabilized zirconia (YSZ) coatings are candidate protective materials for components exposed to molten aluminum environments; however, their long-term erosion behavior and failure mechanisms remain poorly characterized. In this study, YSZ coatings were deposited onto 310S substrates via atmospheric plasma spraying and subjected to systematic molten aluminum erosion experiments at exposure durations of 0, 48, 96, 144, and 192 hours. The evolving thickness, phase composition, and microstructure of the eroded coatings were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS) to establish a time-resolved picture of coating degradation. The as-sprayed YSZ coating exhibited strong interfacial adhesion to the 310S substrates. Erosion progressed in distinct stages: the coating remained structurally intact after 48 hours, localized erosion spots nucleated after 96 hours, rapid lateral expansion of the degraded area occurred after 144 hours. A reaction layer approximately 20 μm wide formed between the aluminum melt and the exposed steel substrate following full coating removal. The YSZ coating thickness was not measurably reduced prior to total failure, and only the ZrO_2 (Y_2O_3) phase was detected throughout all erosion stages, confirming the absence of chemical reactions between YSZ and molten aluminum. These findings indicate that the dominant erosion mechanism is physical dissolution rather than chemical attack, with coating failure driven by progressive pore infiltration and mechanical undermining rather than thermochemical decomposition. This work provides a mechanistic foundation for designing more durable protective coatings for aluminum processing equipment.

Keywords: Atmospheric plasma spraying; Yttria-stabilized zirconia coating; Aluminum alloy melts; Microstructure; Erosion behavior

July 15, 2026 | 4:35 PM

The Impact of Silver Addition on the Stability and Biocorrosion Resistance of Passive Films in Ti-15Zr Alloy

Pengyue Gao[1], Chonghe Li[1], Rongbin Li[2], **Rulin Zhang**[1,2]

[1]Shanghai University, No. 99 Shangda Road, Baoshan District, China, [2]Shanghai DianJi University, 300 Shuihua Road, Pudong District, China

Session 06 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 3:30 PM - 5:05 PM

This study systematically explored the effects of silver addition on the biocorrosion behavior and passive film properties of Ti-15Zr alloy within a simulated body fluid environment. Utilizing potentiodynamic polarization analysis, Mott-Schottky analysis, and electrochemical impedance spectroscopy, we observed that as silver content increased, the alloy's corrosion resistance initially improved and subsequently declined. The incorporation of an optimal amount of silver stabilized the alloy's passive film, thereby enhancing its corrosion resistance. Further increases in silver content led to the precipitation of nano-sized particles at grain boundaries, effectively suppressing the initiation of localized corrosion and further improving the alloy's corrosion resistance. However, excessive silver content resulted in aggregation at grain boundaries, triggering pitting or intergranular corrosion and causing a significant deterioration in corrosion resistance.

July 15, 2026 | 4:50 PM

A hybrid model for plasma discharge and transport during CrN deposition by reactive DOMS

Jianying Gao[1]

[1]AVIC Manufacturing Technology Institute, , China

Session 06 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 15, 2026, 3:30 PM - 5:05 PM

Plasma characteristics and target poisoning condition during reactive deep oscillation magnetron sputtering (R-DOMS) with Cr target are investigated using a time-dependent hybrid model. The hybrid model combines a zero-dimensional global model with a two-dimensional fluid model. Target voltage and current waveforms at charging voltage of 250-400 V and nitrogen flow fraction of 10%-75% are utilized as the input. The global model deals with the plasma chemical reactions to obtain the particle densities in the ionization region. The calculated densities then serve as boundary conditions for the fluid model, which simulates the transport of the plasma towards the substrate. The peak densities of metallic ions notably increase as the charging voltage rises from 250 V to 400 V whereas the gas ions densities show only minor increase. At fN2 = 10%, the dominant species in the plasma are Ar^+ and Cr^+. As the nitrogen fraction increases, there is a growing trend in the peak densities of $Cr2^+$, N^+ and $N2^+$ ions. However, the peak values of gas recycling parameters decline notably over time during the macropulse, whereas the target species recycling is gradually enhanced. The averaged peak values of the generalized self-sputtering parameter increase significantly as the charging voltage rises, driven by enhanced gas recycling. Increasing the nitrogen fraction shifts the discharge from metal mode toward poisoned mode. Target poisoning dynamics reveals that chemisorption and sputtering are the main mechanisms for surface compound formation and removal, respectively. Simulation results provide insights into reactive sputtering for optimization the deposition parameters.

Advancing sustainable food processing:

molecular-scale understanding of incipient protein fouling in falling-film evaporators

Mütesir Temel, **Professor Jia Wei Chew**[1]
[1]Chalmers University Of Technology, Kemigården 4 Forskarhus 1 Våning 5, Sweden
Session 09 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 16, 2026, 1:30 PM - 3:10 PM

Aligned with the green transition of the food industry, this study addresses the downstream processing of food protein ingredients from novel sources and enhanced production methods. As with current liquid foods (e.g., milk), reducing the water content to create concentrates or powders is necessary for longer shelf-life and ease of transport. A dominant unit operation for this purpose is the falling-film evaporator (FFE). This study focuses on the inevitable protein-fouling issue of FFEs that limits energy efficiency. To understand the incipient adsorption behavior (i.e., fouling behavior at the initial stages) of a model protein (namely, lysozyme) onto the chromium (III) oxide (Cr2O3) surface of the stainless-steel heat-transfer surface of FFEs, molecular dynamics simulations were performed. Six lysozyme orientations were initialized at four temperatures each. Results indicate adsorption is primarily governed by attractive electrostatic interactions by basic amino acid residues, whereas acidic amino acids tend to be repulsive due to the negative charges. Temperature effects are secondary to local interactions, with no clear correlation with adsorption tendencies, suggesting the onset of fouling is temperature independent. The adsorption tendencies of amino acid residues onto Cr2O3 revealed here are expected to be valuable for providing insights into FFE-fouling by emerging food protein formulations.

Computationally Efficient Data-Driven Predictive Control for the Economic Operation of Membrane Reactors in Water Treatment

Mingxue Yan[1], **Xunyuan Yin**[1]

[1]Nanyang Technological University, N1.2 B2-22, 62 Nanyang Dr, Singapore

Session 09 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 16, 2026, 1:30 PM - 3:10 PM

Membrane bioreactor (MBR)-based wastewater treatment plants (WWTPs) have attracted increasing interest because they combine activated sludge treatment and membrane separation to produce high-quality effluent within a compact footprint [1]. This makes them attractive where land is limited and discharge standards are stringent. However, their operation remains challenging due to strong nonlinearity, state coupling, and external disturbances. These characteristics make controller design difficult and often impose substantial computational and modeling burdens during real-time optimization and plant operation. Although economic model predictive control (EMPC) is well suited for balancing effluent quality and operating cost [2,3], its application is limited by the difficulty of developing accurate first-principles models and the lack of full-state measurements. To overcome these challenges, we propose a convex data-driven economic predictive control method for MBR-based WWTPs. Building on our previous work [4,5] and the data-enabled predictive control (DeePC) framework [6], the method avoids explicit first-principles modeling and full-state measurements. A neural network maps system outputs to a latent space where the nonlinear economic objective is approximated by a quadratic function, yielding a convex optimization problem that can be solved efficiently online. Simulation results on a benchmark MBR plant demonstrate economically efficient operation and improved economic performance.

References

[1] G. Mannina, G. Di Bella, G. Viviani. Journal of Membrane Science, 376(1-2): 56-69, 2011.

[2] J. Zeng and J. Liu. Industrial & Engineering Chemistry Research, 54(21):5710-5721, 2015.

[3] M. Ellis, H. Durand, and P. D. Christofides. Journal of Process Control, 24(8):1156-1178, 2014.

[4] M. Yan, X. Zhang, K. Zhang, Z. Li, and X. Yin. IFAC-PapersOnLine, 59(6):25-30, 2025.

[5] M. Yan, X. Zhang, K. Zhang, Z. Li, and X. Yin. arXiv preprint, arXiv:2512.23170, 2025.

[6] Coulson J, Lygeros J, Dörfler F. European Control Conference. 307-312, 2019.

July 16, 2026 | 2:10 PM

Directional Droplet Rebound Dynamics on Anisotropic Superhydrophobic Surfaces:

Implications for Self-Cleaning Polymer Thin Films

Dr. Sushanta Sethi[1]

[1]IIT Dharwad, Dept. of Mechanical, Materials & Aerospace Engineering, Indian Institute of Technology (IIT) Dharwad, India

Session 09 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 16, 2026, 1:30 PM - 3:10 PM

Controlled manipulation of liquid droplets on engineered surfaces is essential for applications such as self-cleaning coatings, anti-fouling materials, and functional thin films. However, conventional superhydrophobic surfaces largely depend on gravity or external tilting to enable droplet removal, limiting their effectiveness on horizontal or complex geometries. In this work, molecular dynamics (MD) simulations are employed to investigate the rebound dynamics of water droplets impacting anisotropic nanoscale corrugated surfaces inspired by natural microstructures. The surface is designed with slanted conical features, and the effects of slant angle, feature dimensions, and impact velocity on droplet behavior are systematically analyzed.

The results reveal that the anisotropic surface architecture enables directional droplet to rebound, allowing controlled liquid transport without the need for surface tilting. A critical slant angle is identified beyond which the rebound direction switches from forward to backward, demonstrating a tunable mechanism governed by surface geometry and impact dynamics. This gravity-independent directional transport provides a new pathway for efficient removal of liquid and contaminants, offering significant potential for the design of advanced self-cleaning polymer coatings and superhydrophobic thin films. The findings establish fundamental insights and practical design guidelines for engineering surfaces with programmable droplet motion.

July 16, 2026 | 2:25 PM

Molecular Dynamics Study of Chemical and Physical Crosslink Contributions to Rubbery Modulus in Photocurable Shape Memory Polymer Networks

Mr Taehyub Lee[1,2], Dr. Chin Siang Ng[1,2], Dr. Nannan Li[3], Dr. Jianwei Zheng[3], Prof. Pei-Chen Su[1,2]

[1]Nanyang Technological University, , Singapore, [2]Singapore Centre for 3D Printing, , Singapore, [3]Institute of High Performance Computing, Agency for Science, Technology and Research, , Singapore

Session 09 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 16, 2026, 1:30 PM - 3:10 PM

Shape memory polymers (SMPs) are key materials for 4D printing because they can recover predefined shapes upon external stimulation. The rubbery modulus (Er) is a critical parameter governing mechanical performance and is strongly influenced by the underlying network structure. Although Er is commonly tuned by varying crosslinker length and concentration, the resulting trends are often inconsistent due to competing effects. Specifically, increasing crosslinker length reduces chemical crosslink density while simultaneously enhancing chain flexibility and physical entanglements, making predictive design challenging. In this study, we investigate poly(ethylene glycol) diacrylate (PEGDA)–isobornyl acrylate (IBOA) networks to elucidate how chemical and physical crosslinks jointly determine Er. PEGDA with various concentrations and different ethylene glycol repeating units was incorporated as the crosslinker. Molecular dynamics (MD) simulations were employed to explicitly characterize the network structure, enabling direct quantification of chemical crosslink density and physical contributions such as chain entanglements. The simulation results were compared with experimentally measured Er from dynamic mechanical analysis (DMA), and curve fitting was performed to evaluate the agreement between simulation and experiment. The MD analysis reveals a concentration-dependent transition in the dominant mechanism governing Er. At low crosslinker concentrations and longer chain lengths, physical contributions arising from entanglements and intermolecular interactions become significant, whereas at higher crosslinker concentrations, the network response is primarily dictated by chemical crosslinks. This explicit separation of crosslinking contributions provides a mechanistic explanation for previously inconsistent trends in modulus with respect to crosslinker length and concentration. Overall, this work demonstrates how MD simulations can directly resolve network structure–property relationships and provides practical guidelines for tailoring mechanical properties in VP-compatible SMP systems.

July 16, 2026 | 2:40 PM

Molybdenum dz2 and Sulphur p orbitals form resonant channels during Hydrogen Evolution Reaction in thin film MoS2

Mr Jesaya Christian Ido Raja[1], Prof Shuzhou Li[1]

[1]School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore

Session 09 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 16, 2026, 1:30 PM - 3:10 PM

Perpetual reliance on diminishing fossil deposits has not only caused harsh environmental conditions but also triggered belligerent policies among nations. Low-emissions hydrogen produced through widely accessible thin film semiconductor electrocatalysis has been deemed feasible to both establish greener environment and de-escalate conflict. Central to electrocatalysis is the hydrogen evolution reaction (HER), which constitutes interplay between carrier transport and surface reaction chemistry, particularly for thin-film systems. However, recent evidence suggests a profound missing link between the surmised conductance vis-à-vis Fermi modulation and site activity vis-à-vis Charge localization. By adopting the Landauer-Büttiker formalism, this work proposes that during HER, conductance arises as consequence of certain active sites. Platformed on the underpinning thin film limit of monolayer MoS_2, we report linear conductance trend rising from 0.772 μS, 1.12μS, to 1.59μS under 0V,15V, and 30V gate voltages respectively. Furthermore, conductance upsurge to 3.64μS is found under 45V gate voltage. Startlingly, foundational to these conductance values is the resonance between certain molybdenum and sulphur atoms surrounding the hydrogen adsorption site, primarily formed between the molybdenum dz^2 and sulphur p orbital. Consistent with the macroscopic trend, resonance avalanche is conspicuously evident at the 45V gate voltage. This work resolves that in lieu of accounting conductance separately from site activity, resonance should be embraced for more robust accountability in thin film hydrogen evolution reactions.

July 16, 2026 | 2:55 PM

Polysulfide Anchoring in Sodium-Sulfur Batteries by Non-Metal Doped VS2: A DFT Study

Deepak Gorai[1], Deepak Panda[1], Dr. Shivam Tripathi[1]

[1]Indian Institute of Technology Kanpur, Department of Materials Science and Engineering, India

Session 09 - S04: Computation and AI for Materials & Thin Films (CAM), Kallang - Level 4, July 16, 2026, 1:30 PM - 3:10 PM

The high theoretical energy density and low cost of room temperature sodium-sulfur (Na-S) batteries make them an attractive contender for next-generation energy storage systems. However, the practical use of Na-S batteries is hindered by several drawbacks, including the "shuttle effect," the slow decomposition of solid Na_2S, and the poor electrical conductivity of sulfur. To address these problems, this research explores the possibility of non-metal-doped vanadium disulfide (VS_2) monolayers for immobilizing higher-order polysulfides and accelerating the dissolution of insoluble short-chain polysulfides in Na-S batteries, using first-principles calculations. Our nonmetallic doping approach offers superior structural stability and intrinsic conductivity compared to traditional metal doping methods, which can cause lattice deformation. The generation of S-vacancy in monolayer VS_2 is an endothermic event, while O-doping is an exothermic reaction, based on the defect formation energy. The electronic structure near defects affects the adsorption energies of Na ions relative to those in pure VS2. Overall, non-metal-doped VS2 may be regarded as an efficient AM to suppress the shuttle effect and enhance the performance of Na-S batteries due to its strong adsorption behavior, improved oxidative decomposition kinetics of polysulfides, and increased electrical conductivity.

Keywords: Na-S battery, Non-metal, Vanadium disulfide, Density functional theory, Electrocatalysis

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Molecular Insights into Interfacial Thermodynamics Governing Nanoscale Evaporation from Water Thin Films

Mr Jason Jovi Brata[1], Mr Shuzhou Li[1]

[1]Nanyang Technological University, 50 Nanyang Ave, Block N4.1, Singapore 639798, Singapore

Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Understanding phase-change kinetics in nanoscale liquid films is essential for the development of advanced thermal management systems, energy harvesting devices, and desalination technologies. In particular, evaporation from thin liquid films is governed by interfacial molecular processes that differ significantly from bulk liquid behavior. In this work, equilibrium molecular dynamics simulations are employed to systematically investigate evaporation from water nanofilms with thicknesses ranging from 2.5 to 6.0 nm deposited on eleven different solid substrates, including graphene, silicon, and several face-centered cubic metals with varying solid–water interaction strengths. The simulations quantify unidirectional evaporation fluxes, evaporation and condensation coefficients, and structural and thermodynamic properties across the solid–liquid–vapor interfaces. The results reveal that hydrophilic substrates suppress evaporation rates by up to 20% compared to free-standing water films, whereas hydrophobic surfaces exhibit minimal influence. Detailed analysis of interfacial structure shows that the reduction in evaporation is not directly correlated with the molecular arrangement of water in the first hydration layer at the solid surface. Instead, strong solid–water interactions induce perturbations that propagate into the bulk liquid region of the thin film. These perturbations strengthen the hydrogen-bond network, increase liquid density, and reduce vapor density above the interface. Within a potential-of-mean-force framework, these changes correspond to an increased free-energy barrier for phase transition from liquid to vapor. The influence of the substrate is strongly dependent on film thickness, with thinner films exhibiting greater sensitivity to interfacial perturbations. These findings highlight the importance of coupling interfacial molecular physics with thin-film thermodynamics for accurate predictive modeling. The results provide fundamental insight into substrate-controlled evaporation mechanisms and offer guidance for the rational design of materials and surfaces to optimize nanoscale thin-film evaporation processes.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Generalized thermal rectifier model with optimal thermal rectification ratio and its application to Ga_2O_3-based semiconductors

Professor Jin-Cheng Zheng[1]

[1]Xiamen University, Xiamen University, 422 South Siming Road, Siming District, , China

Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Thermal rectification (TR), characterized by asymmetric heat transport under opposite temperature gradients, is essential for advanced thermal management in electronic devices. We present a generalized optimization strategy for two-segment thermal rectifiers based on Fourier's law. Our analytical framework demonstrates that the rectification ratio (R), defined as the forward-to-reverse heat flux ratio, is maximized when the interface temperatures coincide for both heat flow directions.

The study further reveals that greater nonlinearity in the temperature-dependent thermal conductivity (κ(T)) of the constituent materials significantly enhances the optimized TR effect. This framework is specifically applied to wide-bandgap gallium oxide (Ga_2O_3) heterojunctions. By pairing Ga_2O_3 with various materials, such as diamond, Bi–Sb–Te alloys, and $Al_xGa_{1-x}O_3$, we evaluate the maximum achievable rectification ratios.

Numerical verification using finite-difference time-domain (FDTD) simulations in Energy2D shows strong consistency with our theoretical predictions, with differences within 0.08. This work provides a versatile tool for the systematic design and optimization of high-performance thermal rectifiers across diverse material systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Machine Learning-Driven Colour Matching for E-Coat on Metallised PEI Substrates

Dr Zhaohong Huang[1], Mr Preston Yuelong Zhu[1], Ms Yujie Zhou[1]

[1]A*star Singapore Institute Of Manufacturing Technology, , Singapore

Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The integration of Additive Manufacturing (AM) with high-performance polymers like Polyetherimide (PEI/ULTEM) is increasingly vital for aerospace and industrial applications. However, achieving precise aesthetic colour matching for these parts via traditional electrophoretic coating (E-Coat) is often a trial-and-error process. This study presents a systematic approach to developing a predictive E-Coat colour-matching model using data mining and machine learning (ML). The process begins with a robust metallization of vapor-smoothened ULTEM, creating the necessary conductive surface for E-Coating. A comprehensive database was established by varying E-Coat bath formulations, specifically the concentrations of white, yellow, red, blue, and black electrophoretic pastes. The resulting colours were characterized using the CIELAB (L*a*b*) colour space. A neural network was trained to map five input variables (bath formulation components) to three output variables (L*, a*, and b*). The architecture consists of three hidden layers (64, 32, and 16 units) utilising Rectified Linear Unit (ReLU) activation functions to capture complex, non-linear relationships. The model was trained on 59 samples using the Adam optimizer with a Mean Absolute Error (MAE) loss function. The ML model successfully predicted suitable formulations for target colours such as "Dream Grey," "Pearl White," and "Beige". Validation showed a significant reduction in training MAE from 0.16 to 0.05 and validation MAE to 0.02, indicating high predictive accuracy. Benchmarking confirmed that the developed E-Coat process offers superior surface smoothness (Ra = 0.344 µm), higher pencil hardness (6H), and better colour stability after 5,000 wash cycles compared to conventional painting. This approach enables rapid, automated colour matching for high-performance 3D-printed components.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Beyond Trial-and-Error: Scalable Simulations, Curated Data, and Machine Learning-Driven Design of Recyclable Polymers

Nannan Li[1], Manna Dai[2], Joyjit Chatorraj[2], Jianwei Zheng[2]
[1]Institute of Materials Research and Engineering, 2 Fusionopolis Way, Innovis, #08-03, Singapore 138634, Singapore, [2]Institute of High Performance Computing, 1 Fusionopolis Wy, #16-16 Connexis, North Tower, Singapore
Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Plastic pollution has become one of the most pressing environmental challenges worldwide. In Singapore alone, about one million tonnes of plastic waste are generated annually, yet only 6% is recycled. With the nation's sole landfill at Semakau projected to reach full capacity by 2035, tackling plastic waste is increasingly urgent. Covalent adaptable networks (CANs), which are dynamically crosslinked polymers, offer a promising path to close the materials loop by combining thermoset-like performance with thermoplastic-like recyclability. However, their development remains largely reliant on trial-and-error experimentation, which is slow, costly, and often lacking in mechanistic insight.

I will present our efforts to accelerate CAN design using computational methods. First, we developed an automated computational workflow that enables scalable simulations, systematically mapping structure-property relationships and generating data at reduced cost. Second, we curated a CAN dataset through literature mining and built interpretable machine learning models to extract design rules, providing guidelines for rational CAN development. Together, these advances illustrate how computation, data curation, and machine learning can complement experimental efforts to accelerate CAN innovation and advance their role as sustainable materials for a circular plastics economy.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Multi-Fidelity Machine Learning for Optimal Operating Condition Prediction in SOEC CO_2/H_2O Co-Electrolysis toward Targeted Syngas Composition

Hyunwoo Cho[1], Donghyun Kim[1], Sangcheol Jang[1], Hyunho Lee[1], Wonjong Yu[1]
[1]Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, South Korea

Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Solid oxide electrolysis cells (SOECs) offer a viable route for converting CO_2 and H_2O into syngas (H_2 + CO), a key feedstock for synthetic fuel production. Optimizing cell performance across the full design space, including temperature, pressure, inlet gas composition, electrode material, and functional layer thickness, remains computationally prohibitive with conventional simulation methods. Existing approaches evaluate performance only at discrete, fixed conditions such as selected temperatures or pressure steps, leaving broad regions of the parameter space unexplored and obscuring optima that lie between sampled points.

We present a Multi-Fidelity Machine Learning (MFML) framework that predicts j–V characteristics and syngas composition as continuous functions of a high-dimensional design space. Low-fidelity analytical models densely populate the parameter space at low cost, while targeted high-fidelity SOEC simulations correct systematic bias and enforce physical accuracy. Co-kriging fusion integrates both fidelity levels into a surrogate that achieves high-fidelity accuracy at substantially reduced computational cost.

The surrogate identifies optimal operating windows, including intermediate conditions invisible to fixed-grid studies, where current density and H_2:CO output ratio are simultaneously maximized. Continuous mapping of the design space reveals performance trends and material-condition interactions that discrete parametric sweeps structurally cannot capture.

This work establishes MFML as an efficient, physics-informed design tool for SOEC optimization, accelerating rational development of green syngas production systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Data-Driven Assisted Research and Engineering Applications of Photothermal Regulation Metamaterials

Dr. Yanyu Chen[1], Prof. Yao Li[1]

[1]Harbin Institute of Technology, No. 92, Xidazhijie, China

Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Machine learning technologies, represented by deep learning, have become a powerful tool for the optimized design of photothermal regulatory metamaterials. They can efficiently handle the nonlinear mapping relationships between high-dimensional design parameters and complex physical responses, enabling rapid optimization within vast structural spaces. By constructing surrogate models or conducting end-to-end inverse design, machine learning not only accelerates traditional simulation iteration processes but also discovers innovative structural configurations beyond human empirical intuition. This provides a novel research paradigm and technical pathway for realizing dynamic, broadband, and multifunctional intelligent photothermal metamaterials. This report highlights the team's exploration of leveraging deep learning to empower metamaterial design and its engineering applications, primarily focusing on the application of intelligent thermal control metamaterials in the "Tianwen-2" deep-space exploration mission and bionic metasurfaces in the "Fengyun-4" meteorological satellite. Aiming at spectral regulation objectives across multiple and broadband wavelengths, we achieved intelligent modulation and performance breakthroughs in spectral properties by optimizing material composition and structural design, thereby empowering the entire process—from design and manufacturing to evaluation and on-orbit feedback optimization—with intelligence.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

LAMMPSAgents: An Intelligent Multi-Agent Framework for Parsing LAMMPS Molecular Dynamics Simulation

Mr Yu Du[1], Ms Dongjie Shi[1], Dr Tianruo Shen[1]

[1]National Supercomputer Center in Tianjin, 10 Xinhuan West Road, China

Poster Session - S04: Computation and AI for Materials & Thin Films (CAM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This presentation introduces a multi-agent framework (LAMMPSAgents) powered by large language models with retrieval-augmented generation, aiming to automate the parsing and analysis of molecular dynamics simulation files. Through coordinated collaboration among specialized agents, this system performs key tasks including LAMMPS input/output file parsing, simulation knowledge retrieval, trajectory data analysis, physical process inference, and research guidance into a unified workflow. By conjugating raw simulation files with domain knowledge and automated analytical reasoning, it endows researchers to extract meaningful insights with practical physical significance from simulation data, while substantially reducing the expertise and manual effort conventionally required for molecular dynamics analysis. This framework also demonstrates robust performance across diverse simulation scenarios, such as input script validation, interatomic potential analysis, and dynamics process inference. Therefore, this endeavor holds promise for providing an innovative AI-augmented paradigm for computational materials science, improving both the efficiency and reliability of molecular dynamics research.

July 16, 2026 | 8:30 AM

Transparent conductive coatings with tunable properties for various industrial applications

Senior Principal Scientist Shijie Wang[1]

[1]FEAT & IMRE, A*STAR, 2 Fusionopolis Way, # 08-03 Innovis Singapore 138634 , Singapore

Session 07 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 8:30 AM - 10:15 AM

Transparent conducting oxides (TCOs) have gained increasing importance as key components in the daily lives, especially for applications such as flat panel display technology, optoelectronic devices, photovoltaic devices and electrochromic devices. Zinc oxide (ZnO) is a promising transparent conducting oxide (TCO) substitute for ITO since it is non-toxic, abundant, inexpensive and has a wide direct band gap (Eg) of ~3.4 eV with high transparency in the visible region. Controllable n-type doping enhancement can be achieved by substituting the Zn2+ ions with group III elements. Among the group III elements investigated, gallium (Ga) is attractive because Ga-O has similar ionic (0.76 Å vs. 0.88 Å) and covalent (1.26 Å vs. 1.31 Å) radii as compared to Zn-O. This means that gallium-doped ZnO (GZO) can possibly be achieved without substantial ZnO lattice deformation. Therefore, low resistivity of GZO can be obtained and improvements in the electrical properties of devices employing GZO as a TCO have also been demonstrated. In this talk, I will give a brief introduction of our high quality GZO growth with tunable properties and its related applications.

July 16, 2026 | 8:50 AM

Gradient Multi-Principal Element Nitride Coatings: A Platform for Wide-Temperature-Range Wear Protection

Dr Haiyang Yu[1]

[1]Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, , China

Session 07 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 8:30 AM - 10:15 AM

Titanium alloys are widely used in the aerospace industry due to their high specific strength and excellent corrosion resistance. However, their inherent low hardness and poor wear resistance significantly limit their reliable application in high-temperature moving components. Double-glow plasma surface alloying (DGPSA) technology enhances plasma sputtering through the hollow cathode effect, enabling the preparation of gradient-structured coatings with metallurgical bonding interfaces on titanium alloy surfaces.

This study demonstrates the excellent wear resistance of multi-principal element nitride/carbide ceramic coatings over a wide temperature range (25–700 °C). The outstanding wear resistance can be attributed to the following factors: (1) high strength and toughness of the coating at room temperature; (2) favorable intermediate-temperature strength and the formation of a compliant oxide layer; and (3) the synergistic effect of a dense, smooth amorphous glaze layer on the surface and a gradient amorphous-nanocrystalline composite structure in the subsurface layer at elevated temperatures, which together inhibit crack propagation and enhance surface load-bearing capacity.

Furthermore, this study highlights the potential of DGPSA technology as a versatile platform for the controllable preparation of coatings ranging from multi-principal element to high-entropy nitride/carbonitride systems. Through rational composition design and gradient structure tailoring, these coatings exhibit excellent wear resistance and high-temperature stability over a wide temperature range, offering a new technical pathway for the surface protection of titanium alloys. The findings also provide theoretical foundations and technical support for surface engineering applications in extreme environments, such as high-temperature moving components in aero-engines.

July 16, 2026 | 9:10 AM

Microstructural and Chemical Influences on Colour Stability in Brass Bluing - A Failure Analysis Approach

Dr Zhaohong Huang[1], Ms Yujie Zhou[1]

[1]A*star Singapore Institute Of Manufacturing Technology, , Singapore

Session 07 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 8:30 AM - 10:15 AM

Brass bluing is a critical chemical surface treatment used to provide low-glare, aesthetic, and protective black oxide finishes for precision components such as optical instruments and electronic housings. Despite its widespread use, industrial applications are frequently hindered by colour instability, where processed parts exhibit inconsistent brown or grey tones instead of a stable deep black. This study investigates the microstructural and chemical root causes of these variations in Cu40Zn brass across different material sources using a failure analysis approach. The methodology employed a combination of colorimetry for RGB characterization, Raman spectroscopy to identify oxide phases, and optical microscopy to correlate coating morphology with the underlying substrate microstructure. The findings reveal that colour stability is primarily governed by the content and distribution of the Zn-rich β phase within the brass; a continuous β phase network is essential for uniform ion migration and the growth of a dense CuO passive layer. Conversely, insufficient β phase content or improper process parameters lead to the development of unstable Cu2O at the interface or porous structures that reflect light, resulting in "patchy" or off-colour appearances. This research highlights that achieving a consistent finish requires strict control over both the metallurgical state of the substrate and the specific bluing process parameters to ensure a sufficiently thick CuO buffer against environmental oxidation.

Effect of energy gradient on wear resistance of TiN coatings deposited by magnetron sputtering with stepwise tuning working pressure

I-Sheng Ting[1], **Distinguished Professor Jia-Hong Huang**[1]

[1]National Tsing Hua University, 101 Kuang Fu Road, Section 2, Taiwan

Session 07 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 8:30 AM - 10:15 AM

This study aimed to investigate the effects of stored elastic energy gradient and compressive stress on wear resistance of TiN coatings. TiN coatings deposited by DC unbalanced magnetron sputtering on Si (TiN/Si) and D2 steel (TiN/D2) substrates, where the in-depth stress (σavg(γ)) distribution was determined using the average X-ray strain method with progressively increasing X-ray incident angle (γ). The σavg(γ) in TiN coatings was tailored by stepwise tuning the working pressure ranging from 1.2 to 1.9 mTorr, including increasing (Pi), constant (Pc), and decreasing (Pd) working pressure. The results showed that the crystal structure and hardness of the coatings were not significantly affected by the changing working pressure. Square pyramidal grains sporadically appeared on the surface of TiN/D2 specimen deposited under condition Pc (DPc), while conditions Pi (DPi) and Pd (DPd) respectively eliminated and promoted the growth of square pyramidal grains. An energy-based calculation was proposed to convert σavg(γ) to the layer-resolved energy gradient (LEG). The LEG were substantially different in the three TiN/D2 specimens, and the major difference lay in the upper half of the coatings. Accordingly, wear tests were conducted at two different sliding distances, 100 and 150 m. The results showed that specimen DPd exhibited the highest adhesion strength and the lowest wear rate at the sliding distance 100 m. In addition, the formation of square pyramidal grains in specimen DPd showed a positive enhancement on the wear resistance. The wear rates of the three specimens changed in the sliding distance between 100 to 150 m, which was attributed to the interplay between the energy gradient and compressive stress. The results also showed that the surface morphology and LEG of the coatings could be tailored by adjusting working pressure, by which the adhesion strength and wear resistance could be controlled.

July 16, 2026 | 9:45 AM

Ceramic Coatings on Stainless Steel Substrate by Plasma Spray: Comparison between Y2O3 and YF3

Mr. Yee Ng[1], Dr. Yuefan Wei[2], Dr. Andrew Chun Yong Ngo[1], Dr. Hongfei Liu[1]
[1]FEAT, A*STAR, 2 Fusionopolis Way, Singapore 138634, Singapore, [2]ARTC, A*STAR, 3 CleanTech Loop, #01-01 CleanTech Two, Singapore 637143, Singapore, [3]SIMTech, A*STAR, 5 CleanTech Loop #01-01, CleanTech Two Block B, Singapore 636732, Singapore, [4]IMRE, A*STAR, 2 Fusionopolis Way, Singapore 138634, Singapore
Session 07 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 8:30 AM - 10:15 AM

Yttrium-based ceramic coatings have attracted significant attention for corrosion protection in aggressive environments, particularly in semiconductor, chemical processing, and plasma-assisted manufacturing systems. Among them, yttrium oxide (Y2O3) and yttrium fluoride (YF3) are widely recognized for their excellent chemical stability and plasma resistance. However, a systematic comparison of their microstructure, bonding characteristics, and corrosion behavior when deposited on stainless steel substrates remains limited. In this work, Y2O3 and YF3 coatings of ~110 μm thick were deposited onto stainless steel substrates using atmospheric plasma spray (APS). The phase composition, microstructure, and coating/substrate interface were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM). Coating density, porosity, hardness/modulus, and dielectric breakdown strength were evaluated to assess mechanical and dielectric integrities. Furthermore, corrosion performance was investigated through electrochemical testing, including potentiodynamic polarization (PDP) and electrochemical impedance spectroscopy (EIS), and exposure experiments in fluorine-containing environments. This comparative study provides critical insights into the structure-property relationships of plasma-sprayed yttrium-based ceramic coatings on stainless steel substrates. The findings offer guidance for selecting appropriate ceramic protective layers for applications requiring high corrosion resistance and plasma durability.

Writable electronic textiles based on ACEL fiber coatings

Jiajun Qin[1]

[1]Fudan University, , China

Session 07 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 8:30 AM - 10:15 AM

Textile displays represent fundamental components for next-generation wearable electronics. However, their widespread commercialization is hindered by intricate drive circuits and complex information processing systems. Here, we introduce a writable display textile based on an alternating current electroluminescence (ACEL) co-planar electrode structure. This design incorporates a single AC driving module, enabling the realization of large-area textile displays. By integrating light-emitting fiber electrodes with cotton yarns, we have developed a flexible and breathable textile platform that supports easy writing and painting through polarized media such as hydrogel or water. By modulating the luminescent medium, we achieve display patterns with diverse color variations. This writable textile technology establishes a foundation for advanced human-computer interaction, demonstrating significant potential for applications in the Internet of Things.

Coating edge distortion measurement for slot die roll to roll process during manufacturing

Dr David Bird, Professor Liam Blunt, Professor Dame Xiangqian (Jane) Jiang, Dr Prashant Kumar, **Hussam Muhamedsalih**[1]

[1]University of Huddersfield, , United Kingdom

Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

Slot-die coating is widely recognised as a cost-effective technique for roll-to-roll (R2R) processes, enabling high precision thin film deposition on a large web areas. This technique is simple but widely applied in modern industries such as lithium-ion batteries, flexible displays, and flexible solar cells, where uniform coatings over large areas are critical to device performance and production efficiency. The uniformity can reach sub-micron across the web width and be produced at high speed with minimal material waste, making it ideal for large-scale production in high-value manufacturing sectors.

The process is based on dispensing a controlled amount of fluid through a precision die onto a continuously moving web. The tight control of coating thickness and uniformity is essential to maintaining functional performance across large areas. However, one major issue that can compromise coating uniformity is edge elevation, a phenomenon where excess material accumulates at the lateral edges of the coated track.

The impact of edge elevation is significant. In high-precision applications like battery electrodes or optical films, uneven coating thickness can lead to mechanical defects (e.g., cracking or delamination during calendaring) or performance inconsistencies (e.g., optical distortion or poor conductivity).

In this paper, we propose a real time dynamic interferometric technique that can measure the edge profile of the dried film to quantify the edge overshoot “on the fly” as a feedback signal to control the operating conditions. A single shot multi-wavelength polarising interferometer (MPI) was implemented to measure the surface topography of coated films at different slot-die pump flow rates. In this work, we aim to demonstrate that edge overshoot along the printed track can be quantitatively assessed in real-time as metric values using the proposed interferometry, and that the variations in edge overshoot can be directly linked to changes in the pump flow rate.

Ultrasonic and Shearography Techniques for Non-Destructive Evaluation of Coatings

Dr. Lei Zhang[1]

[1]Institute of Materials Research and Engineering (IMRE), Agency for Science, Technology and Research (A*STAR), 2 Fusionopolis Way, Innovis #08-03, Singapore 138634, Republic of Singapore

Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

Coatings play an important role in protecting industrial components against environmental degradation, mechanical wear and chemical attacks. Ensuring the quality and integrity of coatings is essential for long-term performance, reliability and durability. Therefore, the quantitative characterization of coating quality is important. In this talk, recent developments in non-destructive evaluation (NDE) techniques for coating assessment will be discussed, with a particular focus on ultrasonic and shearography-based methods. Approaches such as acoustic shearography, laser ultrasound and acoustic emission will be highlighted for their ability to provide high-resolution imaging of coating defects, non-contact measurement of residual stresses, and monitoring of damage evolution. The talk will conclude with perspectives on future directions, including the role of hybrid sensing and machine learning in enhancing coating evaluation and lifecycle management.

Thermal barrier coating removal process based on plasma technology

Song chang, **Liu Hong**[1]
[1]Shenyang Aerospace University, ,
Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

Yttria-stabilized zirconia (YSZ) thermal barrier coating has become the core surface protection material for hot-end components such as aero-engine turbine blades due to its excellent low thermal conductivity and high temperature stability. However, in the harsh service environment of high temperature and stress coupling, the coating is prone to cracking, peeling and other failure behaviors, so it is urgent to develop efficient and nondestructive coating removal technology to support coating repair and blade remanufacturing. In this paper, a scheme of YSZ coating removal based on plasma electrolysis technology is proposed. The effects of solution system and process parameters on the removal efficiency and surface quality of YSZ coating on GH4169 superalloy and its internal mechanism are systematically studied. The solution system optimization results show that the mixed solution with concentration of 3.5% and the ratio of ammonium fluoride to potassium fluoride of 1:3 has the best removal performance, and the highest removal rate of the coating is 46.38%, which is 1.64 times that of ammonium sulfate solution (28.31%). Under this system, the fluoride residue on the coating surface is low and the cleanliness is better. Orthogonal test and range analysis of process parameters show that solution temperature has the most significant effect on coating removal, followed by working voltage and working time. The optimal process parameters are working voltage 265V, solution temperature 50°C and working time 120s s. Under these conditions, the coating removal rate can reach 100%, and the substrate has not been obviously damaged. This study provides a key theoretical basis and technical support for the maintenance, repair and remanufacturing of thermal barrier coatings, and is of great significance for improving the operational reliability and maintenance economy of key equipment of aero-engines.

Surface modification and integrity enhancement of duplex stainless steel 2205 by severe shot peening

Mr Yee Ng[1,2], **Dr Guangxu Yan**[1], Dr Andrew Chun Yong Ngo[2], Mrs Huiru Tan[1], Dr Ming Lin[1], Dr Hongfei Liu[1,2,3]

[1]Institute of Materials Research and Engineering (IMRE), A*STAR (Agency for Science, Technology and Research), 2 Fusionopolis Way, Innovis Building, Level 9, Singapore 138635, Singapore, [2]Future Energy Acceleration and Translation (FEAT), A*STAR (Agency for Science, Technology and Research), 2 Fusionopolis Way, Innovis Building, Level 9, Singapore 138635, Singapore, [3]Department of Materials Science and Engineering (MSE), National University of Singapore, 9 Engineering Drive 1, Singapore 117575, Singapore

Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

Duplex stainless steel 2205 (DSS 2205) is widely used in aggressive environments due to its balanced austenite-ferrite microstructure, offering high strength and excellent corrosion resistance. However, its surface integrity remains a critical factor governing performance under wear, fatigue, and localized corrosion conditions. In this work, severe shot peening (SSP) is employed as an effective surface modification technique to enhance the mechanical and functional properties of DSS 2205. The SSP process introduces significant plastic deformation, leading to the formation of a refined surface layer characterized by high dislocation density, grain refinement, and the possible development of deformation-induced martensite. These microstructural changes result in substantial surface hardening and the generation of beneficial compressive residual stresses. The combined effects contribute to improved wear resistance and fatigue performance. Furthermore, the influence of SSP on surface integrity is systematically evaluated in terms of microstructure evolution, hardness distribution, and residual stress profiles. The relationship between processing parameters and property enhancement is also discussed. This study demonstrates that SSP is a promising and scalable approach for tailoring the surface properties of DSS 2205 for demanding industrial applications, particularly in marine and oil and gas environments.

Selective oxide layer formation on NiAl alloys by anodization with electrolyte variation

Mr. Ryota Kawakami[1,2], Naofumi Ohtsu[2]

[1]Hokkaido Research Organization, N13-W11, Kita-ku, Japan, [2]Kitami Institute of Technology, 165 Koen-cho, Japan

Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

Anodization is a simple method for forming oxide layers on metal surfaces, and it is widely used to improve corrosion resistance. In particular, anodization of valve metals such as aluminum and titanium has been extensively studied. In contrast, anodization of equiatomic alloys containing both valve and non-valve metals results in the formation of various oxide layers. The resulting oxide composition is determined by the balance between dissolution and oxidation of each constituent element, which is strongly influenced by the reactivity of the electrolyte.

This study aims to establish a method for controlling the formation of oxide layers by utilizing reactions between the alloy surface and the electrolyte by promoting selective dissolution through electrolyte chemistry. This approach is expected to enable improved control over the formation of oxide layers in multi-component alloy systems. In this work, we focus on NiAl alloys, which contain both a valve metal and a non-valve metal.

The samples consisted of NiAl alloy thin films (~4 μm thick, 57 at% Ni) prepared by sputtering. An aqueous NH_3 solution was used as the electrolyte, and anodization was carried out for 1 h at 3.5 V. As a result, numerous cracks were observed at an NH_3 concentration of 1.0 mol/L, and a dense oxide layer approximately 2 μm thick was formed. In contrast, no significant oxide growth was observed at 0.3 mol/L. XPS analysis revealed that the surface layer consisted of NiO and Al_2O_3. These results indicate that the anodization behavior of NiAl alloys depends on NH_3 concentration, which controls the balance between oxide formation and selective dissolution. At higher NH_3 concentration, enhanced dissolution of Al leads to a Ni-rich surface and promotes the growth of a NiO-containing oxide layer. This method shows potential as a simple process for directly forming NiO layers on NiAl alloys.

July 16, 2026 | 12:15 PM

Protective Coating by Plasma Electrolytic Oxidation (PEO) and Its Industrial Applications

Mr. Yee Ng[1], **Mr. Jayden Ong**[1], Dr. Guangxu Yan[1], Miss Anna Yong[1], Principal Scientist Andrew Ngo[1], Principal Scientist Hongfei Liu[1]

[1]Institute Of Materials Research And Engineering, , Singapore

Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

Plasma Electrolytic Oxidation (PEO) has emerged as a versatile surface engineering technique for producing thick, adherent, and multifunctional ceramic coatings on light metals such as aluminum, magnesium, and titanium alloys. This presentation provides an overview of the fundamental mechanisms governing PEO coating formation, with particular emphasis on plasma-assisted electrochemical reactions, microarc discharges, and the resulting hierarchical microstructures. The relationships between processing parameters, coating architecture (porous outer layer and dense inner barrier layer), and functional properties, including hardness, wear resistance, corrosion protection, and dielectric performance, are discussed. Recent advances in tailoring coating composition through electrolyte design and post-treatment strategies are highlighted, enabling enhanced performance for demanding environments. Industrial applications of PEO coatings in sectors such as oil and gas, marine/offshore, aerospace, and biomedical engineering are reviewed, demonstrating their capability to improve component durability and reliability. Key challenges, including process scalability, energy efficiency, and coating uniformity on complex geometries such as particle surface and inner walls of conduit structures, are also addressed. Finally, future directions toward hybrid coatings and smart functional surfaces are outlined, positioning PEO as a promising technology for next-generation industrial applications.

Investigation on the Low Secondary Electron Emission Mechanism of Magnetron Sputtered TiN Nanofilms

Doctor Jialong He[1]

[1]China Academiy Of Engineering Physics, No. 64, Mianshan Road, China

Session 08 - S05: Coating towards Industrial Applications (CIA), Kallang - Level 4, July 16, 2026, 10:45 AM - 12:45 PM

The magnetron sputtering TiN coating technology for secondary electron (SE) suppression has been widely applied in high energy particle accelerators, spacecraft, and high power pulse systems. Previous studies have revealed that while the maximum secondary electron yield (SEY) of bulk TiN material is 2.12, the SEY values of alumina ceramic and stainless steel substrates can be significantly reduced from 6.17 and 2.32 to 1.53 and 1.76, respectively, after depositing TiN nanofilms via magnetron sputtering. This indicates that the remarkable suppression of SE emission on coated surfaces is not attributable to the inherently low SEY of TiN itself, but rather to significant alterations in the microstructural characteristics of the deposited films during the magnetron sputtering process. The precise mechanism underlying the exceptional SEY suppression capability of TiN nanofilms remains unclear. Building upon previous research, we have proposed two plausible hypotheses: (1) the lattice defect mediated trapping mechanism, wherein lattice defects within the film act as traps for low energy SEs, and (2) the interface charge effect, which suppresses SE emission through charge redistribution at the film-substrate interface. Theoretical analyses have been conducted to elucidate how the distribution of lattice defects and surface charges in these two scenarios influences the SEY suppression performance of the films. Subsequent experimental validation will focus on fine-tuning key microstructural parameters during film preparation and post-treatment processes to verify the consistency of these hypotheses with experimental observations.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effect of Y2O3 nanoparticle inclusions on alumina coatings formed by multi-step plasma electrolytic oxidation on Al6061 substrates.

Mr Yee Ng[1,2], Mrs Anna Marie Yong[2], Dr Andrew Chun Yong Ngo[1,2], Dr Hongfei Liu[1,2,3]
[1]Future Energy Acceleration and Translation (FEAT), A*STAR (Agency for Science, Technology and Research), 2 Fusionopolis Way, Innovis Building, Level 9, Singapore 138635, Singapore, [2]Institute of Materials Research and Engineering (IMRE), A*STAR (Agency for Science, Technology and Research), 2 Fusionopolis Way, Innovis Building, Level 9, Singapore 138635, Singapore, [3]Department of Materials Science and Engineering, National University of Singapore, 9 Engineering Drive 1, Singapore 117575, Singapore, Singapore

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Alumina coatings were produced on Al6061-T6 substrates using a multi-step plasma electrolytic oxidation (PEO) process with the incorporation of Y_2O_3 nanoparticles (30~50 nm diameter) suspended in an aqueous electrolyte containing Na_2SiO_3 (10 g/L), NaOH (1.0 g/L), and glycerol (3.0 g/L). The resulting PEO coatings exhibit a typical bilayer structure consisting of a dense, crack-free inner layer and a porous outer layer with comparable thicknesses. By increasing the Y_2O_3 nanoparticle concentration in the electrolyte from 0 to 2.5, 5.0, 7.5, and 10 g/L, both elemental Y and crystalline Y_2O_3 contents in the coatings increased monotonically without causing significant changes in surface morphology or overall macrostructure. However, a gradual increase in coating thickness from ~30 to ~45 μm was observed after a five-step process with a total treatment time of 60 min. This increase correlates well with the increase in average surface roughness (from 2.85 to 3.91 μm) and dielectric breakdown voltage (from ~770 to ~880 V). Cross-sectional elemental analysis indicates that Y-containing inclusions are predominantly distributed in the outer layer rather than in the inner layer, following a depth-distribution trend similar to that of Si in the PEO coatings, although with different relative concentrations. Consequently, the microhardness of the dense inner layer (2094 ± 205 $HV_{0.05}$), which is significantly higher than that of the Al6061 substrate (123.0 ± 4.6 $HV_{0.05}$), remains essentially unaffected by the addition of Y_2O_3 nanoparticles to the electrolyte. Nanoindentation measurements further revealed that both the hardness and elastic modulus of the porous outer layer are lower than those of the inner layer, which may contribute to improved strain tolerance of the PEO coatings. The effects of Y_2O_3 nanoparticle incorporation on the mechanical and corrosion resistance properties of the PEO coatings will be discussed in detail.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Design of Mold Flux for High-Manganese Steel Continuous Casting: Optimizing Lubrication and Heat Transfer for Multi-Sequence Operations

Prof Jiangshan Zhang[1], Mr Shuhao Jiao[1], Prof Bin Hu[1]

[1]University Of Science And Technology Beijing, , China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The continuous casting of high-manganese steel (containing ~25% Mn) shows worldwide challenges due to severe interfacial reactions between the molten steel and conventional mold fluxes, leading to drastic changes in flux properties. This study focuses on the design of a novel mold flux system to regulate lubrication and heat transfer, which are critical for achieving stable multi-heat （≥4 heats） casting. The presence of 25% Mn triggers a strong reduction reaction with SiO_2 in the flux, disrupting the formation of a uniform glassy film. To overcome this, the flux chemistry was modified by controlling the basicity and optimizing the MnO and SiO_2 content to mitigate the reaction kinetics while ensuring controlled heat transfer. A tailored solid slag film structure was developed to balance horizontal heat flux, preventing sticker breakouts, and to maintain a consistent liquid reservoir for superior lubrication. Laboratory simulations and plant trials demonstrate that the optimized flux enables stable continuous casting of four consecutive heats, which significantly improves productivity and surface quality by managing the coupled thermophysical properties essential for friction and heat transfer control at the mold interface.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Friction surface evolution of Ni-based superalloy with addition of revert at high temperature

Prof Jiangshan Zhang[1], Mr Kuo Zhang[1], Prof Zhengyi Jiang[1], Prof Shufeng Yang[1]
[1]University of Science and Technology Beijing, , China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Superalloys are often subjected to harsh conditions, including high stress, rapid movement, and elevated temperatures, which can significantly impact their friction and wear behavior. Two types of superalloys, one containing 60% revert and the other without revert, were dry-sliding tested to study the friction surface evolution behavior at 730 °C for 1, 15, 30 and 60 min respectively. Results show that adding revert contributes to higher wear-resistance and suppression of undersurface crack formation. The wear mechanism transitions from predominantly abrasive-adhesive wear to oxidative-adhesive wear over time. A sudden drop (about 40%) in friction coefficient occurs within the initial 2.5 min. The oxide layer is discontinuous after 1 min of sliding test. After 15 min, a more fully developed oxide layer was observed, along with the enrichment of Al, Cr, and Ti. The wear debris undergoes repeated compaction and sintering, leading to the formation of a dense oxide layer. As the continuously sliding and compaction for 30/60 min, an internal oxide layer and an outer dense glaze-like structure are sequentially formed on the friction surface of sample with revert. This study is useful to understand the wear mechanisms in high-temperature environments and enhance the tribological properties and even prolong their operational life.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

HiPIMS induced a facile synthesis of Ti3SiC2 MAX phase coating

Yuxi Xu[1]

[1]Ningbo Institute of Materials Technology And Engineering, Cas, , China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Ti3SiC2, as a type of the MAX phase, possesses a unique nano-layered structure and exceptional amalgamation of metallic and ceramic, facilitating its potential application as a protective coating used in harsh high-temperature environment. However, the extremely narrow phase-forming region makes it difficult to prepare Ti3SiC2 MAX phase with high purity. In this study, the Ti3SiC2 MAX phase coatings on Ti-6Al-4V substrates were successfully synthesized through a two-step method involving High Power Impulse Magnetron Sputtering (HiPIMS) deposition followed by vacuum annealing at 850 ◦C for 90 min. The microstructural evolution of the coatings before and after annealing was meticulously examined, and the phase transition of the Ti-Si-C coating during annealing was comprehensively elucidated through X-ray diffraction (XRD) and differential scanning calorimetry (DSC) analyses. The crystallization pathway of Ti3SiC2 during annealing treatment comprises two stages: an initial stage starting from 550 ◦C, involving the formation of Ti5Si3 interphases, followed by a subsequent stage starting from 750 ◦C, transitioning to the Ti3SiC2 MAX phase. Additionally, the resulting Ti3SiC2 MAX phase coatings exhibited a remarkable hardness of 25.33 GPa and demonstrated significant corrosion resistance in a 3.5 wt% NaCl solution, highlighting their potential for applications in demanding environments.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Fabrication of superhydrophobic CFRP surfaces and evaluation of their anti-Icing performance under static and impacting droplets

Prof. Chunfang Guo[1], Ms. Yaqin Ang[1], Mr. Jiangtao Lu[1], Mr. Rui Fan[1]
[1]Donghua University, 2999 North Renmin Rd, Songjiang District, China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Ice accumulation presents a critical challenge in key engineering fields, such as aerospace and wind energy, where effective anti-icing is crucial for operational safety and efficiency. With the increasing demand for lightweight and high-strength materials, the utilization of carbon fiber-reinforced polymers (CFRP) in these fields has grown. Given the promising potential of superhydrophobic surfaces in mitigating ice accumulation, the fabrication of such surfaces on CFRP substrates is of great importance. In this study, we fabricate hierarchical micro/nanostructures on CFRP substrates by integrating hydrophobic silica nanoparticles and a metal sieve template through a hot-pressing process. The resulting surface achieves exceptional superhydrophobicity with a static water contact angle of 155° and a sliding angle of 4° while conferring robust mechanical and chemical durability against abrasion and chemical etching. Static freezing experiments demonstrate the superior icing delay performance of the superhydrophobic CFRP surface through prolonging both the cooling time and the freezing time. Impacting droplets exhibit full rebound behavior within Weber numbers of 20–140 when the surface temperature is above −25 °C. The transition from full rebound to partial rebound and ultimate adhesion appears sequentially as the surface temperature decreases to −30 °C. These findings highlight the anti-icing performance of the superhydrophobic CFRP surface by effectively mitigating the ice formation of both static and impacting droplets.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Electroless Nickel Plating of Silicone Rubber

Ms Yujie Zhou[1], Dr Zhaohong Huang[1]

[1]A*STAR Singapore Institute of Manufacturing Technology, , Singapore

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Electroless nickel plating of silicone rubber offers a scalable and cost-effective alternative to dry physical vapor deposition for applications in flexible electronics, soft actuators, and EMI shielding. However, the low surface free energy and rapid hydrophobic recovery of silicone rubber typically result in poor metal adhesion. This paper presents a novel multi-step chemical metallization process designed to overcome these surface inertness challenges. The method utilizes an advanced oxidation process (AOP) involving a Fe+2/O3 aqueous solution to generate high concentrations of hydroxyl radicals (•OH), effectively converting the hydrophobic surface into a hydrophilic state rich in polar groups such as Si•, SiO•, and SiOH. To combat the characteristic "hydrophobic recovery" of the polymer chains, a critical "hydrophilicity locking" step is introduced immediately after oxidation, utilizing water molecules to stabilize the high-energy surface through hydrogen bonding and chemical reactions. The stabilized surface is subsequently modified with an alkoxysilane solution and an imine-containing compound, creating a chemically grafted molecular layer that provides robust active sites for ionic catalyst adsorption. This structured pre-treatment sequence ensures the deposition of a continuous nickel layer with superior bond strength. Experimental validation via tape tests on various commercial silicone rubber grades demonstrates that this wet-chemical approach achieves high adhesion without the surface cracking or mechanical degradation associated with traditional corona or plasma treatments. This process provides a reliable pathway for the industrial-scale metallization of complex, non-polar polymer geometries.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Hot-corrosion behavior of CrHfNbTaTiCN high-entropy carbonitride coatings induced by NaCl

Mengjuan Yin[1]

[1]Nanjing University of Aeronautics and Astronautics, College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics, Nanjing, 211106, China, China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

High-temperature titanium alloys such as Ti60 are critical for aeroengine hot-end components, yet their operational reliability is severely compromised in marine environments where synergistic salt deposition triggers aggressive NaCl-induced hot corrosion— a degradation pathway distinct from conventional oxidation or sulfate-only hot corrosion. Here, we report a investigation of CrHfNbTaTiCN coatings fabricated via double-glow plasma surface alloying on Ti60 substrates. We reveal that the HEACN coating delivers exceptional performance: (i) lowest mass gain ($k = 4.80\times10^{-2}$ $mg^{2}\cdot cm^{-4}\cdot h^{-1}$) and slow parabolic kinetics ; (ii) formation of a dense, adherent, Cr/Hf/Ti-rich oxide-carbide composite scale that impedes Cl^{-}/SO_4^{2-} ingress and suppresses volatile metal chloride (e.g., $TiCl_2$, $NbCl_2$) formation; and (iii) superior mechanical integrity (H = 23.2 GPa, H/E* = 0.099, We = 63.5%), attributed to nanocrystalline fcc phase coherence, lattice distortion–enhanced dislocation pinning, and gradient metallurgical bonding confirmed by TEM/FFT/EDS. Crucially, ab initio DFT modeling elucidates the thermodynamic origin: O-incorporation into the fcc-HEACN lattice stabilizes oxygen-deficient interfacial configurations, raising the activation barrier for Cl-assisted cation dissolution and enabling a delayed breakdown mechanism. This work establishes HEACN not merely as a hard coating, but as an entropy-stabilized corrosion armor, providing a design paradigm for next-generation protective systems operating at the nexus of high temperature, mechanical load, and chemically aggressive marine atmospheres.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effect of Ti/C contents on the microstructure, mechanical properties and wear resistance of a low alloy high strength Fe-based surfacing alloy

Junfeng Gou[1], Bin Huang[1], Guan Wang[1], Jiangwen Liu[1], Yongkang Zhang[1], Dongyang Li[2]

[1]Guangdong University Of Technology, , China, [2]University of Alberta, , Canada

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Low alloy high strength Fe-based surfacing alloys with different Ti/C contents were prepared to reveal the effect of Ti/C addition on the microstructure, mechanical properties and wear resistance of the surfacing alloy. The microstructure was observed through SEM and EBSD. The micro-hardness and tensile properties were measured by a micro-hardness tester and a universal tensile testing machine. The wear behavior was evaluated through reciprocating sliding test. The experimental results showed that the microstructure of the surfacing alloys changes from lath bainite to martensite accompanied by obvious grain refinement with the increase of Ti/C content. The average grain size decreases from 15μm to 10μm. The micro-hardness and tensile strength of the surfacing alloys increase with Ti/C content increased. The micro-hardness and tensile strength of TC1.25 increase by 21% and 24.5% compared with those of TC0. TC0.75 has the highest yield strength which increases by 22.9% compared with that of TC0. The increase in the strength of surfacing alloy can be attributed to the grain refinement and formation of hard particles containing TiN. The wear resistance of the surfacing alloys is also improved with Ti/C content increased. The wear rates of TC1.25 under loads of 5N and 30N decrease by 47% and 68% compared with those of TC0. The wear resistance improvement for the surfacing alloys can be attributed to the increased high hardness and strength, which mitigated ploughing effect and plastic deformation damage caused by the counter ball during the reciprocating sliding process.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Microstructural Evolution and Tribological Performance of Fe-based Amorphous Coatings via Wide-beam Laser Cladding: Role of Powder Feed Rate

Zhendong Li[1], Manyu Bao[1], Ruijun Wang

[1]China Academy of Agricultural Mechanization Science Group Co., Ltd., 北京朝阳区北沙滩 1 号, China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Wide-beam laser cladding was employed to fabricate Fe-based amorphous composite coatings, with a focus on elucidating the decisive role of powder feed rate in governing microstructure and wear performance. The coatings exhibited a amorphous-crystalline composite structure, with the amorphous phase content first increasing and then decreasing as the feed rate rose, reaching a maximum of about 72% at 0.8 rpm. This condition produced a gradient microstructure with a uniform interfacial layer and a fine dispersion of hard intermetallic/ceramic particles, yielding the peak hardness of 928.7 HV0.2 and the lowest wear volume of 108174.9 μm3 via the formation of a protective oxide tribolayer. In contrast, lower or higher feed rates resulted in coarse crystalline growth or defect formation, respectively, triggering severe abrasive or brittle wear. This study revealed that the excellent wear performance was fundamentally governed by a microstructurally-enabled synergistic strengthening-toughening effect. This effect, arising from the combination of a hard amorphous matrix and dispersed crystalline phases, provides the necessary mechanical support for the development and stability of the protective oxide tribolayer during sliding.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Atmospheric Pressure Plasma for Surface Engineering: Treatment and Deposition

Yibo Guo[1], Mr. Qizhong Loi[2], Dr. Yuefan Wei[1]

[1]Singapore Institute Of Manufacturing Technology, A*Star, 2 Fusionopolis Way, Singapore 138634, Singapore, [2]Advanced Remanufacturing Technology Centre, A*Star, 3 Cleantech Loop, CleanTech Two, Singapore 637143, Singapore

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Plasma-based surface engineering technology stands out among the approaches for surface modification and coating deposition, due to its cost-effectiveness, high controllability, and fast processing speed. As atmospheric pressure plasma (APP) can be generated and maintained easily, this technology becomes a more effective and lower cost way for surface engineering. The two main functions of APP are surface treatment, such as cleaning and activation and coating deposition.

In this study, APP was applied on different polymers (PMMA, PC, and CFRP), which led to a great decrease in water contact angles (WCA), indicating the enhancement of surface energy. The variations in working distance and scanning speed didn't provide much difference in wettability change, while changing the gas from compressed air to nitrogen reduced the WCA more, indicating more effective surface activation. The effect of APP on adhesion with a silver paint coating was further verified by the crosshatch test, where APP-treated polymers show better adhesion after scratch than untreated polymers.

APP was also used for deposition of hexamethyldisiloxane (HMDSO) on fine surface finish SS316 samples. The effect of coating thickness on electrical resistance was investigated by varying precursor flow rate, scanning speed, and number of layers. When the thickness was deposited to about 4 μm, the sample showed more than 100 MΩ resistance under 250 V; and when the thickness increased to approximately 5 μm, better electrical resistance was observed under 500 V for over 100 MΩ.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Microstructure and properties of laser-deposited nitride on mild steel

Senior Scientist Baisong Cheng[1], **Senior Research Engineer Li Tian Chew**, Senior Research Engineer Gary Teh

[1]Institute of Materials Research and Engineering, , Singapore

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Nitrides (CrN) were deposited on the surface of mild steel using laser deposition technology. The microstructure and mechanical property of the deposited layer were investigated using OM, SEM, EDS, EBSD, and a microhardness tester. The results showed that the surface deposited layer exhibited a typical ultrafine-grained structure with uniform distribution and a thickness of up to 400μm, which is the main reason for its high strength and wear resistance. The Cr and N contents gradually decreased from the surface to the core of the deposited layer, while the Fe content gradually increased. Mechanical property tests showed that the surface hardness was approximately HV 601, more than twice that of the mild steel.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Anisotropic Radiative Cooling Dynamics Enabling Efficient Thermal Hazard Mitigation via Hierarchically Engineered Thermal Diodes

Liangyuan Qi[1]

[1]The Hong Kong Polytechnic University, , China

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Radiative cooling coatings demonstrate broad applicability on equipment surfaces, spanning spacecraft to precision instruments, for sub-ambient cooling. However, unlike conventional equipment relies on solar reflection and infrared emission for cooling, the heat-generating equipment relies on coupled thermal conduction and radiative cooling, representing a distinct heat transfer paradigm. This study introduces an innovative fire-safe radiative cooling-enhanced anisotropic thermal rectification coating (TRC) by leveraging the thermal rectification effect. The rectification mechanism stems from engineered thermal conductivity gradients with temperature-dependent anisotropy, where asymmetric phonon transport in multilayer architectures enables unidirectional heat flux control. Through the rational coupling of radiative cooling emitters at the cold terminal with thermal diodes, the TRC achieves unidirectional heat transfer enhancement through conduction-radiation coupling, demonstrating a thermal rectification coefficient of 1.78 and 3.1-3.4°C daytime temperature reduction below ambient. Crucially, under concurrent solar irradiation and simulated heat-generating equipment (50°C), TRC attains 6.8°C maximum cooling enhancement. Notably, the TRC integrates gas-phase and condensed-phase flame retardant mechanisms to effectively mitigate the risk of thermal runaway in heat-generating devices. This multifunctional integration advances radiative cooling technology toward practical implementation in thermal-critical infrastructure, including power electronics thermal management and smart building systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Study of ta-C based coatings developed by pulsed cathodic arc evaporation

Dr. Marian Harsani[1], Dr. Martin Sahul[2], Dr. Martin Truchly[3], Dr. Barbora Ludrovcova[4], Dr. Tomas Vopat[4]

[1]STATON, s.r.o., Sadová 1148, Slovakia, [2]Faculty of Material science and technology, Slovak University of Technology in Bratislava, Institute of Material Science, J. Bottu 25, Slovakia, [3]Centre for Nanotechnology and Advanced Materials, Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava, Mlynská Dolina F2, 842 48 Bratislava, Slovakia, [4]Faculty of Material science and technology, Slovak University of Technology in Bratislava, Institute of Production technologies, J. Bottu 25, Slovakia

Poster Session - S05: Coating towards Industrial Applications (CIA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In this study, series of tetrahedral amorphous carbon (ta-C) coatings have been deposited by pulsed Cathodic Arc Evaporation technology with a different content of silicon (Si), and they were analyzed in terms of their mechanical, tribological properties and adhesion. Graphite and graphite-silicon cathodes were used to deposit ta-C and ta-C:Si coatings, respectively.

Doping of silicon to a ta-C coating leads to decrease of mechanical hardness from pure ta-C of 55.4 GPa to 16.3 GPa for silicon-rich ta-C:Si coating. Coefficient of friction (COF) of ta-C and ta-C:Si coatings showed that silicon doping leads to a slight decrease in COF from 0.15 to 0.11 for ta-C:Si with 5 % of Si. On the other hand, ta-C:Si with higher silicon content (10 %) exhibited a higher coefficient of friction and overall wear due to lower hardness, lower thickness and high wear rate that resulted in a quick contact with the base material. Silicon addition affects not only mechanical properties but also decreasing deposition rate by slowing it down.

July 14, 2026 | 10:50 AM

Alkaline aqueous redox flow batteries using non-vanadium active materials

Yongchai Kwon[1]

[1]Seoul National University of Science and Technology, 232 Gongneungro Nowongu, South Korea

Session 01 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Alkaline aqueous redox flow batteries (AARFBs) are a promising technology for large scale energy storage system. For improving the performance and stability of AARFBs, determining proper active materials is most critical. The active materials shoule be well mixed into supporting electrolytes, and such produced electrolytes such as anolyte and catholyte are stored in tank. Namely, the active materials decide cell voltage and maximum solubility, followed by energy and power densities of AARFBs. To date, vanadium is a main candidate of active materials. However, since this vanadium has natural limitations, many researches are explored to change it to other alternatives that have proper properties. Amid them, organic and/or ornanometallic complex materials can be regarded the purpose because they can provide the merits like controllable redox potential and solubility and cheap cost. In this presentation, the performance and stability of AARFBs including specific iron based complex materials that can be dissolved in high pH electrolyte are explained. Initially, electrochemical properties and kinetic parameters of the iron based complex materials are investigated to decide their optimal condition. Next, cycle tests of AARFBs including them are carried out to improve their performance and stability. With that, it is substantiated that AARFB including the ornanometallic complex materials as redox couple can be considered to supplement vanadium RFBs and littium batteries.

July 14, 2026 | 11:10 AM

Doped metal oxide of Ti as multi-functional material for degradation of Indigo carmine dye in wastewater

Ms. Barkha Sharma[1], **Dr. Chandra Mohan**[1], Dr. Anand Kumar[2]

[1]K. R. Mangalam University, Sohna Road, India, [2]Guangdong Ocean University Zhanjiang, Zhanjiang, China

Session 01 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Dyes are toxic in nature and commonly found in wastewater from various industries like textile and printing industries. It is harmful to both the environment and human health due to its non-biodegradable and carcinogenic nature. Removing such dyes from wastewater in a cost-effective way is a major challenge. In this study, we used metal doped TiO2 for the degradation and removal of Indigo carmine dye from wastewater. In a process called photocatalysis, where light energy helps to break down harmful chemicals, to degrade dye. Titanium dioxide (TiO_2), a well-known photocatalyst, was used as the base material. To improve its efficiency, doping with small amounts of rare earth elements like Cerium (Ce) and Samarium (Sm) was done in the TiO_2 structure and was prepared by co-precipitation method. Over 90% of the dye was removed in a short time, with doped-TiO_2 due to better electron trapping and redox properties. This study suggests that doping TiO_2 with rare earth metals is a promising and eco-friendly method for treating dye-contaminated wastewater.

July 14, 2026 | 11:30 AM

Thin-Film Surface Engineering of Graphite Anode with N/Co-Doped Carbon Coating for Lithium-Plating Suppressed High-Safety Lithium-Ion Batteries

Ling Che[1], Zhaowen Hu[1], Keyu Xie[1]

[1]Northwestern Polytechnical University, 127 West Youyi Road, China

Session 01 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Lithium-ion batteries (LIBs) under fast-charging and low-temperature conditions suffer from severe lithium plating on graphite anodes, leading to capacity decay and catastrophic thermal runaway. The root cause lies in the sluggish Li^+ desolvation kinetics and unfavorable solid electrolyte interphase (SEI) chemistry, which are governed by the nanoscale interfacial structure. Herein, we report a kilogram-scale producible lithium-plating suppressed graphite (LPSG) anode modified with a thin N/Co-doped carbon coating layer derived from ZIF-67. This functional thin film, with a thickness of several nanometers, is uniformly coated on the graphite surface via epitaxial growth and subsequent pyrolysis. The defective N/Co-doped carbon layer induces local electron deviation, which preferentially adsorbs PF_6- anions into the inner Helmholtz plane, thereby enriching anions in the primary solvation sheath. This unique thin-film surface engineering promotes the formation of an inorganic-rich SEI with enhanced Li+ transport kinetics and suppressed lithium dendrite growth. In 5 Ah $LiFePO_4$||LPSG pouch cells, the thin-film coated anode enables ultra-fast charging with 90.4% of 1C capacity achieved in 5.5 minutes at 10C without detectable lithium plating. At –20°C, the cell retains 66.86% of room-temperature capacity—nearly 20 times higher than pristine graphite. Moreover, thermal safety evaluation reveals a significant increase in thermal runaway trigger temperature from 152.3°C to 195.3°C after 10C charging. This work demonstrates that thin-film surface coating engineering of graphite anodes is a powerful strategy to simultaneously achieve high-rate capability, low-temperature adaptability, and enhanced safety in LIBs

July 14, 2026 | 11:45 AM

Nanotube-Patterned Microchannels for Durable Osmotic Energy Harvesting

Professor Lidong Sun[1]

[1]Chongqing University, Shazheng Street 174, Shapingba, , China

Session 01 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Ion-selective membranes have long been constrained by the trade-off between nanoscale precision and macroscopic durability, especially in systems with large pores. Traditional mechanisms relying on overlapping electrical double layers fail in such systems, making porous metals unsuitable for selective ion transport. Current solutions face contrasting issues: organic membranes offer excellent ion selectivity but insufficient stability, while inorganic membranes, though mechanically strong and stable, suffer from high internal resistance due to their ultralong and tortuous ion transport pathway. This presentation introduces the design of robust porous titanium membranes patterned with TiO2 nanotube arrays through a straightforward and efficient electrochemical anodization process, which uniquely reverse ion selectivity from cation to anion transport. This inversion is driven by the enhanced charge separation effect and high surface area of the TiO2 nanotubes, enabling cation adsorption along microchannel walls while facilitating selective anion transport through the central tunnel—even in microchannels up to 100 μm, far beyond the nanoscale channel of current membranes. Our membranes successfully achieve the proof-of-concept of osmotic energy conversion based on inversed ion selectivity, with remarkable durability of 110 days due to the structure and chemical stability of TiO2 nanotubes.

Achieving Multi-Dimensional Stability in O3-Type Sodium Layered Cathodes through High-Entropy Design and Liquid-Phase Engineering

Wujiu Zhang[1], Chao Shen[1]

[1]Northwestern Polytechnical University, 127 West Youyi Road, Beilin District, China

Session 01 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

In contrast to the limited availability and uneven geographical distribution of lithium resources, the progressive advancement of sodium-based batteries facilitates development of clean energy technologies which are not subject to regional disparities. O3-type layered oxides are promising cathode materials for sodium-ion batteries due to their stable framework and tunability. However, practical application is hindered by surface residual alkali and structural degradation during storage and cycling. Here, we propose a synergistic strategy combining high-entropy lattice design with precise liquid-phase post-treatment to achieve multi-dimensional stability.

For high-entropy design, we developed a Na-based cathode using non-precious metals (Ni, Fe, Mn, Cu, Ti). Strong TM-O bonding anchors lattice oxygen, suppresses unfavorable P3-OP2 phase transitions, and reduces strain accumulation. This ensures structural integrity during high-voltage cycling and excellent air stability, with minimal capacity decay after 30 days of exposure.

Furthermore, to address residual surface alkali without damaging the robust structure, we investigated solid-liquid interaction mechanisms during liquid-phase dealkalization. Compared with conventional water washing, which induces protonation and Na ions leaching, ethylene glycol efficiently removes surface alkali while preventing solvent intercalation due to its molecular size, thus preserving the structural integrity.

This integrated approach from bulk high-entropy stabilization to surface engineering provides fundamental guidance for developing high-performance, air-stable sodium-ion battery cathodes, offering a practical and scalable pathway to address the critical challenges of moisture sensitivity and structural degradation that have long impeded the commercialization of O3-type layered oxides.

Enabling the Circular Carbon Economy: Using Density as a Key Factor to Directly Convert Composite Waste into Battery Anodes

Wendi Chen[1], Lingjun Guo[1]

[1]Materials Science and Engineering of Northwestern Polytechnical University, 127 West of Youyi Road, Xi'an, ShaanXi, China 710072., China

Session 01 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

The pursuit of sustainable energy storage is intrinsically linked to developing circular solutions for industrial waste. Current recycling of waste carbon/carbon composites primarily focuses on extracting carbon fibers, while neglecting the higher-proportion pyrolytic carbon matrix. This leads to severe resource wastage and solid waste accumulation, failing to achieve high-value, closed-loop recycling of all components. Moreover, the graphite anodes widely used in commercial lithium-ion batteries are approaching their theoretical limits in capacity and fast-charging performance, struggling to meet the growing demand for high-performance energy storage. To tackle this, a sustainable manufacturing paradigm centered on functional upcycling is proposed. The key innovation lies in utilizing the inherent density variation of the precursor as a guiding parameter to program the electrode's microstructure during physical conversion. This intrinsic property acts as a built-in structural gene, directing the formation of an optimal dual-phase carbon matrix where a percolating conductive network seamlessly integrates with a porous lithium-host carbon phase. This designable structure not only ensures efficient ion/electron transport but also promotes the formation of a stable electrode-electrolyte interface. When evaluated in practical lithium-ion full cells, this upcycled anode demonstrates excellent specific discharge capacity and lifespan, retaining 79.6% of its capacity after 1000 cycles, thereby outperforming conventional graphite. This work pioneers a feasible in-situ resource regeneration pathway, transforming the structural signature of composite waste from an environmental liability into a critical asset for green electrode engineering. This “waste-as-feedstock” approach provides a scalable model for closing the material loop in energy-intensive industries, directly contributing to sustainable manufacturing and the development of resource-efficient energy storage systems.

July 14, 2026 | 1:20 PM

Study on the conductivity and corrosion resistance of M-Al-C (M=Ti/Cr) coating on the surface of PEMFC metal plate

Associate Researcher Guanshui Ma, Researcher Aiying Wang[1]

[1]Ningbo Institute Of Materialstechnology And Engineering, Chinese Academy Of Sciences, 1219 Zhongguan West Road, Zhenhai District, China

Session 02 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Metal bipolar plates, as the core components of proton exchange membrane fuel cells (PEMFCs), directly determine the manufacturing cost and performance of the cells. However, in the high temperature and acidic working environment of fuel cells, the surface of metal bipolar plates is prone to oxidation, leading to a significant decrease in conductivity and corrosion resistance. In the study, we utilized a combination of arc and sputter deposition techniques to prepare Cr-Al-C coatings on stainless steel substrates. The phase transformation behavior of the Cr-Al-C coatings was investigated in situ using transmission electron microscopy. Through annealing techniques, Cr2AlC MAX phase coatings with different degrees of crystallization and preferred orientations were obtained. The conductivity and corrosion resistance of these coatings were studied in the PEMFC working environment. The results demonstrate that all of the Cr2AlC coatings significantly enhanced the performance of stainless steel 316L. The lowest interface contact resistance was 3.16 mΩ·cm2, and the lowest corrosion current density was 2×10-2 μA cm-2. The superior corrosion resistance is attributed to the formation of a passive film on the coating surface after polarization tests, which effectively protects the substrate and improves its corrosion resistance. However, under prolonged operating conditions, the formation of a passive film can increase interfacial contact resistance. Based on the fact that Sn-containing coatings can form a SnO_2 passive film with good conductivity after corrosion, we propose the design and preparation of $Ti_2(Al_{1-x}Sn_x)C$ solid-solution MAX phases and investigate the conductivity and corrosion resistance of solid-solution MAX phases with varying Sn contents. The findings not only facilitate the design and development of new MAX phase coating systems that integrate conductivity and corrosion resistance but also provide crucial support for the development of high-performance bipolar plate materials for PEMFCs.

Hydrogen-free carbon-based coatings deposited by the combined HiPIMS

Prof. Yixiang Ou[1]

[1]Beijing Academy of Science and Technology, , China

Session 02 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Hydrogen-free carbon-based coatings deposited by the combined HiPIMS

Yixiang Ou*, Xiaopan Wu, Haoqi Wang, Zhiqiang Che, Yue Zhang
Joint Laboratory of Advanced Energy Materials and Intelligent Equipment, Beijing Academy of Science and Technology, Beijing 100061, China
*Corresponding Author: ouyx16@tsinghua.org.cn (Yixiang Ou)

Abstract:
Hydrogen-free carbon-based coatings are typical functional hard coatings, widely used in key components of hydrogen fuel cells, aviation engine, etc., for their combined improvement in wear and corrosion resistance. Hence, Hydrogen-free carbon-based coatings, such as Ti-C/a-C, TiAlSiCN, (Ti,Zr)-C/a-C nanocomposite coatings, deposited by the combined HiPIMS are introduced in this work, as well as their applications.
Key words: Hydrogen-free carbon-based coatings; Functional hard coatings; HiPIMS

Effect of TiO2-doped half-layer PDMS on the output performance of Al-PDMS TENG

Prof Chen-Kuei Chung[1], Mr C,W. Hung[1], Mr T.H. Lin[1], Mr Y.J. Huang[1]
[1]National Cheng Kung University, No. 1, Univ. Rd., Taiwan
Session 02 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Al-PDMS Triboelectric nanogenerators (TENGs) is a popular candidate for mechanical energy harvesters and natural-energy collection. Enhancing TENG output performance has become a key research objective and two approaches are generally applied: (1) increasing the effective contact area of two triboelectric materials and (2) modifying or doping the component materials. Typical examples of doping approach include using conducting graphite or dielectric titanium-dioxide (TiO2) particles into PDMS. This approach can effectively raise the output performance by approximately two-fold at some doping concentration via either increasing TENG electrical conductivity for promoting charge transfer, or by increasing its dielectric constant to boost surface charge accumulation. However, this conventional single-layer full-doping approach lacks improvements in specific areas to push its performance to higher levels.

This study proposes a novel bilayer triboelectric nanocomposite film with nanoparticles of P25 TiO2 doped half-PDMS only at the contact interface of the triboelectric film, while the region near the electrode remains as undoped half-layer pure PDMS. Therefore, this bilayer doping process can significantly increase surface charge accumulation while preserving the TENG's charge-transfer capability. The bilayer doped 5 wt% TiO2@PDMS-PDMS-Al TENG reaches VOC of 159.5 V and ISC of 85.7 μA, which are 2.4 and 2.6 times greater than the pure PDMS-TENG, respectively. Compared with a conventional single-layer 5 wt% TiO2@PDMS TENG, the bilayer-doped TENG still achieves 1.5-fold and 1.2-fold gains in voltage and current. This result indicates that the half-doped bilayer PDMS successfully promotes the dielectric constant at the triboelectric interface without diminishing the charge-transfer capability.
Keywords: Triboelectric nanogenerator, TENG, TiO2, doping.

Enhancing Low-Humidity Performance of PEMFCs via Magnetron Sputtered ITZO Coatings on Anodic Gas Diffusion Layers

Mr. Po-sen Yang[1], Dr. Du-Cheng Tsai[1], Mr. Ming-Che Cheng[1], Mr. Ching-Hao Huang[1], Mr. Wen-Wei Chang[1], Prof. Fuh-Sheng Shieu[1]

[1]National Chung Hsing University, No. 145, Xingda Rd., South Dist., 402204, Taiwan

Session 02 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Effective water management is crucial for maintaining high proton conductivity in proton exchange membrane fuel cells (PEMFCs). However, under low-humidity conditions, severe membrane dehydration at the anode often leads to significant performance degradation. To address this challenge, this study proposes a novel hydrophobic-gradient anodic gas diffusion layer (GDL) modified with a hydrophilic oxide thin film. Specifically, indium-tin-zinc oxide (ITZO) films of varying thicknesses (25, 50, 100, and 150 nm) were deposited onto 30% PTFE-treated hydrophobic carbon cloths utilizing DC magnetron sputtering. The morphological and wetting properties of the modified GDLs were characterized via FE-SEM and contact angle measurements. SEM observations revealed that the ITZO nanoparticles were uniformly deposited on the carbon fibers, forming a roughened surface. Consequently, the contact angle decreased significantly from 128.51° (highly hydrophobic) to 78.78° (hydrophilic), confirming the successful construction of a hydrophobicity gradient. These ITZO-coated GDLs were then assembled into membrane electrode assemblies (MEAs) for single-cell performance evaluation. Electrochemical analyses indicated that the MEA with a 25 nm ITZO coating (MEA25) consistently exhibited superior performance across various operating temperatures. Remarkably, under near-dry conditions (25 °C without external humidification), MEA25 demonstrated a 113.96% increase in maximum power density compared to the pristine GDL. Furthermore, at 65 °C with 60% relative humidity, the cell performance improved by 5.34%. Nevertheless, when the ITZO thickness exceeded 50 nm, the overall performance declined due to increased ohmic resistance and induced cathode flooding. In conclusion, applying a precisely controlled 25 nm ITZO layer via sputtering effectively enhances water back-diffusion, retains anodic hydration, and mitigates cathode flooding. This sputtering approach provides a scalable and promising strategy for optimizing water management in PEMFCs, particularly for low-humidity operations.

Keywords : Magnetron sputtering; Proton exchange membrane fuel cell (PEMFC); Water management; ITZO thin film; Hydrophilicity.

July 14, 2026 | 2:30 PM

Dynamic Synergy of Cu0/Cu+/Cu2+ for CO2 Electroreduction: Unlocked by Spatiotemporally Resolved Characterizations

Yatai Li[1], Professor Hui Pan[1]

[1]University of Macau, , China

Session 02 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Copper-based materials are the most effective catalysts for producing multi-carbon (C2+) products through electrochemical CO2 reduction (eCO2R). However, the structure-activity relationship remains elusive due to dynamic surface reconstruction and the involvement of distinct active sites governing specific reaction steps, such as CO2 to CO conversion and CO-CO coupling. Conventional characterization lacks the spatial resolution to identify transient active phases and correlate them with key intermediate behaviors. Here, we employ a pulsed voltage strategy to dynamically modulate the population of active sites, including valence states and facets, and integrate in-situ electrochemical atomic force microscopy (EC-AFM) with spatiotemporally resolved confocal Raman imaging to address this challenge. This innovative combination enables real-time tracking of surface reconstruction, mapping of copper species (Cu0, Cu+, Cu2+) spatial distributions, and visualization of *CO-intermediate redistribution under operando conditions. Our results reveal that synergistic interactions among Cu0, Cu+, and Cu2+ significantly enhance C2+ production. Specifically, Cu+ accelerates *CO2- to *COOH conversion, while Cu2+ optimizes *CO coverage, promoting dimerization kinetics at the Cu0. This integrated approach not only resolves long-standing uncertainties about active sites in copper-based eCO2R catalysts, but also establishes a versatile framework for identifying active sites in multi-component systems and elucidating step-specific mechanisms in multi-step reactions.

July 14, 2026 | 2:45 PM

Unraveling Nitrogen Reduction Pathways on Transition Metal Electrocatalysts: Insights from First-Principles Calculation

Deepak Gorai[1], Deepak Panda[1], Dr. Shivam Tripathi[1]

[1]Indian Institute of Technology Kanpur, Department of Materials Science and Engineering, India

Session 02 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

The conventional Haber–Bosch process for ammonia synthesis operates under extreme temperature and pressure, contributing significantly to global energy consumption. As a sustainable alternative, the nitrogen reduction reaction (NRR) enables ammonia production under ambient conditions via electrocatalytic, photocatalytic, or enzymatic pathways. Among these, electrochemical NRR using transition metal catalysts has emerged as a promising route due to its tunability and potential for decentralized synthesis. NRR can proceed via two primary mechanisms: dissociative, in which the N≡N bond is cleaved before hydrogenation, and associative, in which hydrogenation occurs before bond dissociation. The associative mechanism further divides into alternating and distal pathways, depending on the sequence of hydrogen addition to the nitrogen atoms. In this work, the adsorption energies of important NRR intermediates on different transition metals on the (111) and (110) surfaces for the FCC crystal structure and on the (0001) surface for the HCP crystal structure are determined using density functional theory (DFT). The chemical route is predicted by the adsorption energies of intermediates, including 2*N, *NNH, *NHNH, and *NNH_2. Comparing the adsorption values of 2*N and *NNH reveals whether the N_2 molecule has a propensity to dissociate or not before hydrogenation. The more stable intermediate between *NHNH and *NNH_2 requires that the associative mechanism's route be either distal or alternating. These energies serve as descriptors to predict the most favorable reaction pathway. The insights derived from this computational analysis contribute to a deeper understanding of NRR mechanisms and offer guidance for the rational design of efficient electrocatalysts for ambient-condition ammonia synthesis.

Keywords: Nitrogen Reduction Reaction (NRR), Ammonia, DFT, Adsorption Energy

July 14, 2026 | 3:30 PM

Critical thickness effect on fracture path and interfacial delamination in plasma sprayed NiCr/NiAl coated revealed by DIC

Shi-jia Yu[1], Nan Yang[2], Shu-cheng Duan[1], Jun Zhou[2], Long-long Zhou[1], **Xiu-yang Fang**[1], Zhen-bing Cai[1]

[1]Southwest Jiaotong University, No. 111, North Section 1, Second Ring Road, Jinniu District, Chengdu City, China, [2]Chengdu State-owned Jinjiang Machine Factory, No. 100 Huajin Road, Sujin Subdistrict, Wuhou District, Chengdu, China

Session 03 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

Crack initiation and propagation are critical for assessing coating stability. This study investigates the fracture mechanism of plasma sprayed NiCr/NiAl coatings on TC4 substrates as a function of NiCr layer thickness. Using dual channel digital image correlation (DIC) and in situ microscopic observation, the dynamic strain evolution and cracking process were analyzed. A critical thickness of approximately 0.4 mm is identified. Below this value, multiple channel cracking, high crack density, dispersed strain, deep dimples, and higher energy dissipation indicate progressive damage. At or above 0.4 mm, strain localization intensifies; a single dominant crack rapidly penetrates and laterally deflects along the NiAl interface, triggering fast delamination, reduced energy dissipation, and shallow dimples. NiCr exhibits interlamellar ductile fracture, while NiAl fails in an intergranular brittle manner. DIC and in situ observations confirm that true failure corresponds to penetrating crack formation and interfacial propagation, not initial cracking. This work provides a quantitative thickness dependent failure framework for plasma sprayed coating/bond coat systems.

July 14, 2026 | 3:50 PM

Fast-Response Self-Powered Ultraviolet Photodetector Based On Cs2CuBiI6 Thin Films

Baofei Sun[1], Wang Qingqing[1], Huang Lei[2], Kuang Faguang[1], Zhou Yongqiang[2], Tang Xiaosheng[2]

[1]Guizhou Medical University, , china, [2]Chongqing University of Posts and Telecommunications, , china

Session 03 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

Bismuth-based perovskites are emerging as promising alternatives to toxic lead-based perovskites in the field of optoelectronics. They are valued for their excellent photoelectric properties, high environmental friendliness, and superior stability under wet, light, and thermal conditions. However, there is still a scarcity of reports on high-performance bismuth-based perovskite ultraviolet detectors. Here, we report a self-powered CS_2CuBiI_6-based photodetector that exhibits outstanding photoelectric detection performance. This photodetector performs exceptionally well across both the UV and deep ultraviolet spectral regions. Under a 0 V bias, the device achieves an on-off ratio as high as 1.54×10^3, with a responsivity of 37.45 mA/W and a detectivity of 6.2×10^{13} Jones in the UV region. In the deep ultraviolet region, the responsivity and detectivity reach 7.93 mA/W and 3.86×10^{13} Jones, respectively. The response times are as fast as 5.7/10.8 ms. This work significantly propels the advancement of bismuth-based UV photodetection technology.

July 14, 2026 | 4:10 PM

Monomeric Pyrrole for additive engineering and stability enhancement in $MAPbI_3$ Perovskite thin films

Nalini Venkatesan[1,2], coauthor, faculty Sreeram K. Kalpathy[2,3], coauthor, faculty Tiju Thomas[2,3], Ariful Rahaman[4], coauthor faculty Mousumi Upadhyay Kahaly[5,6], Sumangala T P[1]

[1]Department of Physics, School of Advanced Sciences, Vellore Institute of Technology, Vellore, Tamil Nadu 632014, India., VIT Vellore Campus Tiruvalam Road, Katpadi , India, [2]Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Madras, Chennai, 600 036, Tamil Nadu, India , Sardar Patel Road, IIT Madras, India, [3]Center for Resource Efficiency, Recyclability and Circularity in Energy Transition, School of Sustainability, Indian Institute of Technology Madras, Chennai 600036, India, Sardar Patel Road, IIT Madras, India, [4]Department of Manufacturing Engineering, School of Mechanical Engineering, Vellore, Institute of Technology, Vellore, Tamil Nadu 632014, India, VIT Vellore Campus Tiruvalam Road, Katpadi , India, [5]ELI ALPS, ELI-HU Non-Profit Ltd., , Wolfgang Sandner utca 3., , Hungary, [6]Institute of Physics, University of Szeged, , Dóm tér 9, H-6720, , Hungary

Session 03 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

Organometal halide perovskites, particularly methylammonium lead triiodide ($MAPbI_3$), have achieved power conversion efficiencies (PCEs) up to 26.7%, yet their commercialization is limited by ambient instability and intrinsic defects that accelerate charge recombination and reduce carrier mobility and lifetime. To address these challenges, we developed a dual-function pyrrole passivation strategy: its hydrophobic ring structure acts as a moisture barrier to enhance stability, while the nitrogen's lone pair selectively passivates uncoordinated Pb^{2+} defects, suppressing iodide migration. This synergistic effect improves film quality, carrier dynamics, and optoelectronic performance, making pyrrole a promising additive for stable, high-efficiency perovskite solar cells (PSCs). Systematic variation of pyrrole concentration revealed that 0.5% and 1% loadings provide the optimal balance, yielding high initial water contact angles of 55° and 62°, respectively, with stable equilibrium values of 47° and 50°, indicating improved moisture resistance. Space-charge-limited current (SCLC) measurements confirmed a substantial reduction in hole trap density (from 1.47×10^{16} to 4.91×10^{15} cm^{-3}) and a significant enhancement in hole mobility (from 7.10×10^{-4} to 2.08×10^{-2} $cm^2/V\cdot s$). Fourier Transform Infrared Spectroscopy (FTIR) analysis further verified strong pyrrole–perovskite interactions, showing a shift of the ammonium functional group to higher wavenumbers and an increased spectral area of the methyl group, consistent with coordination to uncoordinated Pb^{2+} sites. Also, films with 0.5% and 1% pyrrole show ~40 days of ambient stabili d charge transport and transient

photocurrent confirming improved perovskite film quality. This work highlights the potential of a hydrophobic small molecule addition in $MAPbI_3$ for robust, scalable, and air-stable PSCs. Also, enhanced durability and sustainable energy conversion are provided by an economical ambient fabrication using lab-synthesized precursors. These combined effects contribute to improved stability and optoelectronic performance, positioning pyrrole as a multifunctional additive for durable and efficient perovskite solar cells.

July 14, 2026 | 4:25 PM

Low-Power PS-PVD for Coating Deposition: Processing and Performance

Bing-ru Song[1]

[1]Beihang University, , China

Session 03 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

In recent years, plasma spray-physical vapor deposition (PS-PVD) has emerged as a promising technique for the fabrication of thermal barrier coatings (TBCs), attracting considerable research attention. However, conventional PS-PVD typically relies on high power and high gas flow rates, leading to substantial energy consumption and severe electrode erosion, which hinder its broader implementation in energy systems. This study explores the feasibility of vapor-phase deposition under low-power conditions and combines computational fluid dynamics (CFD) analysis to elucidate the underlying mechanisms. Then, coatings deposited at low power conditions were systematically evaluated for their mechanical and thermal properties.

A key advantage of PS-PVD is its ability to deposit coatings in viewing shield area while simultaneously enabling the co-deposition of vapor, liquid, and solid phases. This feature provides precise control over microstructure and considerable flexibility for tailoring functional performance. Leveraging this capability, low-power PS-PVD was further employed to achieve liquid-phase deposition of yttria-stabilized zirconia (YSZ) coatings with ultralow porosity, demonstrating potential as thin electrolyte films for fuel cells.

By combining energy-efficient deposition with enhanced microstructural control, this work highlights the potential of low-power PS-PVD to support next-generation high-temperature energy systems, including gas turbines and solid oxide fuel cells. The approach offers a pathway toward reducing energy consumption, extending component lifetime, and improving thermal management, ultimately contributing to more efficient and reliable energy conversion technologies.

July 14, 2026 | 4:40 PM

Dual governing effects of nanocrystalline Cr-N barrier layer thickness on high-temperature interfacial stability and fretting wear resistance of Cr-N/FeCrAl coatings

Xiaohan Deng[1], Hao Peng[3], Weijiu Huang[1,2,3], Haibo Ruan[2], Yongyao Su[2], Haiyan Liao[4], Yuan Niu[2], Xiangkong Xu[1], Junjun Wang[3]

[1]College of Materials Science and Engineering, Chongqing University, , China, [2]College of Materials and Engineering, Chongqing University of Arts and Sciences, , China, [3]College of Materials Science and Engineering, Chongqing University of Technology, , China, [4]Faculty of Materials Science and Engineering, Kunming University of Science and Technology, , China

Session 03 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

In this study, a Cr-N/FeCrAl bilayer composite coating system incorporating nanocrystalline Cr-N barrier layers of varying thicknesses (2, 4, and 6 μm) was fabricated on Zry-4 alloys. The effects of barrier-layer thickness on the high-temperature steam oxidation behavior at 1200°C and the fretting wear behavior in a H_3BO_3 and LiOH aqueous solution were systematically investigated. The results demonstrate that when the Cr-N layer thickness reaches 6 μm, a continuous and dense $Zr(Fe,Cr)_2$ Laves phase layer forms in situ at the coating/substrate interface. This interfacial layer acts as a robust barrier against atomic interdiffusion, thereby inhibiting the formation of low-melting-point eutectics at elevated temperatures and ensuring the stable, continuous growth of the outermost α-Al_2O_3 protective scale. Furthermore, under flow-induced vibration grid-to-rod fretting (GTRF) conditions, increasing the barrier-layer thickness fundamentally alters the wear mechanism. By achieving an optimized H^3/E^2 ratio, the 6 μm Cr-N layer establishes a highly rigid mechanical load-bearing platform at the interface, fundamentally mitigating the thin-shell instability typically associated with hard coatings deposited on soft substrates. This enhanced mechanical synergy effectively accommodates and redistributes high-frequency alternating shear stresses, thereby suppressing substrate plastic deformation and subsurface fatigue cracking. Consequently, it promotes the rapid formation and sustained stability of a low-dissipation, self-lubricating tribolayer, ultimately delivering superior anti-friction performance and an exceptionally low wear rate.

July 14, 2026 | 4:55 PM

Enhancing electrochemical properties of Loofah sponge with spirulina-derived carbon through physical activation and self-doping

Mr. Ching Hao Huang[1], Mr. Du-Cheng Tsai[1], Mr. Po-Sen Yang[1], Mr. Ming-Che Cheng[1], Mr3 Wen-Wei Chang[1], Prof. Fuh-Sheng Shieu[1]

[1]National Chung Hsing University, 145 Xingda Rd., South Dist., Taichung City 402, Taiwan (R.O.C.), Taiwan

Session 03 - S06: Energy & Sustainability (ENS), Sentosa - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

In recent years, researchers have dedicated significant effort to developing biomass-derived activated carbons with high specific surface areas for advanced energy storage applications. However, achieving these high surface areas typically requires activation processes that rely on highly corrosive and environmentally polluting acidic or alkaline chemicals. Furthermore, to enhance their capacitive performance, these carbon materials often require the addition of external nitrogen dopants (such as urea or Ammonium hydroxide), which increases both the complexity of subsequent processing steps and the overall environmental burden. To address these challenges, this study designs three distinct processing strategies to systematically investigate the evolution of the material's structure and performance. The first strategy employs pyrolysis for carbonization in an inert atmosphere to preserve the original three-dimensional framework structure of the loofah sponge, thereby forming a biomass carbon material with fundamental porosity and electrical conductivity. The second strategy introduces an atmospheric thermal treatment that utilizes physical activation in an oxygen-containing environment. This approach leverages oxygen to mildly oxidize and etch the surface of carbon materials derived from the naturally nitrogen-rich biomass Spirulina. This method effectively adjusts the pore structure and introduces oxygen-containing functional groups, it also enhance the material's surface activity and electrochemical reactivity while successfully eliminating the need for harsh chemical activating agents. The third strategy involves a two-step process combining pyrolysis and atmospheric thermal treatment to explore how their synergistic effects impact pore development and overall functional performance.

July 16, 2026 | 3:45 PM

Investigation and Modification Optimization of Taiwania cryptomerioides-Derived Biochar for Microporous Layer Applications in Proton Exchange Membrane Fuel Cells

Mr. Wen-Wei Chang, Dr. Du-Cheng Tsai[1], Mr. Po-Sen Yang[1], Mr. Ching-Hao Huang[1], Mr. Wan-Chang Hsu[1], Prof. Fuh-Sheng Shieu[1]

[1]National Chung Hsing University, National Chung Hsing University, No. 145, Xingda Rd., South Dist., Taiwan

Session 10 - S06: Energy & Sustainability (ENS), Seletar1 - Level 3, July 16, 2026, 3:45 PM - 5:00 PM

This study investigates the feasibility and modification strategies of biochar derived from Taiwania cryptomerioides (TCC) as a replacement for commercial carbon black in the microporous layer (MPL) of proton exchange membrane fuel cells (PEMFCs). As the MPL plays a critical role in water management and gas transport, its pore structure and wettability must be carefully balanced to enhance cell performance. In this work, the effects of TCC loading, activation conditions, and doping strategies on electrochemical performance were systematically evaluated. The results show that an optimal TCC loading of 1.25 mg cm^{-2} achieves superior hydrophobicity (contact angle of 129.3°), effectively balancing electronic conductivity and gas mass transport resistance. Chemical activation using KOH at a 1:1 ratio significantly increases the specific surface area and reaction activity, resulting in the highest power output at 65 °C. However, excessive activation (1:3 ratio) leads to increased hydrophilicity, causing severe flooding and performance deterioration. This behavior is consistent with the synergistic effects of pore structure and wettability in porous carbon materials. Furthermore, nitrogen doping via a urea-assisted hydrothermal method successfully introduces approximately 2–3 wt% nitrogen, enhancing intrinsic conductivity and structural stability. Although particle aggregation remains a challenge, the modified TCC demonstrates considerable potential as a low-cost carbon material. Finally, a hybrid design combining TCC and commercial carbon black (CB) is proposed, leveraging their complementary structural and conductive properties to optimize electrode microstructure and improve performance under high current density conditions.

Water-Free Surface Modification with Amorphous Nb2O5 Coating for Improved Stability of High-Ni NCM Cathodes via Plasma-Enhanced Atomic Layer Deposition

Jaeyun Lim[1], Changmin Kim[2], Woosung Kim[3], Sung Eun Jo[3], Hyunmin Lee[3], Jungwoo Park[4], Jeongjin Hong[4], Sungho Kim[2], Soojin Park[2], Jihwan An[1,3]

[1]Graduate School of Semiconductor Technology, POSTECH, 77 Cheongam-Ro, Nam-Gu, Pohang, Gyeongbuk, 37673, Korea, South Korea, [2]Department of Chemistry, POSTECH, 77 Cheongam-Ro, Nam-Gu, Pohang, Gyeongbuk, 37673, Korea, South Korea, [3]Department of Mechanical Engineering, POSTECH, 77 Cheongam-Ro, Nam-Gu, Pohang, Gyeongbuk, 37673, Korea, South Korea, [4]POSCO Holdings Inc., 100 Songdogwahak-ro, Yeonsu-gu, Incheon 21985, Republic of Korea, South Korea

Session 10 - S06: Energy & Sustainability (ENS), Seletar1 - Level 3, July 16, 2026, 3:45 PM - 5:00 PM

High-nickel layered oxides (LiNixCoyMnzO2, x > 0.8) are promising cathode materials for high-energy-density lithium-ion batteries (LIBs) but suffer from severe interfacial degradation during high voltage operation and extended cycling. While atomic layer deposition (ALD) is an effective strategy for surface protection of battery cathodes, however, conventional thermal ALD (T-ALD) typically uses H2O, which triggers H+/Li+ cation exchange and forms detrimental residual lithium species like LiOH on moisture-sensitive high-Ni surfaces.

In this study, we report a water-free surface modification strategy using plasma-enhanced ALD (P-ALD) with a custom-built rotary reactor to coat polycrystalline NCM811 powders with amorphous Nb2O5. Highly reactive oxygen radicals effectively eliminate the nucleation delay phenomena during the initial ALD stages. HR-TEM images reveal that P-ALD achieves a highly uniform ~2 nm coating, whereas T-ALD exhibits island-like growth and inferior conformality. Furthermore, P-ALD facilitates deeper Nb distribution along internal grain boundaries compared to T-ALD, attributed to the higher nucleation density and smaller nuclei growth in P-ALD. Quantitative ICP-OES analysis shows a 30% higher Nb2O5 deposition efficiency for P-ALD under identical ALD cycle numbers.

Chemical analysis using XPS confirms that P-ALD effectively preserves the Ni3+ ratio of 62.2%, significantly higher than the 54.3% observed in T-ALD-coated samples, suggesting a more robust oxidation environment. Most notably, P-ALD reduces the fraction of LiOH impurities to 20.1%, a substantial decrease from the 36.2% in T-ALD, thereby preventing moisture-induced surface degradation. This work underscores the potential of water-free P-ALD as a transformative tool for stabilizing next-generation high-energy battery interfaces.

July 16, 2026 | 4:15 PM

Engineering Localized Graphitic Domains in Jute-Fiber-Derived Carbon Microspheres for Superior Energy Storage

Mr. Ming-Che Cheng[1], Mr. Du-Cheng Tsai[1], Mr. Po-Sen Yang[1], Mr. Ching-Hao Huang[1], Mr. Wen-Yen Chang[1], Mr. Fuh-Sheng Shieu[1]

[1]National Chung Hsing University, , Taiwan

Session 10 - S06: Energy & Sustainability (ENS), Seletar1 - Level 3, July 16, 2026, 3:45 PM - 5:00 PM

Recently, researchers put lots effort in pursuing high specific surface area of biomassderived
activated carbon for advanced energy storage applications. However, carbon materials with high specific surface area often suffer from low conductivity owing to high porosity. Besides, biomass-derived activated carbon usually exhibits a bulk-like morphology, resulting in low effective adsorption area (severe stacking). In this study, jute fibers-derived porous carbon microspheres with localized graphitic domains (fewlayer
graphene) are prepared to overcome previously mentioned issues. The spherical morphology eliminates severe stacking effect, and the graphitic domains significantly enhance electrical conductivity. Moreover, the dual functionality of KOH as activating agent (formation of pores and graphitic domains) and biomass-derived carbon microspheres have been rarely discussed in the literatures, showing the novelty and uniqueness of this study. The obtained sample in this study exhibits high specific surface area (1686 m2/g), low equivalent resistance (0.51 Ω), exceptional stability (97 % capacitance retention after 5000 cycles at 20 A/g) and superior specific capacitance (443 F/g at 0.5 A/g), demonstrating obtained material is a promising material for advanced energy storage applications. The symmetric supercapacitor is also assembled and shows specific capacitance of 202 F/g at 0.5 A/g and delivers energy density of 28.1 Wh/kg at power density of 250 W/kg within 1 V voltage.

July 16, 2026 | 4:30 PM

Regulating Interfacial Charge Transport to Stabilize Ni-Rich Cathodes via Atomic Layer Deposited Al-doped Molybdenum Oxide

Mr. Hyeonmin Lee[1], Mr. Woosung Kim[1], Mr. Yehwan Kim[2], Mr. Jaeyun Lim[3], Mr. Sungeun Jo[1], Mr. Sangwon Lee[3], Prof. Changshin Jo[2], Prof. Jihwan An[1,3]

[1]Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), 77 Cheongam-ro, Republic of Korea, [2]Department of Chemical Engineering, Pohang University of Science and Technology (POSTECH), 77 Cheongam-ro, Republic of Korea, [3]Graduate School of Semiconductor Technology, Pohang University of Science and Technology (POSTECH), 77 Cheongam-ro, Republic of Korea

Session 10 - S06: Energy & Sustainability (ENS), Seletar1 - Level 3, July 16, 2026, 3:45 PM - 5:00 PM

The increasing demand for high-energy-density lithium-ion batteries has driven extensive research on Ni-rich layered oxide cathodes. Despite their promise, these cathodes suffer from serious interfacial instability, particularly during high-voltage operation. Surface coatings have been widely applied to reduce surface degradation, but conventional insulating oxide coatings generally involve a trade-off between stabilizing lattice oxygen and maintaining efficient charge transport.

Although atomic layer deposition (ALD) enables precise control over coating thickness and composition, its versatility has rarely been fully utilized to gain mechanistic insight into cathode surface engineering. In this study, we present a Mo–Al oxide coating fabricated using an ALD super-cycle strategy to simultaneously improve the capacity and stability of Ni-rich cathodes. The combined Mo and Al sub-cycles form a coating layer with strong oxygen affinity and induce oxygen vacancies that promote charge transport. As a result, the coating suppresses interfacial degradation while preserving favorable transport properties.

These findings suggest that the ALD super-cycle strategy is a promising approach for constructing surface coatings that enhance both electrochemical performance and interfacial stability in Ni-rich layered oxide cathodes.

July 16, 2026 | 4:45 PM

Ultra-High Performance Symmetric Supercapacitors Based on Nitrogen-Doped Biomass Carbon and Graphene Composites

Mr. Shih-lung Lee[1], Mr. Ming-Che Cheng[1], Mr. Yu-Sung Chang[1], Mr. Du-Cheng Tsai[1], Mr. Yen-Lin Huang[1], Mr. Fuh-Sheng Shieu[1]

[1]National Chung Hsing University, 145 Xingda Rd., South Dist., Taichung City 402, Taiwan (R.O.C.), Taiwan

Session 10 - S06: Energy & Sustainability (ENS), Seletar1 - Level 3, July 16, 2026, 3:45 PM - 5:00 PM

Balancing high specific surface area with adequate electrical conductivity remains a critical challenge in developing biomass-derived activated carbon for energy storage. This study presents a competitive and eco-friendly approach using lignin- and cellulose-rich jute fibers to synthesize high-value carbon composites. The resulting material exhibits a substantial specific surface area of 1798 m^2/g alongside excellent conductivity. Notably, during the activation process, graphene was observed to form spontaneously on the surfaces and edges of the activated carbon, providing a greener alternative to traditional noble-metal-catalyzed graphene synthesis. To further optimize electrochemical performance and wettability, plasma treatment was employed to introduce a high concentration of heteroatoms (up to 30 at%) into the carbon framework. The functionalized composite (NAJC@G) demonstrated outstanding performance in a three-electrode configuration, delivering a specific capacitance of 503 F/g at 0.5 A/g in 3 M KOH, and maintaining 92% capacitance retention over 5000 cycles at 20 A/g. Furthermore, a symmetric supercapacitor assembled with NAJC@G achieved a high energy density of 30.5 Wh/kg at a power density of 250 W/kg within a 1 V potential window. These quantitative results underscore the exceptional potential of NAJC@G as an advanced material for energy storage applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Rational Design of Heteroatom-Doped Catalysts for Catalytic Upgrading of Biomass Platform Molecules

Botao Fan[1]

[1]University Of Macau, University of Macau Avenida da Universidade Taipa, Macau, China, China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Electrocatalytic oxidation of 5-hydroxymethylfurfural (HMF), a lignocellulosic biomass derivative—via the HMF electrooxidation reaction (HMFOR) presents a transformative alternative to the oxygen evolution reaction (OER) in water electrolysis. Replacing OER with HMFOR drastically lowers the overall cell voltage, cutting energy input while valorizing waste biomass into 2,5-furandicarboxylic acid (FDCA), the key monomer for biodegradable plastics (e.g., PEF). Pioneers a sustainable paradigm shift away from petroleum-derived manufacturing. This presentation summarizes our design of high-performance non-precious metal catalysts via heteroatom doping, elucidating reaction mechanisms and the pivotal role of catalytic active sites.

Two novel catalysts were developed for HMFOR. First, Mn-doped $Ni(OH)_2$ nanoflowers were prepared by co-precipitation. Mn substitution induced lattice expansion, defects, and oxygen vacancies, lowering the proton deintercalation barrier to generate $Ni^{3+}(OH)O$ active sites, the core centers for substrate adsorption and activation. At 1.36 V vs. RHE, this catalyst achieved 98.9% FDCA yield, 99% Faradic efficiency (FE), and 50-cycle stability, outperforming most Ni-based (oxy)hydroxides. Mechanistic studies clarified that $Ni^{3+}(OH)O$ synergizes with OH^- to oxidize the CH_2OH group, while the HC=O group is converted via H_2O-mediated gem-diol intermediates.

Second, Pr-doped $Co(OH)_2$ hexagonal sheets were synthesized by electrodeposition. Pr doping modulated the electronic structure, narrowing the band gap and facilitating in-situ formation of CoOOH active sites, which accelerate charge transfer and reaction kinetics. This catalyst exhibited an ultra-low onset potential of 1.05 V vs. RHE (10 mA cm^{-2} at 1.10 V), achieving 100% HMF conversion, 99.6% FDCA selectivity, and 99.7% FE, among the most efficient Co-based HMFOR catalysts reported.

Our work establishes heteroatom doping (Mn, Pr) as a rational strategy to engineer active site formation and electronic properties. Detailed mechanistic insights into the role of NiOOH and CoOOH active sites provide critical guidelines for designing next-generation catalysts for sustainable biomass valorization.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

In-situ Controlled Reconstruction of $MoO_2/CoMoO_3$ Heterostructure for Durable and High-Performance Alkaline Seawater Electrolysis

Juanjuan Wang[1], Hui Pan[1]

[1]The University Of Macau, Institute of Applied Physics and Materials Engineering, University of Macau, Macao SAR, China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Direct seawater electrolysis offers a sustainable route to green hydrogen without competing for freshwater resources. However, non-noble metal catalysts face dual challenges under industrial alkaline seawater conditions: uncontrollable surface reconstruction at high current densities (>500 mA cm^{-2}) and severe chloride corrosion, limiting durability to only hundreds of hours. Here we report a $MoO_2/CoMoO_3$ heterostructure that undergoes beneficial in-situ controlled reconstruction during operation. The $CoMoO_3$ phase selectively dissolves to form an amorphous cobalt hydroxide active layer while releasing MoO_4^{2-} anions, with MoO_2 serving as an invariant conductive skeleton maintaining structural integrity. Critically, the continuously released MoO_4^{2-} competitively adsorbs on the catalyst surface, effectively repelling Cl^- and preventing corrosion. This self-regulated mechanism ensures sustained active site exposure and exceptional durability. The catalyst delivers ultralow overpotentials of 19, 51, and 169 mV at 10, 100, and 500 mA cm^{-2}, respectively, with outstanding long-term stability. Our work provides a scalable strategy for durable high-performance seawater electrolysis cathodes by harnessing controlled reconstruction rather than suppressing it.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Ternary RuCoCu Catalyst Relay Electrochemical Reduction of Nitrate to Ammonia under Ampere-level Current Density

Ms. Ziwen Feng[1], Prof. Hui Pan[1]

[1]Institute of Applied Physics and Materials Engineering, University of Macau, Institute of Applied Physics and Materials Engineering, University of Macau, Macao SAR, 999078, China, China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Electrochemical nitrate reduction (eNO3R) to ammonia synthesis is a process that truly transforms waste into treasure, as it enables the conversion of harmful pollutants (nitrate wastewater) into high-value-added products. However, at high current densities, the kinetic mismatch between the conversion of NO3- to NO2- and subsequent hydrogenation, and the rapid production of adsorbed hydrogen from water dissociation, severely impedes the industrialisation of eNO3R. Herein, a RuCoCu ternary catalyst with multiple active sites was stepwise electrodeposited onto a cobalt foam substrate (RuCoCu-CF) to enhance the reaction activity and ammonia selectivity. Combining in situ/ex situ characterisation, the active sites in the eNO3R process were revealed to be Co(OH)2, metallic Ru and Cu. By modulating the interactions among active sites: Cu converts NO3- to NO2-, Co deepens the hydrogenation process to form NH3, and Ru promotes water splitting to generate *H, thus enhance the ammonia synthesis. The optimal RuCoCu-CF catalyst achieved a high ammonia Faradaic efficiency of 94.8%, a yield rate of 176 mg h-1 cm-2 at -1.1V vs. RHE, and durability over 100 hours.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

LOW-CONCENTRATION TRANSITION METAL DOPING OF Co_3O_4 ON CARBON PAPER: UNRAVELING THE ACTIVITY–STABILITY TRADEOFF FOR ACIDIC OXYGEN EVOLUTION REACTION

LOW-CONCENTRATION TRANSITION METAL DOPING OF Co_3O_4 ON CARBON PAPER: UNRAVELING THE ACTIVITY–STABILITY TRADEOFF FOR ACIDIC OXYGEN EVOLUTION REACTION **MinJi Kim**[1], LOW-CONCENTRATION TRANSITION METAL DOPING OF Co_3O_4 ON CARBON PAPER: UNRAVELING THE ACTIVITY–STABILITY TRADEOFF FOR ACIDIC OXYGEN EVOLUTION REACTION Xiaohui Deng[1], LOW-CONCENTRATION TRANSITION METAL DOPING OF Co_3O_4 ON CARBON PAPER: UNRAVELING THE ACTIVITY–STABILITY TRADEOFF FOR ACIDIC OXYGEN EVOLUTION REACTION Dongshuang Wu[1]
[1]Nanyang Technological University, 50 Nanyang Ave, Singapore 639798, Singapore
Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The pressing need for sustainable hydrogen production via proton exchange membrane (PEM) water electrolyzers demands robust, earth-abundant electrocatalysts capable of sustaining the acidic oxygen evolution reaction (OER) under industrially relevant conditions. While Co_3O_4 offers high intrinsic activity, its practical deployment is hindered by rapid Co dissolution and structural degradation. This study systematically investigates 2–5 at.% Cu-, Ni-, and Ir-doped Co_3O_4 nanosheets epitaxially grown on carbon paper substrates, employing a comprehensive multimodal characterization suite to resolve the activity–stability tradeoff.

Linear sweep voltammetry establishes 2 at.% doping as optimal (1.55–1.60 V at 10 mA cm^{-2} vs. 1.65 V pure), while cyclic voltammetry and chronoamperometry reveal dramatic lifetime extensions (70+ h Ir vs. ~20 h pure at 100 mA cm^{-2}). ICP-MS quantifies 42–75% dissolution suppression (0.132–0.309 mg vs. 0.529 mg pure), corroborated by SEM-EDS (75–93% Co retention), XRD (92–95% peak preservation), and HAXPES (Co valence rebalancing). The unified dataset establishes a dissolution-crystallinity-performance cascade where dopant-induced lattice pinning arrests vacancy coalescence, maintaining nanosheet architecture and triple-phase boundaries essential for sustained operation.

Ir doping uniquely delivers benchmark stability through Co–Ir–O network formation, while Cu/Ni provide cost-effective alternatives, collectively validating 2 at.% as the critical concentration balancing activity with dissolution immunity. These mechanistic insights, spanning electronic structure to macroscale durability, provide a rational design framework for next-generation acidic OER electrocatalysts deployable in PEM electrolyzers.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A Molecular Dynamics Simulation Study on the Effect of Water on the Carbon Dioxide Absorption in Deep Eutectic Solvents

Deepak Kumar Panda[1], Salman Ahmad Khan[1]

[1]Indian Institute Of Technology Kanpur, Kanpur, India

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Carbon dioxide (CO2) is one of the major components of flue gases. Aqueous amine solvents are typically used for carbon capture through absorption. However, there are major shortcomings to such a process, including high energy cost during regeneration, corrosiveness, and solvent loss. Hence, new-generation solvents, such as deep eutectic solvents (DESs), are now being studied extensively to replace them. However, the high viscosity of DESs is a major hindrance to their widespread applications, which can be overcome by adding water. Molecular dynamics (MD) simulation can be used to calculate gas solubility in various solvents using the free-energy perturbation method and to provide insights into the interactions within the system. Herein, we studied CO2 absorption in two DESs, one hydrophilic and one hydrophobic, at three different water contents (5 wt%, 10 wt%, and 15 wt%) using MD simulations. Although the free energy of solvation decreases gradually with the addition of water, it remains negative up to 10 wt% and turns positive at 15 wt% of water. Hence, we can find an optimal water content that balances DES viscosity and CO2 solubility, thereby helping us prepare systems specifically for carbon capture. The interaction of anion with CO2 is prominent in both systems. Clusters of anions and water molecules are observed in both systems, with larger clusters in the hydrophobic system than in the hydrophilic one.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Optimization of Vacuum quenching of slot die coated perovskite solar mini module

Jiahao Chen[1,3], Doctor Shengdong Zhang[2], Doctor Hang Zhou[2]

[1]School of Software & Microelectronics, Peking University, , China, [2]School of Electronic and Computer Engineering, Peking University Shenzhen Graduate School, , China, [3]Shenzhen Topray Solar Co., Ltd, , China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Perovskite solar cell is a novel solar technology with most potential of achieving high performance and low cost. Perovskite material owns many unique advantage at the same time, such as adjustable bandgap, high minority carrier lifetime, high diffusion length. However, most of the high-performance perovskite solar cell were fabricated in lab with small device area and low production speed. To achieve higher production rate, slot die process was applied in perovskite solar cell production. Different from the spin coating technique that was widely used in lab, slot die coating process rely on quenching technique after coating process to get rid of remaining of the perovskite precursor coated on substrate. Vacuum quenching is one of the most effective and high-speed technique that can remove the excess solvent. The chamber pressure is suddenly lowered by enabling the vacuum pump. The opening of the valve and the length of the vacuum quenching process is essential to the outcome of perovskite film. This research focuses on the effect of changing the vacuum pump valve opening varied from 10% to 70%. At 40%, the champion device of perovskite solar mini module with area of 14.78 square centimeter reached 9.00% of efficiency with Voc of 14.82V and Isc of 18.21mA. The perovskite film achieved high film uniformity and smooth surface. At 10%, the perovskite film is foggy after vacuum quenching and filled with pin holes after annealing, causing the dramatic decrease at device performance with efficiency of 3.28%, Voc of 10.33V and Isc of 16.11mA. The change on film morphology caused by vacuum quenching process indicate that the optimization of this process is one of the most crucial aspects in slot die coated perovskite solar module production.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Preparation and High Temperature Stability of Hafnium Oxide Thermal Barrier/Ytterbium Silicate Environmental Barrier Composite Coating

Dr. Qian Guo[1]

[1]School of Materials Science and Engineering, Beihang University, , China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Ceramic matrix composites (CMCs) are emerging as candidate materials for key hot components in advanced aero-engine. With the increasing service temperatures of next-generation aero-engines, there is an urgent need for novel thermal/environmental barrier coatings (T/EBCs) that combine excellent thermal insulation with superior environmental corrosion resistance. In this work, a tri-layer T/EBCs system is designed, in which the yttria half-stabilized hafnia (YSH) serves as thermal barrier coating (TBC) and the composite ytterbium silicate (Yb2SiO5/Yb2Si2O7) ceramics as environmental barrier coating (EBC). The effects of Yb2Si2O7 content on the properties of composite ceramics, including thermophysical performance, water vapor corrosion resistance, and its interfacial stability with YSH, was investigated. Among the compositions studied, the composite ceramics 3Yb2SiO5•2Yb2Si2O7 exhibited the minimal weight gain after after 500 h of corrosion testing. Furthermore, no interfacial reaction was observed between 3Yb2SiO5•2Yb2Si2O7 and YSH after heat treatment for 100 h.A fabrication method for producing high-crystallinity, high-density composite ytterbium silicate coatings via PS-PVD was established. During deposition, coatings with a crystallinity exceeding 70% were achieved when the substrate temperature exceeded 1100 °C. Additionally, the failure mechanism of the T/EBC was elucidated by analyzing its high-temperature water vapor corrosion behavior and thermal shock performance under a 90%H2O-10%O2 atmosphere at 1300 °C. Based on these findings, the failure mechanism of the tri-layer T/EBC with was clarified, aiming to offer guidance for the design and fabrication of protective coatings for SiCf/SiC CMCs.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Maximizing the number of electrochemically active sites on Pt-coated rough substrates for the Hydrogen Evolution Reaction (HER)

Mr Pandiri Sirish[1], Mrs Peela Lasya[1], Dr. Satyesh Kumar Yadav[1,2]

[1]Materials Design Group, Department of Metallurgical and Materials Engineering, Indian Institute of Technology (IIT) Madras, Chennai-600036,, India, [2]Center for Atomistic Modelling and Materials Design, Indian Institute of Technology (IIT) madras, Chennai-600036,, India

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Reducing platinum group metal (PGM) loading in bipolar plates and catalyst-coated membranes while maintaining high catalytic activity is a fundamental challenge for cost-competitive proton exchange membrane water electrolysers (PEMWEs). This work examines the performance of platinum (Pt) thin films deposited on industrial-grade titanium (Ti) substrates (Grade 2), which have a native oxide layer (TiOx) and inherent surface roughness for the hydrogen evolution reaction (HER). We systematically vary the Pt film thickness from 5 to 500 nm and measure electrochemical active surface area (ECSA), overpotential and kinetics for HER. We also measured the through-plane resistance between the Pt film and Ti substrate using electrochemical impedance spectroscopy. Electrochemical analyses reveal a distinct non-monotonic dependence of catalytic activity on Pt loading. With increasing Pt thickness, ECSA and kinetics increase while overpotential decreases up to 300 nm of Pt. Rough surfaces provide a large exposed surface compared to smoother surfaces. A Pt film of a few tens of nm could not occupy all the exposed surfaces, while increasing the thickness of Pt till optimal thickness leads to larger occupation of exposed surfaces. Further increase in Pt thickness results in deterioration of HER performance. This opens the possibility of utilising the roughness of substrates to design cost-effective, high-performance electrocatalysts for HER.

keywords: Pt Thin Films, DC Magnetron Sputtering, Catalyst Loading Optimisation, Electrochemically Active Surface Area (ECSA), Water Electrolysis, Hydrogen Evolution Reaction (HER)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A step toward industrially scalable PrOx capped nanoporous Pt R-SOC cathode with cathodic electrochemical deposition

Ki Won Hong[1], Geon Hyeop Kim[1], Professor Gu Young Cho[1]
[1]Dankook University, , South Korea

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Lanthanium-Strontium-Cobalt Oxide (LSC) is one of the materials highly regarded as a oxygen electrode material for solid oxide fuel cells. Although LSC is used in many studies due to its excellent properties as a mixed ionic and electronic conductor (MIEC) material capable of simultaneously conducting electrons and oxygen ions, its relatively low ORR efficiency and durability are bottlenecks that prevent its application in actual cells. In various studies, surface treatment using praseodymium has emerged as an effective method to simultaneously improve the oxygen reactivity and durability of LSC. However, existing research has limitations in that it relies on low-productivity surface treatment methods requiring a vacuum environment. This study aims to improve the electrochemical performance of LSC by applying PrOx to the surface of LSC via cathodic electrochemical deposition (CELD). CELD is a plating method utilizing the three-electrode method, it offers significant advantages in accessibility and large-area cell fabrication because it allows for easy deposition over large areas without complex systems. Furthermore, additional electrochemical performance improvements can be expected as the reaction surface area of the deposited film can be maximized through the control of parameter variables. In this study, PrOx was coated onto screen-printed LSC using CELD, and the surface activity of the electrode was successfully enhanced. In addition, the performance and durability of LSC were evaluated under different CELD deposition conditions to identify the optimal deposition parameters.

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT). (No. RS-2023-00213741)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Binder-Free Hydrothermally Grown Cobalt-Free Ni-Mn Phosphate Thin Films as Sustainable Positive Electrodes for High-Performance Hybrid Asymmetric Supercapacitors

Hari Harani P[1]

[1]Sri Sairam Engineering College, West Tambaram, India

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The increasing need for sustainable energy storage devices has brought severe challenges due to the toxicity, high cost, and uncertain supply chain issues of cobalt. Cobalt-free transition metal phosphates have gained considerable attention as potential alternatives. With the earth's abundant elements and unique open framework structures, bimetallic nickel-manganese phosphates (Ni-Mn-P) have intrinsic redox chemistry from the coupled Ni^{2+}/Ni^{3+} and $Mn^{2+}/Mn^{3+}/Mn^{4+}$. Recent studies have explored a binder-free synthesis route to achieve high specific capacity and excellent cycling stability for hybrid supercapacitors, and proper design of Ni-Mn-P has achieved competitive performance.

Binder-free Ni–Mn–P thin films were directly fabricated on stainless-steel current collectors by a facile low-temperature hydrothermal approach. The binder-free electrodes, devoid of polymeric binders and conductive additives, achieved a higher active material fraction and more robust interfacial contact with current collectors. Highly porous, thin films comprising a hierarchical nano/microsheet morphology, as confirmed by FE-SEM, displayed excellent electroactive material performance. X-ray diffraction and XPS results demonstrated the presence of mixed-phase bimetallic phosphate composition.

The material was characterised electrochemically in 1M KOH solution with a specific capacitance of 1120 F g^{-1} at 1 A g^{-1}. The electroactive Ni-Mn-P material showed a reasonable rate capability with 68% retention at 20 A g^{-1} and excellent cycling stability with 94% capacitance retention over 10,000 charge/discharge cycles. An asymmetric supercapacitor device assembled using the electroactive Ni-Mn-P material as the positive electrode and activated carbon as the negative electrode demonstrated a maximum energy density of 46.5 Wh kg^{-1} at a power density of 1.8 kW kg^{-1}, within an operating voltage window of 1.6 V, with 90% capacitance retention over 8000 cycles.

This study presents an important technological advance in solution-derived cobalt-free TMP thin films as environmentally benign surface functionalization for hybrid asymmetric supercapacitors devices intended for applications in portable electronics, wearable technology, and grid storage.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

High-Resolution and Low-powered Integrated Wind Speed and Direction Sensor

Prof. Chaoran Liu[1], Mr. Zhichao Lin[1], Prof. Lufeng Che[2], Dr. Dongfang Yan[1], Mr. Yi Wang[1], Mr. Qianlong Gao[1], Mr. Zhiyuan Yin[1], Dr. Chenxi Yue[1], Prof. Linxi Dong[1], Dr. Gaofeng Wang[1], Prof. Ayodeji Ogunjuyibe[4], Prof. Zhenhua Wu[3], Dr. Hongjian Lin[5]

[1]Hangzhou Dianzi University, , China, [2]Zhejiang University, , China, [3]Chinese Academy of Sciences, , China, [4]University of Ibadan, , Nigeria, [5]City University of Hong Kong, , Hong Kong

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The simultaneous detection of wind speed and direction is paramount for capturing complete wind vector information, which is essential for operational safety and efficiency in meteorological monitoring, civil engineering, transportation, and marine engineering. Herein, we propose a high-resolution and low-powered Integrated wind speed and direction sensor based on a triboelectric nanogenerator (TENG). The optimized wind-speed measurement structure achieves a cut-in wind speed as low as 1 m/s and excellent linearity of 97.7% within the range of 1–12.5 m/s. In addition, the sensor demonstrates high stability, with less than 9.7% voltage attenuation under varying humidity and temperature conditions, and negligible material degradation over prolonged use. For wind-direction measurement, a multi-channel electrode structure exhibits a minimum directional resolution of 6°. A microcontroller unit system enables real-time communication with an upper computer and uploading the synchronized wind speed and direction data to the cloud for computation and analysis. This work provides essential technological support for comprehensive environmental monitoring in IoT applications and promotes the advancement and adoption of TENG-based sensing technologies.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Surface Engineering of Lignin-derived Hard Carbon via Vacuum-assisted In-situ Glucose Coating for High-Efficiency Sodium Storage

Liu Jiayao[1], **Jiawei Zhang**[1], Guo Zihan[1], Li Xiaoyan[1], Li Yu[1], Chen Minghua[1]
[1]Harbin University Of Science And Technology, , China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Lignin is a promising precursor for hard carbon anodes in sodium-ion batteries (SIBs), yet its inherent porous structure often leads to low initial coulombic efficiency (ICE) due to excessive solid electrolyte interphase (SEI) formation. In this work, a robust surface-sealing strategy is proposed by constructing an in-situ glucose-derived hydrochar coating on lignin particles. To ensure coating uniformity, a vacuum-assisted impregnation process coupled with high-power ultrasonication was employed to infiltrate glucose molecules into the superficial pores of the lignin precursor. Subsequently, a hydrothermal treatment was applied to trigger the dehydration and polycondensation of glucose, forming a dense hydrochar layer that encapsulates the lignin core. Upon carbonization, this glucose-derived coating transforms into a defect-compensated carbon shell, which effectively reduces the specific surface area and seals the open macropores of the lignin-based hard carbon. Physical characterizations, including SEM and TEM, confirm the formation of a distinct core-shell-like layered structure with optimized interface compatibility. Electrochemical tests demonstrate that the glucose-coated hard carbon exhibits a significantly enhanced ICE and superior cycling stability compared to the pristine lignin carbon. This surface-modification approach provides a scalable and green pathway for tailoring the interface properties of biomass-derived carbon materials for advanced energy storage applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A vision-based integrated measurement method for assembly accuracy of tower heliostats

Jianlong Zhao[1]

[1]Shenyang University of Technology, No.111, Shenliao West Road, Economic & Technological Development Zone, China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Heliostats serve as critical optical components in solar power tower plants, where their surface shape accuracy fundamentally dictates the concentration efficiency and focal spot quality, thereby impacting the overall energy conversion efficiency and operational stability. Consequently, developing robust surface metrology for heliostats carries significant engineering value. This paper first provides a comparative analysis of conventional detection methods, such as fringe reflection, photogrammetry, and laser displacement, specifically scrutinizing the on-site applicability bottlenecks of 3D laser scanning. To overcome existing constraints in efficiency, accuracy, and environmental adaptability, a collaborative automated 3D scanning methodology is proposed, integrating a mobile platform with a robotic manipulator. The system facilitates large-scale station transitions via the mobile base, while a non-contact 3D scanner mounted on the robotic arm executes high-density point cloud acquisition of the heliostat's rigid backplane following a pre-planned trajectory. Subsequently, by establishing a mapping model correlating backplane structural deformation with mirror surface topology, the actual profile of the mirror is indirectly and precisely reconstructed. This strategy effectively circumvents the challenges of intense specular reflection and potential coating damage inherent in direct mirror scanning, significantly enhancing the degree of automation and practical utility. The research provides an innovative solution for surface quality control during both the manufacturing and maintenance phases of heliostats.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Fluorination-induced Ta-doped RuO2 catalyst achieves stable acidic water oxidation

YANG JIAO[1]

[1]University Of Macau, , China

Poster Session - S06: Energy & Sustainability (ENS), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The development of durable and active electrocatalysts for the oxygen evolution reaction (OER) under acidic conditions remains a formidable challenge for proton exchange membrane water electrolyzers (PEMWE). Herein, we report a rational design strategy to significantly enhance the stability of Ta-doped RuO2 for acidic water oxidation through controlled fluorination. The resulting F-Ta0.05Ru0.95O2 catalyst exhibits substantially improved durability while maintaining high intrinsic activity. Comprehensive experimental analyses and theoretical calculations reveal that the incorporation of fluorine induces strong electronic modulation, effectively optimizing the adsorption energies of reaction intermediates and suppressing the formation of soluble Ru species above +1.4 V. Furthermore, fluorination strengthens the local coordination environment and passivates surface oxygen vacancies, which collectively inhibit the lattice oxygen participation mechanism and prevent structural collapse. Consequently, the F-Ta0.05Ru0.95O2 catalyst demonstrates an exceptionally low overpotential of 198 mV at 10 mA cm-2 and sustains stable operation for over 600 hours in 0.5 M H2SO4 with minimal degradation. This work presents a promising fluorine-incorporation pathway to break the activity-stability trade-off in ruthenium-based oxide catalysts, offering valuable insights for the design of robust anode materials in practical acidic water electrolysis.

Room-temperature two-dimensional multiferroic metal with strong magnetoelectric coupling

Professor Lan Chen[1]

[1]Institute of Physics, Chinese Academy of Sciences, No.8, 3rd South Street, Zhongguanchun, Haidian District, China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

Multiferroic materials, which simultaneously possess ferroelectric and magnetic orders, enable the electrical control of magnetism through magnetoelectric coupling, holding significant promise for ultra-low-power spintronic and quantum devices. However, bulk multiferroics such as $BiFeO_3$ and $TbMnO_3$ have long faced fundamental limitations, including low spontaneous polarization, weak magnetoelectric coupling coefficients, and instability under ambient conditions, which collectively impede their practical application. The emergence of two-dimensional (2D) materials has opened new avenues to circumvent these challenges through atomic-scale engineering. Nonetheless, intrinsic 2D multiferroic systems proposed so far, such as NiI_2, where ferroelectricity is driven by a spiral magnetic order, remain constrained by low magnetic transition temperatures (~21 K) and air sensitivity. Therefore, achieving a room-temperature, air-stable 2D multiferroic material with strong magnetoelectric coupling remains a critical challenge, demanding new paradigms to overcome material limitations.

In this talk, I will introduce our work which addresses this gap using bilayer chromium telluride ($CrTe_2$) synthesized via molecular beam epitaxy. This system exhibits robust ferromagnetism, switchable out-of-plane ferroelectricity, and strong magnetoelectric coupling under ambient conditions. Scanning tunneling microscopy and low-energy electron diffraction reveal an alternating antiferromagnetic/ferromagnetic layered structure that spontaneously breaks inversion symmetry and gives rise to reversible out-of-plane ferroelectric polarization. Scanning probe microscopy demonstrates non-volatile electrical control of the magnetization state, enabling electrical writing and magnetic readout. Crucially, the underlying magnetoelectric coupling mechanism is found to originate from the direct modulation of magnetic order and exchange interactions via charge transfer within the 2D layers, representing a new paradigm distinct from conventional spin-orbit coupling. This electron-filling-driven strategy establishes a novel design principle for achieving strong magnetoelectric effects in van der Waals systems. Bilayer $CrTe_2$ not only overcomes long-standing material obstacles but also pioneers a new approach for electrically manipulating magnetism, charting a new direction for the development of quantum devices and high-performance spintronics.

July 15, 2026 | 1:30 PM

Non-volatile optical response in sliding ferroelectric 3R-MoS2 via exciton tuning

Jing Liang[1]

[1]Shenzhen International Quantum Academy, , China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

Ferroelectricity at the atomic scale is essential for realizing highly integrated, low-power non-volatile optoelectronic chips. However, maintaining spontaneous polarization at the atomic scale in conventional ferroelectric materials is usually challenging. Sliding ferroelectricity in two-dimensional materials offers a novel approach to achieving stable ferroelectricity at the extreme limit: spontaneous polarization arises at the interfaces of rhombohedral-stacked two-dimensional materials (such as hBN, TMDs) and remains stable even at the bilayer limit. In this talk, I will present a series of recent studies on rhombohedral MoS_2 (3R-MoS_2), focusing on the fundamental physical mechanisms behind interface spontaneous polarization, which originates from asymmetric interlayer coupling, and the polarization switching pathways controlled by pre-existing domain wall dynamics. Additionally, I will demonstrate how such polarization switching can induce significant changes in the optical properties of 3R-MoS_2 through strong excitonic resonances in the visible range, which provides valuable insights into the switching pathways in sliding ferroelectricity. The substantial optical reflectance change associated with stacking transitions occurs on an ultrafast timescale, making it a promising candidate for high-performance non-volatile optical memory applications.

Ferroelectric vortex domain configuration for dielectric energy-storage

Prof. Ziming Cai[1]

[1]China University of Mining and Technology, 1# Daxue Road, China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

The utilization of ferroelectrics in the form of ceramics, films and composites towards energy-storage applications is of great interest recent years. However, the simultaneous achievement of high polarization, high breakdown strength, low energy loss and weakly nonlinear polarization-electric field (P-E) relation has been a huge challenge. A vortex domain engineering approach is proposed via the construction of core-shell structure in ferroelectrics. The formation and the switching characteristics of vortex domains (VDs) were validated via phase-field simulation based on the time-dependent Ginzburg-Landau kinetic equation. Results indicated that the switching of VDs was much easier than that of conventional large-sized domains owing to the smaller depth of potential well in the energy profiles, which was found to be the origin of the lower coercive field, lower remnant polarization and weaker nonlinear P-E relation. In general, the vortex domain engineering approach proposed in this work can serve as a universal method in designing high-performance ferroelectrics with simultaneous high breakdown strength, high discharge energy density, and high energy efficiency.

July 15, 2026 | 2:10 PM

From oxides to nitrides: Epitaxial thin films for energy harvesting and conversion

Wei Sea Chang[1]

[1]National Yang Ming Chiao Tung University, ,

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

This talk presents our group's exploration of functional epitaxial thin films across oxide and nitride material systems. In the oxide domain, we synthesize rare-earth-doped bismuth ferrite ($BiFeO_3$ or BFO) ferroelectric thin films, demonstrating that Gd-doping effectively suppresses oxygen vacancies, reduces leakage current by approximately two orders of magnitude, and enhances remnant polarization. We show that ferroelectricity offers a far broader functional landscape, notably by introducing the electrolyte-gated field-effect transistor mechanism into photoelectrochemical systems. We demonstrate that ferroelectric polarization can directly modulate interfacial carrier dynamics and tune electrochemical reactions through field-effect control, establishing a new paradigm in which the internal electric field of a ferroelectric is not merely serves a switching state, but an active, tunable handle over charge-driven chemical processes. In the nitride domain, we investigate gallium nitride (GaN-) and indium nitride (InN-based) epitaxial films for optoelectronics and the piezo-phototronic effect, elucidating how strain-modulated piezopotentials govern carrier transport and recombination in InGaN/GaN heterostructures. Spanning from multiferroic oxides to wide-bandgap nitrides, our work charts a unified materials roadmap for advancing energy harvesting, conversion, and next-generation optoelectronic devices.

July 15, 2026 | 2:30 PM

Schottky Barrier-Conductive Wire Channel Synergistically Regulated Ultra-High Nonlinear Jumping Self-Rectifying Memristor

Professor Ming Hua Tang[1], Postgraduate Jiang Zhao[1], Postgraduate Jiang Bian[1], Associate Professor Gang Li[1], Associate Professor Ying Xiong[2]

[1]Xiangtan University, School of Materials Science and Engineering,411105, China, [2]Xiangtan University, School of Mathematics and Computational Science, 411105, China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

To address the memory wall and power wall challenges within the von Neumann architecture, the development of compute-in-memory technology is of paramount importance. Self-rectifying memristors represent ideal devices for constructing highly energy-efficient compute-in-memory systems. However, their performance has long been constrained by the difficulty in synergistically optimizing rectification properties and memory stability. To this end, the present study introduces and implements a jumping self-rectifying memristor based on a novel paradigm in which the rectification and storage mechanisms are both discrete and interact synergistically. By constructing a Pt/HfO2/Ta2O5-x/Ti heterostructure and systematically controlling the film thickness, deposition process, and testing methods, the study successfully integrates the Schottky barrier rectification mechanism with the oxygen vacancy conductive filament resistive switching mechanism. This approach overcomes the inherent limitations of traditional charge-trapping devices in terms of data retention. This device exhibits outstanding overall performance: a switching ratio exceeding 5×104, a rectification ratio exceeding 4×104, and a nonlinearity exceeding 2×105 (leading among similar devices), with data retention capability exceeding 104 seconds. Band structure and conduction mechanism analyses reveal that its performance arises from the synergistic modulation of dual Schottky barriers at the Pt/HfO2 and HfO2/Ta2O5-x interfaces, as well as the intrinsic stability of the oxygen vacancy-based conductive filaments. Theoretical evaluations show that this device can support array sizes up to 165.7 Gbit. This research not only provides an innovative device design approach for high-performance self-rectifying memristors, but also lays a crucial foundation for the development of highly energy-efficient compute-in-memory hardware.

July 15, 2026 | 2:50 PM

Multiscale heterogeneous-structure design for BNT-based energy storage ceramics

Pro Chaoqiong Zhu[1]

[1]China University of Mining and Technology, , China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

High-performance ceramic dielectrics play a crucial role in the development of next-generation advanced high/pulsed power capacitors. Thereby, the utilization of relaxor ferroelectric ceramics in energy storage applications is of great interest due to the small hysteresis, while the undesirable discharge energy density caused by the limited polarization, especially under a low applied electric field is still a huge challenge in practical applications. To reconcile the relationship between polarization and breakdown strength, various heterogeneous-structure design has been developed in our work, including the local heterogeneous polarization optimization, the precise core-shell structure controlling, laminated-structure design and so on, which can effectively weaken the nonlinearity of the P−E relation and delay the saturation polarization simultaneously. Evidenced by both experiments and simulations, the heterogeneous-structure design can effectively combine the advantages of different dielectrics, achieving a strong alliance and significantly enhancing the energy storage potential.

July 15, 2026 | 3:10 PM

Orbital Guided Design of Unconvensional Two-dimensional multiferroic material

Yunhao Lu[1]

[1]Zhejiang University, , China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

Multiferroic materials are noteworthy for their simultaneous possession of two or more ferroelectric properties, such as ferroelectricity and ferromagnetism. Based on first-principles calculations and utilizing orbital interactions, we demonstrated the anomalous phenomenon of carrier doping-enhanced polarization in a class of layered ferroelectric systems, and designed a class of two-dimensional multiferroic material systems based on this. In our latest research, we theoretically predicted and experimentally confirmed two-dimensional multiferroic metallic systems caused by the splitting difference in interlayer orbital energy levels, and also demonstrated the coupling effect of ferroelastic and antiferromagnetic order caused by orbital interactions in staggered magnets. These principles provide new insights for the development of next-generation ferroic quantum devices.

Nanoscale dielectrics and ferroelectric semiconductors for informational devices

Professor Yu Zhou1

1Central South University, , China

Session 05 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 15, 2026, 1:10 PM - 3:50 PM

In the post Moore era, there is an urgent demand for miniaturization and changes in the manufacturing process of channel materials, insulating layers, and other components in transistors. In two-dimensional transistors, the surface and interface characteristics between the channel material and ultra-thin dielectric layer, as well as the performance of the dielectric layer, become the main limiting factors for the miniaturization of two-dimensional transistors. Using high dielectric constant oxides instead of silicon dioxide insulation layers can achieve lower equivalent oxide layer thicknesses, thereby improving device performance. In recent years, with the continuous development of two-dimensional ferroelectric semiconductor materials, the application of low defect and high-k dielectrics to regulate out-of-plane ferroelectric polarization flip of semiconductor materials has become a major research focus. Therefore, the development of a new synthesis method for two-dimensional high-quality and high-k gate dielectric layers is crucial for advancing the application of two-dimensional electronic devices and ferroelectric storage devices. In this report, the controllable preparation method of a two-dimensional non layered high-k single crystal CaNb2O6 dielectric material and its application in electronic devices are mainly introduced. At the same time, a brief introduction will be given to the atomic control strategies at the surface and interface of two-dimensional electrode materials, the control of ferroelectric phase states, and the structure-activity relationship between electronic device characteristics.

Design and Exploration of 2D Quantum Matters with Exotic Properties

Professor Yi Du[1]

[1]Beihang University, No. 9, South Third Street, Shahe Higher Education Park, Changping District, China

Session 07 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 8:30 AM - 10:05 AM

Designing and realizing two-dimensional lattices offers a powerful route to engineer electronic structure, strengthen interaction effects, and discover emergent quantum phenomena. By tailoring atomic arrangements, symmetry, and local coupling in two-dimensional (2D) systems, energy dispersion, spin textures, and correlated behaviours can be feasibly created and modulated. It thereby creates new opportunities for functional quantum states as well as novel applications. In this talk, I will present our recent efforts in 2D lattice engineering, in which atomic-scale design is used to control electronic and magnetic properties [1-6]. Combining advanced materials synthesis and scanning tunneling microscopy, angle-resolved photoemission spectroscopy, and first-principles calculations, we realized several novel quantum matters with 2D lattices, which can host unconventional electronic states and interaction-driven phenomena. I will further discuss same example 2D materials, including flat-band materials, 2D magnets, and multiferroics, with particular emphasis on the stabilization and manipulation of atomic, magnetic and Moiré lattices. Finally, I will show how coupling among charge, spin, and lattice degrees of freedom in designed 2D systems, which may provide a pathway toward multiferroicity and other multifunctional quantum states.

References

[1] Xi, Y., et al., J. Am. Chem. Soc.144,18887 (2022)
[2] Zhang, H., et al., Adv. Mater. 35, 2301790 (2023)
[3] Zhao, W., et al., Nat. Commun. 14, 8089 (2023)
[4] Yang, M., et al., Phys. Rev. Lett. 133, 256601 (2024)
[5] Zhong, J., et al., Nat. Commun. 16, 1163 (2025)
[6] Tian, D., et al., Nat. Mater. (2026) https://doi.org/10.1038/s41563-026-02537-2

July 16, 2026 | 8:50 AM

Neuron-Inspired Ferroelectric Bioelectronics

Professor Xuemin Du[1]

[1]Shenzhen Institute Of Advanced Technology (siat), Chinese Academy Of Sciences (cas), , China

Session 07 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 8:30 AM - 10:05 AM

Implantable bioelectronics, which are essential to neuroscience studies, neurological disorder treatment, and brain-machine interfaces, have become indispensable communication bridges between biological systems and the external world through sensing, monitoring, or manipulating bioelectrical signals. However, conventional implantable bioelectronic devices face key challenges in adaptive interfacing with neural tissues due to their lack of neuron-preferred properties and neuron-similar behaviors. Here, we report innovative neuron-inspired ferroelectric bioelectronics (FerroE) that consists of biocompatible polydopamine-modified barium titanate nanoparticles, ferroelectric poly(vinylidene fluoride-co-trifluoroethylene) copolymer, and cellular-scale micropyramid array structures, imparting adaptive interfacing with neural systems. These FerroE not only achieve neuron-preferred flexible and topographical properties, but also offer neuron-similar behaviors, including highly efficient and stable light-induced polarization change, superior capability of producing electric signals, and seamless integration & adaptive communication with neurons. Moreover, the FerroE allows for adaptive interfacing with both peripheral and central neural networks of mice, enabling regulation of their heart rate and motion behavior in a wireless, non-genetic, and non-contact manner. Notably, the FerroE demonstrates unprecedented structural & functional stability and negligible immune response even after 3 months of implantation in vivo. We can envision that such bioinspired FerroE would open new opportunities for next-generation brain-machine interfaces, tissue engineering materials, and biomedical devices.

Tunable threshold voltage of solution-processed metal oxide thin film transistors

Zai-xing Yang[1]

[1]Shandong University, shandabeilu 27#, China

Session 07 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 8:30 AM - 10:05 AM

Recently, the solution-processed metal oxide thin-film transistors (TFTs) have attracted extensive attention for large-area electronics, optoelectronics and neuromorphic computing, owing to their high mobility, high optical transparency, and excellent compatibility with low-temperature fabrication processes. With the rapid evolution of electronic systems from single device operation toward circuit-level integration, the precise control on basic electronical parameters of TFTs such as threshold voltage (VTH) has become particularly important. This is because VTH directly determines the operating mode, power consumption, and compatibility with circuit integration. In case of post-von Neumann applications, including neuromorphic computing, multi-level storage, and multiplexed sensing etc., the reliable and wide-range VTH tunability is also of crucial importance because it directly affects the weight accuracy, storage capacity and sensing accuracy etc.

In this talk, various strategies are proposed to modulate VTH of solution-processed metal oxide TFTs, including post-fabrication thermal annealing, chemical doping, and device-level structural design of homojunction films construction. In most cases, these approaches achieve VTH tuning by adjusting carrier concentration, defect-state distribution, or interfacial charge within the channel region. Specially, the solution-processed metal oxide homojunction films are formed by amorphous oxide semiconductors with similar chemical composition but distinct electronic properties, such as oxygen vacancy, carrier concentration, and Fermi-level position, which is beneficial to the built-in electric field between homojunction films along with electron redistribution. Furthermore, owing to the material continuity across junction, the homojunction interface generally exhibits good structural and electronic-state compatibility, thereby avoiding additional interfacial trap states. With tunable VTH, the TFTs can be constructed as inverters, multi-threshold signal encoding, logic computing and image denoising.

July 16, 2026 | 9:30 AM

Lead Salts Semiconductors-based Infrared Sensors

Professor Qisheng Wang[1]

[1]NanChang University, No.999 Xuefu Avenue, China

Session 07 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 8:30 AM - 10:05 AM

Traditional infrared semiconductors, i. e. HgCdTe, InGaAs, lead salt (PbS, PbSe, PbTe), have been commercialized for decades in infrared technologies, such as night vision, military communication and health monitoring. The direct narrow bandgap endows them with high sensitivity and ultrafast response. However, traditional infrared (specifically middle- and long-wave infrared) semiconductors always suffer from serious noise generated by thermal excitation. Although thermal infrared detectors are able to operate at room temperature, their response speed is slow, typically in the order of milliseconds or worse, which limits their application fields. Herein, we reinvent the classical lead salt semiconductor, i.e. PbS and PbSe, as the room-temperature high-performance infrared detector. We first report the growth of wafer-scale single-crystalline lead salts thin film with controllable fabrication of large-area detectors array. Then we show a new detection mechanism of the optical hot carriers-dominated energy conversion in lead salts thin film. This mechanism enables the self-driven (no bias voltage necessary) and ultrafast photo-thermoelectric (PTE) response up to 500 ns (limited by the measurement setup)-there orders of magnitude faster than commercial PTE and photoconductive PbS and PbSe detector. Together with room temperature high sensitivity (D*=1.1×1010 cm Hz1/2 W-1@4.0 μm) and broadband detection range (0.4-5.0 μm), the traditional commercial semiconductor PbS and PbSe is promising to generate a novel infrared detection application such as room-temperature infrared detection, imaging, and positioning. Then we integrate the leads salts thin film with emerging two-dimensional materials (MoS2), fully inorganic perovskite (CsPbBr3) or graphene which exhibit exotic optoelectronic behavior . The nonvolatile and reconfigurable short-wave infrared memory, broadband photodetectors have been achieved in PbS/MoS2 and PbS/CsPbBr3 semiconductors heterojunctions respectively.

July 16, 2026 | 9:50 AM

Design and comparison of AlN/ε-Ga2O3 and AlScN/ε-Ga2O3 Heterostructure High electron mobility transistor

Master Ya-Hsuan Chen[2], Chair Professor Ray-Hua Horng[1], PhD Chih-Yang Huang[2], **Chih-Jou Tseng**[1]

[1] Institute of Electronics,National Yang Ming Chiao Tung University, No. 1001, University Road, Taiwan, [2]Institute of Pioneer Semiconductor Innovation,National Yang Ming Chiao Tung University, No. 1001, University Road, Taiwan

Session 07 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 8:30 AM - 10:05 AM

This study aims to design and compare advanced ε-Ga_2O_3-based ultra-wide bandgap high electron mobility transistors (HEMTs), deeply investigating the physical mechanisms and electrical characteristics of AlN/ε-Ga_2O_3 and AlScN/ε-Ga_2O_3 heterostructures. Possessing an exceptionally high critical breakdown field, a superior Baliga's figure of merit, and inherently being a spontaneous polarization material, ε-Ga_2O_3 serves as an ideal channel material for high-power devices. Based on this, AlN and AlScN are respectively introduced as barrier layers for a comparative analysis. The results indicate that a pure AlN barrier layer can already induce a two-dimensional electron gas (2DEG) at the heterointerface through polarization effects; however, doping aluminum nitride with scandium (Sc) to form an AlScN barrier layer can further significantly enhance the spontaneous polarization strength. This polarization enhancement effect enables the AlScN/ε-Ga_2O_3 structure to exhibit a higher 2DEG concentration and a more superior drain current density than the AlN/ε-Ga_2O_3 structure. Through a comprehensive comparative analysis, this research clarifies the advantages, disadvantages, and trade-offs of the two structures in terms of band alignment, carrier mobility, and breakdown voltage, providing crucial design guidelines for the structural optimization of future high-power electronics and high-frequency microwave devices.

Ferroelectric devices for in-memory computing

Prof Bobo Tian[1]

[1]East China Normal University, Dongchuan Road 500, Shanghai, China

Session 08 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

In recent years, the emergence of numerous applications of artificial intelligence (AI) has sparked a new technological revolution. These applications include facial recognition, autonomous driving, intelligent robotics, and image restoration. However, in the conventional von Neumann architecture, the data processing and storage procedures are discrete, leading to the “memory wall” problem. Therefore, this architecture is incompatible with AI requirements for efficient and sustainable processing. Exploring new computing architectures and material bases is thus imperative. Inspired by neurobiological systems, in-memory and in-sensor computing technologies provide a new means of overcoming the limitations inherent in the von Neumann architecture. The basis of neural morphological computation is a crossbar array of high-density, high-efficiency nonvolatile memory devices. Of the numerous candidate memory devices, ferroelectric memory devices with nonvolatile polarization states, low power consumption, and strong endurance are expected to be ideal candidates for neuromorphic computing. Here I give a talk based on our recent reports about ferroelectric in-memory computing devices[1-5].

1. Feng, G. et al. Nat. Commun. 16, 3027 (2025)
2. Feng, G. et al. Nat. Commun. 15, 9701 (2024)
3. Feng, G. et al. Nat. Commun. 15, 513 (2024)
4. Wu, G. et al. Nat. Mater. 22, 1499 (2023)
5. Wu, G. et al. Nat. Electron. 3, 43 (2020)

Modulating Ferroelectricity in van der Waals Moiré Superlattices

Prof. Yangbo Zhou[1]

[1]Nanchang University, 999 Xuefu Road, China

Session 08 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Moiré superlattices have emerged as a new and cutting-edge frontier in two-dimensional material research in recent years, providing a novel platform for understanding electronic interactions in low-dimensional systems. Using piezoresponse force microscopy, we systematically investigated ferroelectric polarization behaviors in van der Waals moiré superlattices with minimal twist angles (<1°). Firstly, in two-dimensional hexagonal boron nitride (hBN) superlattices, we introduced structures with asymmetric thickness to enhance the material's flexoelectric effect, resulting in unique hollow ferroelectric moiré domain structures. For the first time, we directly observed the coexistence of flexoelectricity and ferroelectricity in Moiré systems. External stress application enables effective modulation of both the orientation and strength of the moiré ferroelectric polarization. Secondly, in twisted bilayer rhombohedral-stacked tungsten diselenide (WSe_2) superlattices with broken inversion symmetry, not only vertical ferroelectric domains exist, but in-plane lateral polarization can also be induced. This lateral polarization (LP) surrounds the vertical polarization (VP), forming a network of Bloch-type merons and antimerons. Our study enhances the understanding of domain distribution and polarization direction in moiré ferroelectrics, opening up new pathways for the precise modulation of moiré ferroelectricity.

Observation and manipulation of 2D topological polar texture confined in moiré interface

Er Pan[1]

[1]University Of Electronic Science And Technology Of China, No.2006, Xiyuan Ave, West Hi-Tech Zone, Chengdu, Sichuan, China, China

Session 08 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Topological polarization structures in ferroelectric thin films have emerged as a vibrant research frontier. Due to the complex balance between intrinsic dipole anisotropy and applied (electrical and mechanical) boundary conditions, topological polarization domains primarily form in complex oxides. Recently discovered sliding ferroelectrics provide an intriguing platform for investigating topological polarization domains. The intrinsic interfacial charge transfer in these materials confines polarization to the stacking interface, naturally introducing polarization discontinuities and promoting strong coupling between polarization and lattice.

In this study, we employed precisely selected AC drive frequencies and amplitudes to enhance the signal-to-noise ratio (SNR) and suppress crosstalk from non-ferroelectric signals, ensuring reliable piezoresponse measurements in sliding ferroelectrics. Using the optimized PFM approach, we constructed local in-plane piezoresponse vector maps from angle-resolved LPFM amplitude and phase images. In the upper triangular region, the in-plane polarization vectors exhibit a counterclockwise rotation pattern, while in the lower triangular region they rotate clockwise, forming Bloch-type meron-like domain structures. Further, we investigated the periodic variations of twisted BN (t-BN) samples at different twist angles. As the twist angle decreases from 0.09° to 0.028°, the size of the topological texture network composed of Bloch-type merons gradually expands. Moreover, by applying local stress via the PFM probe, we studied the evolution of the Bloch-type meron network at the t-BN twisted interface. After stress application, the area of the topological texture changes, while fundamental topological features (winding number, divergence, and curl) remain stable, demonstrating robustness and nonvolatility.

As the topological polar structures are fully confined at the moiré interface, 3D stacking of different topological layers with coupled/decoupled vertical interaction is very straightforward for potential high-density storage and coupling between different topological textures. This work delves into the topological textures in ultrathin 2D sliding ferroelectrics, revealing its potential for the advancement of next-generation electronic devices.

Spatial confinement hot carrier beyond unity quantum efficiency detection

Doctor Yu Wan[1]

[1]NanChang University, No. 999, Xuefu Road,, China

Session 08 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Photon harvesting and conversion in semiconductors hold critical scientific and technological value due to their wide-ranging applications, including optoelectronics, renewable energy, and thermal management. However, the efficiency of optical-to-electrical energy conversion is fundamentally limited by the rapid relaxation of thermalized carriers. Herein, we propose a spatially confinement photoexcited hot carrier effect in a T-shape lead selenide (PbSe), in which an external quantum efficiency (EQE) increases by one order of magnitude as the device channel width decreases from one hundred to ten micrometers. The spatial confinement-induced local phonon scattering enhances the phonon bottleneck effect, which impedes the hot-carrier relaxation pathways via longitudinal optical (LO) phonons emission. Thus, thermalized carriers with extended relaxation lifetime promote a great increase in photovoltage. This spatially confinement-boosted effect enables PbSe detectors a room temperature greater-than-unity EQE in the short-wave infrared range and a peak detectivity (D*) of 6.3×1010 cm Hz1/2 W-1 under blackbody irradiation. Further, the T-shape focal plane array with 5.6×10-6 % non-uniformity achieve a fast response speed (33.8 μs) in the mid-wave infrared range and blackbody irradiation source imaging without external voltage bias. This work establishes a transformative pathway for achieving high-efficiency photodetection and energy conversion technologies.

July 16, 2026 | 1:30 PM

Room-temperature electrically switchable spin-valley coupling in a van der Waals ferroelectric halide perovskite

Professor Jie Jiang[1,2]

[1]Zhejiang University, , China, [2]Institute of Wenzhou, Zhejiang University, , China

Session 09 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Spintronic devices, by harnessing the spin degree of freedom, are expected to outperform charge-based devices in terms of energy efficiency and speed of operation. The use of an electric field to control spin at room temperature has been pursued for decades. A major hurdle that has contributed to the slow progress in this regard is the dilemma between effective control and strong spin relaxation. For example, in a Rashba/Dresselhaus material with strong spin-orbit coupling, although the internal magnetic field could be substantial enough to effectively control spin precession, often, the spin-relaxation time becomes extremely short as a consequence of Dyakonov-Perel scattering. To address this, a persistent spin helix has been proposed in systems with SU(2) symmetry. Here we show the discovery of the persistent spin helix in an organic-inorganic hybrid ferroelectric halide perovskite whose layered nature makes it intrinsically like a quantum well. We demonstrate that the spin-polarized band structure is switchable at room temperature via an intrinsic ferroelectric field. We reveal valley-spin coupling through a circular photogalvanic effect in single-crystalline bulk crystals. The favoured short spin helix wavelength (three orders of magnitude shorter than in III-V materials), room-temperature operation and non-volatility make the hybrid perovskite an ideal platform for understanding symmetry-tuned spin dynamics, towards designing practical spintronic materials and devices that can resolve the control-relaxation dilemma.

Harnessing Interfaces to Tailor Phase Transitions, Polarization, and Toughness in 2D Ferroelectrics

Professor Jiong Zhao, **Professor Xiaodong Zheng**
[1]Hebei University of Technology, No. 5340, Xiping Road, Beichen Distric, China, [2]The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, China
Session 09 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Two-dimensional (2D) ferroelectric materials, which exhibit switchable polarization under an electric field, are promising for next-generation memory devices due to their ability to maintain ferroelectricity even at atomic thickness and its flexibility. However, achieving large-area, phase-controllable growth and effective polarization modulation in such materials remains challenging. Here, by employing in situ transmission electron microscopy, we reveal a strain-governed phase transition mechanism in 2D ferroelectric In_2Se_3 and realize the phase-controlled synthesis of two distinct polymorphs: α-In_2Se_3, exhibiting both in-plane and out-of-plane polarization, and β′-In_2Se_3, displaying in-plane antiferroelectricity. Furthermore, through precise control of the interlayer twist angle, we constructed nanometer-scale in-plane vortex polarization domains whose size can be tuned by the twist angle. At a twist angle of 30°, a quasicrystalline vortex configuration emerges, and in situ manipulation of the ferroelectric domain was demonstrated. Finally, we discover that the toughness of 2D materials can be enhanced without compromising strength via layer twisting. Through in situ scanning transmission electron microscopy, supported by nanoindentation and theoretical analysis, we demonstrate that twisted bilayer architectures promote sequential fracture events: initial cracks heal to form stable grain boundaries, which subsequently shield advancing crack tips from stress concentration. This process dissipates additional energy compared to conventional fracture, with the extent of toughening being adjustable via the twist angle. Collectively, these findings provide new pathways to engineer advanced flexible and memory devices based on 2D ferroelectric materials.

BPVE Synaptic Array in BiFeO3 for Polarization-Sensitive In-Sensor Computing

Professor Lin Sun[1]

[1]East China Normal University, Road Dongchuan 500#, China

Session 09 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Compared with the conventional photovoltaic effect in semiconductor p–n junctions, the bulk photovoltaic effect (BPVE), originating from broken inversion symmetry, exhibits a unique sensitivity to light polarization. In ferroelectric materials, domains can be dynamically tuned by an external electric field, which alters the crystal symmetry and enables electric-field control of the BPVE. Although the BPVE has been widely studied in various ferroelectric materials, the electric-field control of BPVE remains largely unexplored, leading to the lack of understanding for its field-dependent behavior. Moreover, the combination of gradual ferroelectric domain switching under an electric field and the polarization-resolved nature of the BPVE suggests the potential for realizing polarization-sensitive in-sensor computing, which has rare been explored.

Our group has extensively investigated the ferroelectric photovoltaic effect in $BiFeO_3$ (BFO) epitaxial films [1–3]. In this talk, we present the experimental phenomena and underlying mechanisms of electric-field-controlled BPVE in BFO epitaxial films, and further demonstrate polarization-resolved BPVE synaptic arrays. Planar synaptic devices were fabricated using [001] and [111]-oriented BFO epitaxial films. Under an external electric field, the BPVE in [001]-oriented devices exhibits simultaneous modulation of amplitude and phase, while the amplitude and phase in [111]-oriented devices remain unchanged but the BPVE response undergoes a rigid shift. These results indicate that the crystallographic orientation governs the mechanism of electric-field control of the BPVE in BFO films. Based on this mechanism, we further fabricated a 4×4 polarization-resolved ferroelectric photovoltaic synaptic array, demonstrating both simple classification and polarization-resolved sensing functions. These results provide deep insights into the electric-field control of BPVE in ferroelectrics and highlight its potential for polarization-sensitive vision systems with in-sensor computing architectures.

References

[1] Phys. Rev. Appl., 19, 024050 (2023).

[2] Adv. Mater., 37, 2414113 (2024).

[3] Appl. Phys. Lett., 127,142904 (2025).

July 16, 2026 | 2:30 PM

Ferroelectric optoelectronic sensor for intelligent flame detection and in-sensor motion perception

Prof. Wei Han[1]

[1]Hubei University, , China

Session 09 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Next-generation fire safety systems demand precise detection and motion recognition of flames. In-sensor computing, which integrates sensing, memory, and processing capabilities, has emerged as a key technology in flame detection. However, the implementation of hardware-level functional demonstrations based on artificial vision systems in the solar-blind ultraviolet (UV) band (200-280 nm) is hindered by the weak detection capability. Here, we propose Ga2O3/In2Se3 heterojunctions for the ferroelectric (abbreviation: Fe) opto-electronic sensor (abbreviation: OES) array (5×5 pixels), which is capable of ultraweak UV light detection with an ultra-high detectivity through ferroelectric regulation and features in configurable multi-mode functionality. The Fe-OES array can directly sense different flame motions and simulate the non-spiking gradient neurons of insect visual system. Moreover, the flame signal can be effectively amplified in combination with leaky integration-and-fire (LIF) neuron hardware. Using this Fe-OES system and neuromorphic hardware, we successfully demonstrate three flame processing tasks: achieving efficient flame detection across all time periods with terminal and cloud-based alarms; flame motion recognition with a lightweight convolutional neural network achieving 96.47% accuracy; and flame light recognition with 90.51% accuracy by means of a photosensitive artificial neural system. This work provides effective tools and approaches for addressing a variety of complex flame detection tasks.

July 16, 2026 | 2:50 PM

High-Quality AlN Thin Films Grown by HiPIMS: A Comparative Analysis with Conventional DC and RF Sputtering

Ya-Hsuan Chen[1], Master Chih-Jou Tseng[2], PhD Chih-Yang Huang[1], Chair Professor Ray-Hua Horng[2]

[1]Institute of Pioneer Semiconductor Innovation, National Yang Ming Chiao Tung University, No. 1001, University Road, Taiwan, [2]Institute of Electronics, National Yang Ming Chiao Tung University, No. 1001, University Road, Taiwan

Session 09 - S07: Ferroelectric Films & Functional Devices (FFF), Boardroom - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

This study conducts a comprehensive comparative analysis of aluminum nitride (AlN) thin films grown on sapphire substrates using High-Power Impulse Magnetron Sputtering (HiPIMS), Direct Current (DC) sputtering, and Radio Frequency (RF) sputtering. Conventional reactive DC sputtering is susceptible to target poisoning and micro-particle contamination, while RF sputtering is limited by low deposition rates, hindering industrial mass production. In contrast, HiPIMS effectively overcomes these limitations by leveraging its exceptionally high peak power density and metal ionization rate. By systematically modulating pulse parameters (e.g., on/off ratio), sputtering power, and the N_2/Al gas ratio, this study successfully optimizes film quality. Experimental results demonstrate that the intense high-energy ion bombardment induced by HiPIMS significantly enhances surface adatom mobility. This energetic process facilitates the formation of a highly oriented (0002) crystalline structure at relatively low substrate temperatures. Consequently, the X-ray diffraction (002) peak full width at half maximum (FWHM) of HiPIMS-grown films is significantly narrower than that of DC-sputtered films. Furthermore, AlN films deposited via HiPIMS exhibit superior surface flatness, extremely low roughness, enhanced optical transparency in the deep-ultraviolet region, and excellent mechanical stability. In summary, HiPIMS combines high deposition efficiency with process stability, providing an outstanding technical solution for the low-temperature growth of high-quality AlN templates, thereby laying a solid foundation for next-generation wide-bandgap power electronics and deep-ultraviolet optoelectronic devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Interlayer Self-Doping Multiferroics

Yunhao Lu[1]

[1]Zhejiang University, , China

Poster Session - S07: Ferroelectric Films & Functional Devices (FFF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Multiferroic materials are noteworthy for their simultaneous possession of two or more ferroelectric properties, such as ferroelectricity and ferromagnetism. Based on first-principles calculations and utilizing orbital interactions, we demonstrated the anomalous phenomenon of carrier doping-enhanced polarization in a class of layered ferroelectric systems, and designed a class of two-dimensional multiferroic material systems based on this. In our latest research, we theoretically predicted and experimentally confirmed two-dimensional multiferroic metallic systems caused by the splitting difference in interlayer orbital energy levels, and also demonstrated the coupling effect of ferroelastic and antiferromagnetic order caused by orbital interactions in staggered magnets. These principles provide new insights for the development of next-generation ferroic quantum devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Parametric Analysis and Characterization of Double-Gate Junctionless Ferroelectric FETs with HfZrO2 for Low-Power Memory Applications

Mrs Harsha Ragini Aturi[1], Dr RAMANA MURTHY Gajula[1]

[1]Alliance University, Chikkahagade Cross, Chandapura - Anekal Main Road, Anekal, , India

Poster Session - S07: Ferroelectric Films & Functional Devices (FFF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This work presents a comprehensive parametric analysis and compact drain current model for double-gate junctionless ferroelectric field-effect transistors (DG-JL-FeFETs), leveraging hafnium zirconium oxide ($HfZrO_2$) thin films as the ferroelectric material. This novel architecture synergistically combines the simplicity and low-voltage operation of junctionless (JL) transistors with the negative capacitance (NC) effect of ferroelectrics, enabling steep subthreshold slopes and enhanced memory performance. The model employs symmetric gate stacks with tunable $HfZrO_2$ layer thicknesses (5–20 nm) and undoped silicon channel thicknesses (5–20 nm). Derived using the Landau-Khalatnikov equation for ferroelectric polarization dynamics and the parabolic potential approximation, it accurately captures device behavior across linear, saturation, and subthreshold regions. Key extracted parameters include mobile charge density (Qm), surface potential (ϕs), threshold voltage shift (ΔVth), and gate capacitance (Cg).

Results demonstrate DG-JL-FeFETs functioning as step-up voltage transformers, achieving subthreshold slopes below 60 mV/dec, surpassing the Boltzmann limit, due to NC amplification. The ferroelectric layer mitigates JL transistor variability from dopant fluctuations, yielding a good memory window, on/off ratio >{10}^7, and optimized subthreshold swing of ~60 mV/dec. Parametric sweeps show that thicker $HfZrO_2$ (5–20 nm) expands the memory window by strengthening ferroelectric coupling, while thinner channels (20–5 nm) enhance gate control, reducing swing.

Analytical predictions align closely with Silvaco ATLAS TCAD simulations, validating the model's fidelity across operating regimes. These findings furnish critical design guidelines for $HfZrO_2$ thin-film FeFETs in non-volatile memory, neuromorphic computing, and low-power electronics, paving the way for scalable beyond-CMOS technologies.

On the micromechanics of refractory-metal-based high entropy nitrides

Lukáš Vrána[1], Thomas Edwards[2], **Professor Pavel Souček**[1]
[1]Masaryk University, , Czech Republic, [2]National Institute for Materials Science, , Japan
Session 09 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 1:30 PM - 2:50 PM

Since the Bronze Age, new alloys have traditionally been developed by alloying a single principal element with small amounts of additional elements. The resulting properties are therefore largely governed by the base element, while alloying additions are used to enhance desirable characteristics or suppress unfavourable ones. In 2004, a fundamentally new paradigm for alloy design was introduced, abandoning the concept of a single principal element in favour of multiple principal elements in near-equiatomic ratios. These so-called baseless or multi-principal-element alloys increase the entropic contribution to the Gibbs free energy, enabling the formation of chemically complex yet structurally simple solid solutions. When five or more principal elements are employed, such materials are referred to as high-entropy alloys.

In this contribution, we focus on medium- and high-entropy nitride coatings based on refractory metals, specifically Cr, Mn, and Mo, which exhibit similar atomic radii, alloyed with Si and Y characterised by a large atomic size mismatch. This material system deliberately combines high atomic-radius mismatch with elements exhibiting both strong and weak nitride-forming tendencies, as well as distinct bonding characteristics, thereby probing the limits of entropy-driven stabilisation.

The micromechanical response of the coatings is investigated in detail using micropillar compression tests at both ambient and elevated temperatures, complemented by micropillar splitting experiments to elucidate fracture toughness. These mechanical tests are accompanied by comprehensive analyses of temperature-induced structural evolution. Together, these approaches enable a detailed description of the deformation and failure mechanisms governing Cr–Mn–Mo–Si–Y–N medium- and high-entropy nitride coatings.

July 16, 2026 | 1:50 PM

Entropy-Engineered MnAlCrCoCu High-Entropy Alloy/CNT Flexible Thin Films for Efficient Water Splitting and Hydrogen Generation

Mr. Aswini Kumar Nath[1], Prof. Po-Chih Yang[1], Prof. Chien-Te Hsieh[1]

[1]Yuan Ze University, No. 135 號, Yuandong Rd, Zhongli District, Taoyuan City, 320, Taiwan

Session 09 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 1:30 PM - 2:50 PM

The successful development of efficient electrocatalysts for water splitting requires an optimal balance between catalytic activity, reaction kinetics, durability, and cost. Although transition-metal catalysts have emerged as promising alternatives to noble metals, their practical application is often limited by sluggish charge-transfer kinetics and poor structural durability under operational conditions. In this work, we systematically investigate the entropy-driven catalytic enhancement of flexible high-entropy alloy (HEA) thin-film electrodes composed of Mn, Al, Cr, Co, and Cu integrated with conductive carbon nanotube (CNT) networks for hydrogen and oxygen evolution reactions in alkaline media. HEA nanoparticles were synthesized via a rapid microwave-assisted alloying process, followed by spin coating deposition onto carbon cloth substrates to fabricate binder-free binary, ternary, quaternary, and quinary HEA/CNT thin films. X-ray diffraction analysis confirms nanocrystalline mixed-oxide phases with partial alloying, producing defect-rich surfaces and catalytically active oxide-metal interfaces that enhance electrochemical catalytic performance. Compared to lower-entropy compositions, the quinary HEA/C thin film exhibits significantly enhanced catalytic performance, delivering noticeably reduced overpotential and faster reaction kinetics for both hydrogen evolution reaction (HER) and oxygen evolution reaction (OER). Tafel analysis demonstrates lower slope, improved reaction pathways and accelerated charge-transfer processes, while electrochemical impedance spectroscopy confirms a substantially reduced charge-transfer resistance (Rct) 2.8 Ω in oxygen atmosphere, highlighting efficient electron transport facilitated by the CNT conductive framework and multi-metallic synergy. Furthermore, the quinary HEA electrode exhibits superior durability compared with binary and ternary counterparts, overcoming typical activity-stability trade-offs in thin-film electrocatalysts. This enhanced performance originates from entropy-induced lattice distortion, optimized electronic structure, increased electrochemically active surface area, and strong mechanical adhesion of spin-coated films on carbon substrates. This work elucidates entropy-engineered catalytic mechanisms and presents a scalable approach for developing low cost high-entropy electrodes with superior catalytic

efficiency for sustainable hydrogen generation and renewable energy conversion systems.

Energy-modulated structural evolution in amorphous alloys

Xing Tong1

1Songshan Lake Materials Laboratory, , China, 2Dongguan Institute of Materials Science and Technology,CAS, , China

Session 10 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 3:45 PM - 4:45 PM

Understanding how energy input modulates structures in metallic glasses is central to tailoring their functional properties. Here we present a systematic study on energy-controlled structural evolution in Fe-rich amorphous alloys, combining low-heating-rate annealing and pulse-current training (PCT). Compositionally optimized Fe-Si-B-P-Cu-C alloys exhibit enlarged glass-forming ability and a broad relaxation window, enabling uniform nanocrystallization under slow thermal activation. In bulk toroidal geometries, low-rate annealing suppresses crystallization gradients and promotes homogeneous α-Fe(Si) precipitation with refined grain size. Beyond conventional thermal pathways, PCT introduces a distinct energy-injection mode via internally generated pulsed Joule heating. Repeated short activation-relaxation cycles drive cooperative atomic rearrangement in the amorphous matrix, reduce quenched-in structural heterogeneity, and weaken magnetic domain-wall pinning without inducing bulk crystallization. Structural analyses reveal enhanced medium-range ordering and improved exchange coupling after PCT. These results highlight that the mode and temporal profile of energy delivery, rather than heating rate alone, critically determine the relaxation trajectory on the potential-energy landscape. The work provides a unified perspective on structural modulation in metallic glasses through tailored energy pathways.

Multi-scale guided optimization of (Hf-Zr-Ta-Nb)C coatings above 2000 °C: Element, Composition and Ablation property

Ms Xiaoxuan Li[1], Prof. Qiangang Fu[1]

[1]Northwestern Polytechnical University, 127 West Youyi Road, Beilin District, China

Session 09 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 1:30 PM - 2:50 PM

Traditional composition design of UHTCs for extreme anti-oxidation applications seriously relies on experience-based trial-and-error process towards different service temperatures (>2000°C). The vast element design space (e.g. Hf, Zr, Ta, and Nb) and potential synergistic effects empowers significant performance response. We innovatively proposed an analytical design strategy to construct the “Environment-Composition-Performance” feature relationship based on multi-scale simulation techniques. Take the (Hf-Zr-Ta-Nb)C high-entropy ceramic system as an example, the high-enthalpy heat flow was firstly reconstructed by chemical reaction process (Fluent), followed by the first-principles analysis (DFT) to reveal the enrichment effect of Ta and Nb in HfO_2 and ZrO_2 lattices and structural instability process (MD). Guided by the preferred composition range and further experiment verification on the evolution of oxide scales, the optimized $(Hf_{0.45}Zr_{0.45}Nb_{0.1})C$ coating demonstrated the superior long-term ablation resistance at ~2000 °C (> 300 s) with a near-zero linear ablation rates. This work clarifies the regulation effect of element content on the integrity of oxide scale and provides a robust framework for the rational design and protective mechanism of multi-principal element ceramics.

July 16, 2026 | 2:35 PM

Enhancing CFRP drilling performance using multi-layer ta-C coatings: morphological, mechanical, and tribological evaluation

Wenxuan Zhao[1], Feng Xu[1], Xianqing Shi[1], Chengzuan Gao[2], Yuan Liu[1], Yanchao Zhao[3], Dunwen Zuo[1]

[1]Nanjing University of Aeronautics and Astronautics, , China, [2]Changzhou Institute of Technology, , China, [3]Tongling University, , China

Session 09 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 1:30 PM - 2:50 PM

Carbon fiber reinforced polymer (CFRP) composites are increasingly employed in aerospace, energy, transportation, and other advanced engineering fields due to their high specific strength and excellent structural reliability. In this study, multilayer Cr/ta-C coatings with different numbers of ta-C functional layers were designed and systematically compared, revealing the existence of an optimal layer-number window for stabilizing sp3 bonding and regulating interfacial stress in multilayer ta-C architectures. The results demonstrate that the double-layer ta-C coating achieves an optimal balance between bonding configuration and internal stress state, exhibiting a moderate compressive residual stress (−3.81 GPa) and the highest interfacial adhesion, with the critical load LC1 increased to 23.8 N. Further CFRP drilling experiments reveal that micro-drills coated with the double-layer ta-C structure maintain superior coating integrity at the cutting edge and promote the formation of a stable resin-rich transfer layer during drilling, which effectively reduces interfacial friction, suppresses edge micro-chipping, and preserves hole-exit quality. These findings provide both experimental evidence and mechanistic insights for the structural optimization of multilayer ta-C coatings toward efficient and stable CFRP drilling applications.

Structures and Properties of CrMoNbSiC High-Entropy Films Prepared by Magnetron Sputtering

PhD Jiasheng Wang[1], Professor Yong Zhang[1]

[1]State Key Laboratory for Advanced Metals and Materials, University of Science and Technology Beijing, , China

Session 10 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 3:45 PM - 4:45 PM

Multicomponent amorphous high-entropy thin films are highly promising candidates for high-temperature protective coatings, yet the mechanistic roles of deposition-induced densification and elemental volatility in controlling oxidation stability under harsh conditions remain poorly understood. In this work, CrMoNbSiC high-entropy amorphous films were prepared via direct-current magnetron sputtering, with deposition rates and thicknesses systematically varied to uncover the structure-property-oxidation relationships in extreme thermal environments. All as-deposited films feature a fully amorphous structure, smooth and dense morphologies, and uniform elemental distribution. A higher deposition rate enhances film densification via intensified atomic peening, yielding stable nano-hardness (~20 GPa) and elastic modulus (~265 GPa), as well as significantly improved corrosion resistance in 3.5 wt.% NaCl solution. Crucially, film densification plays a dominant role in regulating high-temperature oxidation behavior. At 800 °C, dense films form fine, uniform and continuous oxide scales that limit oxygen inward diffusion, effectively suppressing oxidation-induced buckling and morphological instability. In contrast, oxidation at 1000 °C accelerates scale growth, triggers severe Mo volatilization and C depletion, leading to thickened, inhomogeneous oxide scales and failed protective performance, particularly in low-deposition-rate films with poor compactness. Results confirm that deposition-rate-controlled densification is a key factor governing oxide scale morphology and stress accommodation in amorphous high-entropy films, while Mo volatility and limited film thickness act as intrinsic limiting factors at ultra-high temperatures. This work provides key mechanistic insights and a rational design strategy for optimizing multicomponent amorphous high-entropy coatings, supporting their high-temperature protective applications in aerospace and energy fields.

July 16, 2026 | 4:00 PM

Tribological and Adhesion Behaviour of Cold-Sprayed Ti-HEA Composite Coatings on Laser-Textured SS316L

Mr J Sharath Kumar[1], Dr Rajeev Verma[1], Dr Rakesh Kumar[1]

[1]Dr B R Ambedkar National Institute of Technology Jalandhar, GT bypass road, amristar highway, jalandhar, punjab-144008, India

Session 10 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 3:45 PM - 4:45 PM

High-entropy alloys (HEAs) have emerged as promising candidates for surface engineering in biomedical implants due to their excellent mechanical strength and wear resistance. In this work, Ti-CoCuFeNbMo HEA composite coatings were deposited on SS316L substrates using the high-pressure cold spray process, with two reinforcement levels: Ti-10%HEA. The tribological performance of the coatings was systematically investigated through microhardness, scratch adhesion, and dry sliding wear tests. Both composite coatings exhibited significantly enhanced hardness and improved resistance to material removal compared to the uncoated substrate. Frictional response and scratch behaviour indicated that the incorporation of HEA particles improved splat interlocking and coating cohesion, thereby increasing resistance to sliding and delaying crack initiation. The influence of substrate surface condition was also examined by comparing mirror-polished and laser-textured substrates, revealing improved interfacial adhesion and tribological stability on textured surfaces. Microstructural analysis using FE-SEM confirmed dense coating formation without macroscopic delamination, while the Ti–50% HEA coating exhibited relatively higher porosity, which may be beneficial for osseointegration despite its effect on wear mechanisms. Overall, the results demonstrate that cold-sprayed Ti-HEA composite coatings offer a promising pathway for enhancing the tribological durability of biomedical implant surfaces.

July 16, 2026 | 4:15 PM

Mechanical properties and wear behavior of high entropy (TiZrHfCrW)Nx coatings

Hsiu-ming Chang[1], Dr. Yung-I Chen[1], Dr. Li-Chun Chang[2]

[1]National Taiwan Ocean University, No.2, Beining Rd., Zhongzheng Dist., Keelung City 202301, Taiwan (R.O.C.)., Taiwan, [2]Ming Chi University of Technology, 84 Gungjuan Rd., Taishan Dist., New Taipei City 243303, Taiwan (R.O.C.)., Taiwan

Session 10 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 3:45 PM - 4:45 PM

In this study, (TiZrHfCrW)Nx coatings were deposited by magnetron cosputtering. The sputter powers for TiZr and Hf targets were set at 160 and 100 W, respectively, and the power applied to the CrW target was controlled at 25, 35, 45, and 55 W. The effects of composition variation on structure, mechanical properties, and wear behavior were systematically investigated. Increasing CrW target power raised the combined Cr and W content from 12.6 to 24.4 at.%, and decreased the nitrogen content from 43.8 to 41.5 at.% due to the low affinity between N and W. All the (TiZrHfCrW)Nx coatings exhibited an FCC phase and hardness and elastic modulus values of 25.0–27.6 and 293–308 GPa, respectively. The decreased tendency for hardness variation was observed for the films prepared using CrW target powers of >45 W, which was accompanied by the residual stress changed from compressive to tensile. The wear tests showed that the (TiZrHfCrW)Nx sample prepared with CrW target powers of 35–55 W exhibited low wear rates of 2–4 × 10-5 mm3/Nm, whereas the sample prepared with a CrW target power of 25 W was worn-through.

Study on Electrochemical and Tribological Properties of ReCN Coatings Prepared by Magnetron Sputtering

Yuan Liu[1], Feng Xu[1], Ming Zhou[2], Huilun Cheng[2], Wenxuan Zhao[1], Chengzuan Gao[3], Xianqing Shi[1], Dunwen Zuo[1]

[1]Nanjing University of Aeronautics and Astronautics, , China, [2]Tongguan Youchuang Special Materials Co., Ltd, , China, [3]Changzhou Institute of Technology, , China

Session 10 - S08: High Entropy and Amorphous Coatings (HEA), Seletar2 - Level 3, July 16, 2026, 3:45 PM - 4:45 PM

This study focuses on rhenium carbonitride (ReCN) coatings deposited on 15-5PH stainless steel and silicon wafers via pulsed DC magnetron sputtering, investigating nitrogen and carbon content regulation of their microstructural evolution and comprehensive properties. By adjusting the N_2/Ar flow ratio (fixed at 50:150 sccm), coatings with stable nitrogen content were prepared, and C_2H_2 flow rate (2–8 sccm) was further tuned to fabricate ReCN coatings (C2–C8) with gradient carbon contents. XRD, XPS, nanoindentation, tribological and electrochemical tests confirm the coatings are mainly composed of Re, ReC and ReN phases. With rising C_2H_2 flow, Re content decreases sharply while C content increases, coating thickness rises to 2.03 μm, and surface roughness is reduced. Mechanical tests show hardness and elastic modulus decrease with increasing C_2H_2 flow, yet fracture toughness and H^3/E^2 are enhanced significantly, with C8 reaching 14.61 MPa·m1/2 and 0.0462. Electrochemically, all ReCN coatings exhibit far better corrosion resistance than the substrate; C8 achieves the highest Ecorr (-0.14 V), lowest icorr (4.90×10-7 A) and maximum Rp (7.11×105 Ω). Tribologically, ReCN coatings remarkably lower the substrate's friction coefficient and wear rate, with C6 and C8 showing superior tribological performance. This work clarifies the gas flow-regulated structure-property relationship of ReCN coatings, providing experimental support for their engineering application in wear-corrosion coupling extreme environments.

Effects of substrate temperature and bias voltage on mechanical properties and corrosion resistance of (TiZrHfTa)SiyNx films

Yan-Zhi Liao[1], Dr. Li-Chun Chang[2], Guan-Ting Lu[1], **Dr. Yung-I Chen**[1]

[1]National Taiwan Ocean University, , Taiwan, [2]Ming Chi University of Technology, , Taiwan

Poster Session - S08: High Entropy and Amorphous Coatings (HEA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study investigated the influences of substrate temperature and bias voltage on the structures, mechanical properties, and corrosion resistances of (TiZrHfTaSi)Nx films. The deposition variables included substrate temperatures, ranging from room temperature to 400 °C, and bias voltages, ranging from 0 to −150 V. All the fabricated (TiZrHfTaSi)Nx films exhibited a face-centered cubic structure. Lattice parameters were affected by the variations in temperature and bias, indicating the influence of ion bombardment and adatom mobility during film growth. Substrate heating evidently enhanced (TiZrHfTaSi)Nx films' mechanical properties attributed to densification. A maximal hardness of 30.9 GPa was achieved when the films were prepared at a substrate temperature of 400 °C, with respect to 26.2 GPa for the films deposited at room temperature. Moreover, the highest corrosive resistance was obtained for the films prepared at a substrate bias of −100 V without external heating. The results indicated that the controls of substrate temperature and bias voltage affected the microstructure and properties of (TiZrHfTaSi)Nx films, exhibiting valuable insights for optimizing the performance of high entropy nitride coatings.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A Percolation Perspective on Abrupt Electrical and Magnetic Changes in High-Entropy Alloy Films

Professor Xiaona Li[1]

[1]Dalian University of Technology, , China

Poster Session - S08: High Entropy and Amorphous Coatings (HEA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The incorporation of interstitial atoms (IAs) into high-entropy alloy films provides a promising pathway for achieving exceptional functional tunability. However, during the interstitial-filling process, abrupt changes in electrical and magnetic properties often do not coincide with structural phase transitions, posing challenges for reliable property prediction and composition design. In this work, percolation theory is employed as a unified framework to elucidate these anomalous transitions in highly disordered high-entropy alloy films. For electrical transport, the system is mapped onto a two-color site-percolation model, consisting of highly conductive vacancy-centered octahedra and poorly conductive IA-centered octahedra. A sharp resistivity jump is observed when the fraction of vacancy-centered octahedra approaches the face-centered-cubic site-percolation threshold, enabling quantitative prediction of the critical composition. For magnetism, the competition among exchange interactions is described within a bond-percolation framework. The non-monotonic evolution of saturation magnetization is attributed to the percolation of ferromagnetic Cr-O-Cr bonds at low oxygen content, followed by the re-establishment of ferromagnetic metal-metal exchange networks at higher oxygen content. These results demonstrate that the abrupt functional transitions in high-entropy alloy films are governed not by phase changes, but by connectivity-driven percolation processes. The proposed approach provides a physically transparent and predictive framework for understanding composition-induced property transitions, and offers practical guidance for the targeted design of high-entropy alloy films with tailored electrical and magnetic functionalities.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Photo-Activated Chemiresistive Methane Gas Sensor Based on High-Entropy Fluorite $(Ce_{0.2}La_{0.2}Gd_{0.2}Sm_{0.2}Pr_{0.2})O_2$ Thin Film

Maran M[1]

[1]Sri Sairam Engineering College, West Tambaram, India

Poster Session - S08: High Entropy and Amorphous Coatings (HEA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

High entropy oxides (HEOs) containing multiple elements have gained their unique intrinsic properties and interactive synergy resulting from the structure of multiple elements. The excellent gas sensing performances of HEOs are mainly attributed to entropy stabilization, structural flexibility, and chemical tunability. Synergistic effects among multiple cations facilitate oxygen vacancy generation, thus increasing sensing active sites, surface chemistry, and adsorption–desorption kinetics for target gas molecules. Here, we report the first photo-activated chemiresistive gas sensor comprised of high-entropy fluorite oxide thin film with an equimolar composition of $(Ce_{0.2}La_{0.2}Gd_{0.2}Sm_{0.2}Pr_{0.2})O_2$, which is highly sensitive and selective to detect trace amount of methane (CH_4), one of the most significant greenhouse gases.

Most previous HEO-based gas sensors were prepared with powder or pellet forms and operated in a dark or thermal activation state. In this work, highly sensitive and selective gas sensors were fabricated by depositing thin films through nebulizer spray pyrolysis method at room temperature, and were directly excited by light for efficient gas detection at low temperature. The as-prepared thin films are uniform and continuous films consisting of a single-phase fluorite lattice. Based on the synergistic effect of rare earth ions and the mixed valence states of Ce and Pr, the obtained films have a stable and highly active fluorite lattice with abundant oxygen vacancies.

The sensor under visible or UV light illumination at room temperature shows a much enhanced response to CH_4 compared to the dark condition. The photoactivation process facilitates the generation of electron–hole pairs, leading to enhanced adsorption–desorption kinetics and charge transfer that result in improved sensitivity, faster response and recovery times and high selectivity towards CH_4 over possible interfering gases like CO_2, NO_2, H_2 and VOCs.

This work presents a simple, sustainable and energy-efficient environmental monitoring platform that exhibits excellent selectivity and sensitivity as well as long-term stability.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Refractory High-Entropy (WMoNbV)O_x Thin Films Deposited by Magnetron Sputtering: Microstructure Control and Promising Electrocatalytic Performance

Sevda Jafari Aghdam[1], Dr Yahya A. Sorkhe[2], Prof. Dr. M. Lütfi Öveçoğlu[2]

[1]sabanci University, Orta Mahalle, Üniversite Caddesi No:27 Tuzla, 34956 İstanbul, Turkey, [2]istanbul technical university, Reşitpaşa, İTÜ Ayazağa Kampüsü Rektörlük Binası, 34467 Sarıyer/İstanbul, turkey

Poster Session - S08: High Entropy and Amorphous Coatings (HEA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Refractory high-entropy oxides are attracting growing attention as thin-film materials because their high configurational entropy, severe lattice distortion, and rich defect chemistry offer powerful ways to tune electronic structure and catalytic activity. In this study, we synthesized (WMoNbV)O_x refractory high-entropy thin films for the first time by DC magnetron sputtering from a single equimolar WMoNbV alloy target onto Cr-coated silicon substrates. By simply adjusting chamber pressure (0.5–1.5 Pa) and substrate bias voltage (0 or –80 V), we achieved good control over oxygen incorporation while maintaining the multicomponent high-entropy character of the system.

Detailed characterization showed that all films adopt a dominant body-centered cubic (BCC) high-entropy solid-solution phase, in excellent agreement with CALPHAD thermodynamic predictions. Raman spectroscopy and XPS confirmed mixed-valence metal–oxygen bonding (W^{6+}/W^{5+}, Mo^{6+}/Mo^{4+}, Nb^{5+}/Nb^{4+}, V^{5+}/V^{4+}), with interstitial oxygen inducing significant lattice strain. Cross-sectional SEM, AFM, and EDS mapping revealed a clear transition from columnar to dense nanocrystalline morphology (grain size < 50 nm) under optimized conditions, together with uniform elemental distribution and controlled surface roughness that increases the number of active sites. The best-performing film, deposited at 1.0 Pa with –80 V bias, combined an optimal oxygen level, maximum lattice distortion, and low charge-transfer resistance while preserving sufficient electrical conductivity.

The optimized film exhibits promising bifunctional electrocatalytic performance toward both the hydrogen and oxygen evolution reactions in alkaline media, supported by sustained electrochemical stability and competitive charge-transfer kinetics. These findings establish refractory high-entropy oxide thin films prepared by magnetron sputtering as a viable and scalable platform for energy conversion applications, opening new directions for defect-engineered, multicomponent electrocatalysts.

Keywords: refractory high-entropy oxide, magnetron sputtering, oxygen defects, thin-film microstructure, water splitting

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Controlled Oxygen-Induced Property Enhancement in NbMoTaW Based Refractory High Entropy Alloy Films via Alloy Chemistry

Sheikh Haris Mukhtar[1], Prof. Mohammad Farooq Wani[1], Dr. Mukund Dutt Sharma[1], Prof. Rakesh Sehgal[2]

[1]National Institute Of Technology Srinagar, Hazratbal 190006, India, [2]National Institute Of Technology Hamirpur, Anu, India

Poster Session - S08: High Entropy and Amorphous Coatings (HEA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Oxygen is ubiquitous in materials processing and is traditionally considered an undesirable impurity, often leading to embrittlement. However, limited oxygen incorporation can modify the structural and functional response of these alloys. This work investigates the potential to harness this effect in refractory high entropy alloy (RHEA) films, using the NbMoTaW system as a base. We examine how the addition of Vanadium and controlled post deposition annealing in an Ar/O_2 atmosphere influences oxygen incorporation and the resulting properties.

Structural analysis confirmed that both NbMoTaW and VNbMoTaW films retained a single-phase BCC structure after annealing. Preliminary results indicate that the presence of vanadium significantly alters the interaction of the film with oxygen. This process is correlated with the development of substantial lattice strain and a notable increase in hardness, with the VNbMoTaW film annealed at 600°C reaching approximately 17 GPa. Annealing resulted in diffusion-assisted microstructural refinement, resulting in a denser morphology with reduced feature size in both films.

The mechanical and tribological responses showed strong dependence on composition and annealing temperature. While NbMoTaW exhibited moderate strengthening, VNbMoTaW demonstrated significant improvement at higher temperature, accompanied by enhanced structural stability during sliding. Annealing enabled a transition from premature failure to stable friction behavior, leading to a substantial reduction in wear, with VNbMoTaW achieving an ultra-low wear rate of 6.7× 10 mm3 N-1 m-1.

These findings demonstrate that controlled oxygen incorporation, combined with alloy chemistry, can be used as a design strategy to enhance the performance of RHEA films.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Cracking Behavior of High-Entropy Ceramic Targets During RF Sputtering: Failure Analysis

Han Li[1], Chin-Chieh Hsu[1], Dr. Wei Sea Chang[1]

[1]National Yang Ming Chiao Tung University, , Taiwan

Poster Session - S08: High Entropy and Amorphous Coatings (HEA), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

High-entropy ceramics (HECs) have emerged as promising target materials for physical vapor deposition, offering exceptional properties that arise from their unique multi-element compositions. However, their inherently non-conductive nature promotes charge accumulation and non-uniform thermal expansion during RF sputtering, generating thermomechanical stresses that render these targets susceptible to cracking. This study investigates the cracking behavior of HEC targets during RF sputtering under controlled power ramping conditions. Despite a gradual increase in the power ramp, fracture was still observed, underscoring the severity of the thermomechanical loads involved. Post-failure analysis by optical microscopy revealed spatially distributed crack propagation throughout the target, and crack widths were measured at multiple locations along the fracture path. These findings highlight the critical importance of thermal management, target bonding design, and power protocol optimization when working with brittle ceramic sputtering targets. This work provides foundational insight into the failure mechanisms of HEC targets and informs future strategies for extending target lifetime in HEC thin film deposition processes.

July 15, 2026 | 3:30 PM

3D Photonic Crystal Additives on Piezoelectric Response of PVDF/TPU Nanofiber Sensors

Professor Yongling Wu[1]

[1]Shandong University Of Technology, 266 Xincun West Road, 中国

Session 06 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Seletar1 - Level 3, July 15, 2026, 3:30 PM - 5:05 PM

Piezoelectric nanocomposites have been a rapidly growing field in energy harvesting, with applications in wearable electronics, strain sensors, mechanical actuators, and electromechanical membranes. Flexible wearable piezoelectric sensors are made by Poly (vinylidene fluoride) (PVDF)-based nanofibers with different types of nano-fillers, such ZnO, Ag:ZnO, graphene, MXene, providing high sensitivity response to applied mechanical strain and converting into electric signals[1-3]. This research reports the use of three-dimensional polymer photonic crystals (PC) with varying ratios grafting onto the piezoelectric fibers to enhance the photosensitivity. Due to its superior elasticity, thermoplastic polyurethane (TPU) was blended with PVDF to obtain high flexibility nanofibers processed by electrospinning. Photonic crystals were synthesized by a chemical reduction method and grafted onto the PVDF/TPU fibers, and photonic piezoelectric sensor devices were fabricated. The piezoelectric responses of different blending ratios of PC@PVDF/TPU were investigated. It was found that PC grafted fibers give higher output voltage at different stress conditions and higher photosensitivity. This work evidenced that PCs help increasing the strain sensitivity and mechanical elasticity of piezoelectric sensors, making it a unique contribution in a new research direction and valuable for future devices.

Confined Pyrolysis-Driven Evolution of g-C_3N_4/PAN nanofibers into Nitrogen-Doped 1D/2D Carbon Heterostructures for Highly Efficient Microwave Absorption

Jingwei Li[1], Dr. Haibao Lu[1], Dr. Jianjun Li[1], Mr. Yicheng Yu[1], Mr. Haolin Bai[1]

[1]Laboratory of Science and Technology on Advanced Composites in Special Environments,Harbin Institute of Technology, No. 92 West Dazhi Street, Nangang District, Harbin 150001, P.R. China, China

Session 06 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Seletar1 - Level 3, July 15, 2026, 3:30 PM - 5:05 PM

Developing lightweight, high-efficiency electromagnetic wave (EMW) absorbers is crucial for stealth and electronic protection. Electrospun carbon nanofibers (CNFs) are promising but often suffer from excessive conductivity and impedance mismatch. Integrating 2D g-C_3N_4 can address these issues, yet conventional open-system pyrolysis leads to rapid nitrogen (N) volatilization, resulting in poor N-doping and weak 1D/2D interfaces.

In this study, a confined-pyrolysis strategy is proposed to overcome these limitations. By encapsulating g-C_3N_4-modified PAN fibers within a sacrificial silica (SiO_2) shell, we create a localized nanoreactor that restricts gas-phase evolution. The SiO_2 barrier prevents the premature escape of nitrogenous species, increasing internal vapor pressure and facilitating the in-situ integration of pyrrolinic and pyridinic N into the carbon lattice. Furthermore, the confined atmosphere, synergized with cobalt catalysts, triggers the growth of secondary carbon nanotubes at 1D/2D contact sites, forming a hierarchical 1D/2D/1D interconnected conductive network.

The engineered heterostructures exhibit superior EMW absorption. Enhanced N-doping provides abundant dipole polarization centers, while densified 1D/2D heterojunctions maximize interfacial polarization. Moreover, selective etching of the SiO_2 shell creates a hierarchical porous architecture, optimizing impedance matching and increasing multi-path scattering. This strategy ensures high reflection loss and a broad effective absorption bandwidth at minimal thicknesses. This work provides mechanistic insights into using confined-space regulation to govern atomic doping and microscale architecture for advanced electromagnetic functional materials.

July 15, 2026 | 4:05 PM

Armoring Boron Nitride with Pyrolytic Carbon Layers for Tunable Rigidity and Flexibility

Doctor Meng Lan[1], Professor Qiangang Fu[1]

[1]Shaanxi Key Laboratory of Fiber Reinforced Light Composite Materials, Science and Technology on Thermostructural Composite Materials Laboratory, Northwestern Polytechnical University , No. 127, Youyi West Road, China

Session 06 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Seletar1 - Level 3, July 15, 2026, 3:30 PM - 5:05 PM

Ceramic aerogels are acclaimed as ideal materials for extreme environments due to their ultrahigh porosity, low density, and exceptional thermal stability. However, the practical application of traditional ceramic aerogels has been constrained by their inherent mechanical brittleness. Herein, we propose a strategy to customize mechanically tunable aerogels by armoring ceramic nanounits with pyrolytic carbon (PyC). The PyC encapsulating layers with various thicknesses are transformed into ductile tights or rigid armors, facilitating the mechanical customization of BN@PyC aerogel from superelasticity to rigidity across scales. Interestingly, the PyC armor imparts unique versatility to the aerogel, including flame retardancy, elastic response conductivity, and thermal conductivity. Furthermore, owing to the thermal stability of the PyC armor, the BN@PyC aerogel maintains its mechanical integrity even after high-temperature thermal treatment, and exhibits an unexpected resistance to butane torch ablation. Integrating mechanical stability, high-temperature resistance, and multifunctionality, BN@PyC aerogels offer new possibilities for scalable applications in extreme environments. This facile strategy of armoring brittle ceramic aerogels with PyC provides a novel reference for customizing the mechanical properties of multifunctional aerogels.

July 15, 2026 | 4:20 PM

Laser-Textured Bionic Functional Suarfaces for Controlled Droplet Transport

Kongbo Wang[1]

[1]Shandong University Of Technology, , China

Session 06 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Seletar1 - Level 3, July 15, 2026, 3:30 PM - 5:05 PM

Many biological organ surfaces exhibit unique micro/nano structures, which may be adopted for directional transportation of droplets. (1) Magnetic-responsive omniphobic microciliary arrays (MMAs) are fabricated by combining nanosecond laser machining of PTFE template and transfer replication process. The optimized MMAs with 40 wt% iron oxide content has omniphobic properties with water contact angle > 140, rolling angle < 3, and oil contact angle of 129. Under the stimulation of a moving magnet, microcilia pillars bend and deform sequentially in a wave-like manner, which generates the directional driving force and rapidly transports water and oil droplets, solid spheres and air bubbles in both water and oil media. A droplet up to 25 L and a solid sphere up to 2 g can be continuously transported at a maximum velocity of 2.4 mm/s. (2) Magnetically responsive micro-plate arrays (SMMAs) with reverse switching wettability were studied for in-situ capturing, releasing, and directional bouncing of droplets over a large distance. A novel method for producing low-adhesion force (superhydrophobic) on the side surface of the vertical micro-plate arrays was developed by laser texturing the bent individual arrays at 90 degree, which resulted in a water contact angle of 151°, a rolling angle of <10°, and a maximum surface adhesion force of 35.5 μN. Reversible switching between droplets capturing with high adhesion force (hydrophilic surface) and droplet releasing with low adhesion force was achieved. In addition, the high instantaneous energy conversion due to the immediate response of the SMMAs bending between 0 and 90 degree provided a guarantee for the directional bouncing of droplets. Droplets transportation up to 30 μL, directional bouncing of 5 μL droplets with a vertical bounce height of 4.5 mm and a horizontal bounce distance of 24.7 mm have been achieved.

Backside Electrostatic Patterning Enables Programmable Droplet Capture on a Superhydrophobic Surface

Mr. En-zhe Li[1], Prof. Jiann Shieh[1]

[1]National United University, No.2, Lienda, Taiwan

Session 06 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Seletar1 - Level 3, July 15, 2026, 3:30 PM - 5:05 PM

Superhydrophobic surfaces exhibit extremely low liquid–solid adhesion, enabling droplets to roll easily with minimal resistance. While this property underpins many self-cleaning technologies, it simultaneously limits applications requiring precise droplet positioning, such as chemical reactions, spectroscopy, and open-surface microfluidics. Conventional strategies to immobilize droplets typically rely on lithographically patterned hydrophilic regions, which disrupt the integrity of the superhydrophobic surface and introduce additional fabrication complexity.

Here we report a fundamentally different strategy to localize droplets on superhydrophobic surfaces by engineering the electrostatic charge distribution from the backside of the substrate. Superhydrophobic glass was fabricated by growing silica nanowires on quartz via chemical vapor deposition, providing nanoscale roughness while preserving high optical transparency and excellent electrical insulation. These properties enable efficient liquid–solid contact electrification and long-lived surface charge accumulation.

By selecting different backside materials, the electrostatic landscape on the surface can be modulated. Triboelectrically charged polytetrafluoroethylene (PTFE) introduces strong negative charges that enhance droplet adhesion through electrostatic attraction, whereas conductive copper layers generate electrostatic shielding that reduces local charge accumulation and promotes droplet mobility. Importantly, instead of patterning the front surface, droplet capture sites are defined by geometrical discontinuities in the backside conductive layer. These discontinuities act as localized electrostatic traps that create strong anchoring forces capable of abruptly stopping rolling droplets at predetermined positions.

This backside electrostatic patterning strategy transforms an inherently slippery superhydrophobic surface into a programmable droplet manipulation platform. The approach enables simultaneous droplet transport and localization without compromising surface integrity, opening new opportunities for droplet-based sensing, microreactors, and open-surface microfluidic systems.

July 15, 2026 | 4:50 PM

Multiscale Ultrafast Laser Texturing for Structural and Functional Metals

Yi Ma[1], Qirui Zhang[1], Xing Li[1], Yingchun Guan[1]
[1]Beihang University, ,

Session 06 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Seletar1 - Level 3, July 15, 2026, 3:30 PM - 5:05 PM

Ultrafast laser micro/nano-texturing is a highly versatile tool for functionalizing metallic surfaces. This presentation systematically explores a "dimensional scaling" approach to laser surface engineering, demonstrating how tailored topographies—from nanoscale features to micro-interfaces—effectively address multi-physics challenges in structural and functional metals.

At the nanoscale, picosecond laser-induced periodic surface structures (LIPSS) on Ti6Al4V drive significant grain refinement and gradient dislocation cell formation. This localized crystallographic transformation lowers interface energy, substantially enhancing electrochemical corrosion resistance.

At the microscale, femtosecond lasers are used to fabricate micro-nano hybrid textures that improve hydrophobicity and anti-reflectivity. By optimizing structure geometries (specifically the depth-to-width ratio), we manipulate tribological behavior while preserving bulk mechanical integrity, limiting the Ultimate Tensile Strength (UTS) reduction to just 0.16%–3.27%.

Finally, extending this texturing strategy to internal interfaces during the Selective Laser Melting (SLM) of W/Cu dual metals, laser-induced structures on the tungsten substrate actively control metallurgical dynamics. They promote liquid copper spreading, inhibit defects, and create robust mechanical interlocking, enabling transition-layer-free W/Cu joints with a high bonding strength of 123 MPa.

In conclusion, these results establish laser texturing as a scalable strategy that decouples surface functionalization from bulk mechanical degradation, simultaneously improving corrosion resistance, tribological performance, and dissimilar material integration.

Laser Processing-Assisted Fabrication of Si/YbDS/GYbZ Thermal and Environmental Barrier Coatings and Their Mechanisms of Functional Realization

Associate Professor Jian He[1], Dr. Qijie Zhou[1], Professor Hongbo Guo[1], Professor Shengkai Gong[1], Professor Huibin Xu[1]

[1]Beihang University, No. 37, Xueyuan Road, 100191, China

Session 07 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 8:35 AM - 10:15 AM

SiCf/SiC ceramic matrix composites (CMCs) are gradually replacing single-crystal superalloys as the key and ideal materials for hot-section components of aero engines. Due to the water vapor corrosion in the hot gas environment, the practical application of CMCs relies heavily on environmental barrier coatings (EBCs), which ensure the safe and stable service of CMC hot-section components. As engine thrust-to-weight ratio continues to increase, the operating temperatures for hot-section components rise accordingly, demanding EBCs with higher temperature tolerance and longer service life. However, as a representative third-generation EBC, Si/$Yb_2Si_2O_7$ (YbDS) coating suffers from insufficient temperature capability and poor corrosion resistance. To address these issues, an additional thermal insulating ceramic layer, $(Gd_{0.9}Yb_{0.1})_2Zr_2O_7$ (GYbZ), was introduced onto the Si/YbDS coating to form a thermal and environmental barrier coating (TEBC) in this study. Laser processing was applied to remelt and etch the YbDS surface, followed by the deposition of a columnar-structured GYbZ layer containing interstitial particles via PS-PVD. This approach enabled the construction of a novel TEBC system. Its resistance to water vapor corrosion, CMAS corrosion and gas thermal shock at 1300 °C was investigated and the thermal insulation was evaluated. The influence mechanisms of laser surface treatment on corrosion resistance, thermal shock resistance and thermal insulation were revealed. This work provides a new pathway for developing ultra-high-temperature TEBCs with long life.

Plasma-Assisted Reduction of Silver Nanoparticles on Various Substrates for Raman Signal Enhancement

Dr. Magdaleno Jr Vasquez[1]

[1]University of the Philippines Diliman, , Philippines

Session 07 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 8:35 AM - 10:15 AM

This talk explores the synthesis, characterization, and application of plasma-reduced silver nanoparticles (AgNPs) for surface-enhanced Raman spectroscopy (SERS), with a focus on the role of different substrates in optimizing analytical performance. Plasma-based reduction offers a rapid, chemical-free, and environmentally friendly route for producing AgNPs with controlled size, morphology, and surface properties. These attributes are critical in tailoring localized surface plasmon resonance, which supports the signal enhancement mechanisms in SERS. Presented is a systematic study of AgNPs reduced via low-temperature plasma processes and deposited onto different substrates such as laser-induced graphene, glass, paper, among others. Each substrate introduces distinct surface energies, roughness profiles, and NP-substrate interactions, all of which influence NP distribution, aggregation behavior, and hotspot formation. These factors directly impact SERS sensitivity, reproducibility, and detection limits.

The talk also highlights practical considerations for integrating plasma-reduced NP into scalable and cost-effective sensing devices. By correlating synthesis conditions, substrate properties, and spectroscopic performance, this work provides design guidelines for next-generation SERS substrates. Ultimately, the findings underscore the importance of substrate engineering in maximizing the analytical capabilities of plasma-reduced Ag nanostructures for applications in chemical sensing, environmental monitoring, and biomedical diagnostics.

July 16, 2026 | 9:15 AM

Improvement the stability of the localized surface plasmon resonance of copper nanoparticles fabricated by vacuum coating

Mr. Runze Zhang[1], Mr. Lingfeng Yin[1], Mr. Cailin Lu[1], **Professor Yingcui Fang**[1,2]
[1]Hefei University Of Technology, , China, [2]Intelligent Manufacturing Institute of Hefei University of Technology, , China

Session 07 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 8:35 AM - 10:15 AM

Copper nanoparticles (CuNPs) pose strong localized surface plasmon resonance (LSPR), whose intensity is compatible to those of AgNPs and AuNPs. However, the CuNPs fabricated by vacuum coating lose their LSPR quickly in air. Their absorption spectra show large valley around 575 nm which is much different from the CuNPs fabricated by chemical methods. In this study, we firstly analyze the special absorption spectrum, and then explore three kinds of methods, including oxygen plasma irradiation (OPI) to form CuO covered CuNP core-shell structure to improve the LSPR stability of CuNPs. Our study provides scientific and technology support for the antioxidation of CuNPs and other easy oxidation metal nanoparticles.

July 16, 2026 | 9:30 AM

Construction of 3D Hetergeneous Carbon Conductive Pathways for Efficient Thermal Management

Zhongkai Wang[1], Prof.Dr Deyu Yang[1], Prof.Dr Xianghui Hou[1]

[1]Northwestern Polytechnical University, 710072, China

Session 07 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 8:35 AM - 10:15 AM

Heat dissipation is a major challenge for high power-density devices and systems. The combination of light weight, ease of processing, and low cost has established thermally conductive polymer composites as a focal point in thermal management research. These materials hold substantial promise for applications ranging from 5G infrastructure to electronic packaging and energy transmission systems. However, as the power gradually increases, thermal conductivities of traditional polymer composites are unable to meet the heat dissipation requirements. Establishing 3D interconnected networks as the primary thermal pathways enables directional heat transport, significantly boosting the thermal conductivities of the composites. However, the realisation of structural and functional continuity from individual building blocks remains challenging. Inspired by the inosculation of twinned-trunk in nature and the capability of resource sharing and exchange, a new strategy for constructing 3D carbon networks with structural and functional continuity is developed in this study. Carbon nanotubes (CNTs) are grown directly on carbon fibers (CFs) via chemical vapor deposition to create nanoscale branching structures. Subsequently, pyrolytic carbon (PyC) is coated onto both the CNTs and CFs, generating bridging interconnections between neighboring fibers. This biomimetic "inosculation" architecture, inspired by biological cellular fusion mechanisms, enables seamless integration of distinct carbon phases into a unified network. To validate efficient resource transfer and functional synergy, the heterogeneous carbon framework is graphitised and embedded in polydimethylsiloxane to enhance thermal transport. The resulting composites exhibit exceptional through-plane thermal conductivity of 18.8 W/(m·K) with a 21.4 vol% filler content. This bio-inspired inosculation concept represents a groundbreaking approach for engineering next-generation materials demanding spatially continuous 3D interconnected networks.

SiO_2 Nanoparticle Surface Charge Modulation of Ion Selectivity and Energy Conversion in AAO Nanochannels

Fang Wei Pai[1], Prof. Shih-Chieh Hsu[1]

[1]Tamkang University, No.151, Yingzhuan Rd., Tamsui Dist., New Taipei City 25137, Taiwan (R.O.C.), Taiwan

Session 07 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 8:35 AM - 10:15 AM

Anodic aluminum oxide (AAO) membranes with well-defined nanochannels are promising platforms for ion transport and osmotic energy conversion. In this study, surface charge-modified SiO_2 nanoparticles are introduced into 300 nm AAO nanochannels fabricated via phosphoric acid anodization to enhance ion selectivity. By increasing the negative surface charge of SiO_2, the electrical double layer (EDL) within the nanochannels is effectively extended, promoting stronger ion selectivity under electrolyte conditions. The incorporation of SiO_2 nanoparticles not only tailors the surface charge density but also influences ion transport behavior within confined nanochannels. This approach is expected to enhance selective ion transport and is estimated to achieve a power density of approximately 4–5 W/m^2 in osmotic energy conversion systems. The proposed strategy provides a feasible route for tuning nanochannel properties toward advanced membrane-based energy harvesting applications.

High-throughput composition screening of Pt-modified aluminide coating for corrosion resistance in molten Na2SO4-NaCl salts

Mengqi Li[1], Hui Peng[1], Hongbo Guo[1]

[1]Beihang University, 737Xueyuan Road,Haidian District, China

Session 07 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 8:35 AM - 10:15 AM

A high-throughput magnetron sputtering technique was developed to fabricate multi-component Pt-modified aluminide ((Ni, Pt)Al) coatings to enhance corrosion resistance through compositional optimization. (Ni, Pt)Al, Dy-doped (Ni, Pt)Al, and Zr-doped (Ni, Pt)Al coatings were successfully prepared, all exhibiting dense and uniform microstructures with the thickness of approximately 30 μm. The (Ni, Pt)Al coatings featured composi- tional gradients of Pt (3–20 at.%) and Al (40–55 at.%). Increasing Pt content induced a phase transition from single-phase β-(Ni, Pt)Al to two-phase consisting of β-(Ni, Pt)Al and ζ-PtAl2. The hot corrosion behavior of representative coatings was investigated in the Na2SO4/NaCl (75:25, wt%) environment at 900 oC for 100 h. The coating with the composition 45.1Ni-8.3Pt-46.6Al (at.%) exhibited superior performance, forming the thinnest and compact α-Al2O3 oxide scale (~5 μm) while exhibiting the smallest internal oxidation depth (~10 μm). Furthermore, Dy and Zr doping improved the hot corrosion resistance by delaying the θ-Al2O3 to α-Al2O3 phase transition and reducing stress-induced cracking. Zr was more effective between the two dopants, as Dy extended the presence of the less protective θ phase. The experimental results provide some theoretical guidance for the subsequent design of (Ni, Pt)Al coatings and can lead to the development of thermal barrier coatings in corrosive environments.

Laser-Assisted Engineering of Functional Nanostructures: From Super-Tetragonal Ferroelectric Films to High-Performance Flexible Sensors

Prof. Zhipeng Li[1], Dr. Zhen Zhang, Mr. Qingchun Li
[1]University Of Science And Technology Beijing, ,

Session 08 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 10:45 AM - 12:10 PM

The advancement of next-generation electronic devices relies on the precise modulation of material properties at the nanoscale. This presentation highlights recent progress in utilizing laser-assisted synthesis techniques to engineer functional materials for ferroelectric memory and wearable sensing applications.In the domain of ferroelectric thin films, we demonstrate that oxygen inhomogeneity and strain gradient control can significantly enhance interfacial properties. Specifically, by tuning the oxygen distribution in BaTiO3 (BTO) films via pulsed laser deposition, we achieved an interfacial spontaneous polarization of 70muC cm-2—a nearly 100% increase compared to bulk values—extending across a thickness of 8 unit cells. Furthermore, we report the fabrication of super-tetragonal PbTiO3 (PTO) thin films with self-assembled nanocolumn structures. These films exhibit a giant out-of-plane to in-plane lattice parameter ratio of 1.2, leading to an estimated spontaneous polarization of approximately 177muC cm-2.Extending these laser-processing methodologies to flexible electronics, we developed high-performance sensors using laser ablation in liquid (LAL) to synthesize high-purity, silver nanoparticle-modified carbon nanotubes (Ag-MWCNTs). Integrating these with conductive polymers (PEDOT:PSS) or 2D materials (MXene) yielded sensors with exceptional performance. These results demonstrate that the active control of defects and nanostructural self-assembly via laser-assisted techniques provides a robust pathway for the development of both high-density nonvolatile memory and sophisticated wearable healthcare monitoring systems.

Design and Development of $BiFeO_3$–Activated Carbon Nanocomposite for high density Supercapacitors applications

Professor Mohammad Ahmad[1]

[1]University of Guyana, South America, Department of MPS, Faculty of Natural Sciences,, Guyana

Session 08 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 10:45 AM - 12:10 PM

In the present work, the electrochemical performance of bismuth ferrite (BFO) and BFO–activated carbon (BFO–AC) nanocomposites as electrodes material has been investigated. Bismuth ferrite (BFO) and BFO–activated carbon (BFO–AC) nanocomposites were successfully synthesized by the sol–gel technique. The X-ray diffraction, Raman spectroscopy, FTIR, and field emission scanning electron microscopic analyses revealed the formation of BFO/AC nanocomposite. The structural studies confirmed the BFO–AC nanocomposite has rhombohedral structure. Morphological studies revealed uniformly distributed spherical shape with relatively smooth surfaces, indicating homogeneous dispersion and effective incorporation of activated carbon within the BFO matrix. FTIR and Raman spectroscopic studies corresponds to vibrational bands and corresponding to functional groups that confirms the presence of strong chemical interactions between BFO and activated carbon. The electrochemical performance was evaluated such as cyclic voltammetry and galvanostatic charging/discharging suggested that BFO/AC nanocomposite electrode has a significant potential for energy storage system. The electrode containing 20 wt.% activated carbon exhibited excellent electrochemical performance in terms of specific capacitance of 404 F g^{-1} at a current density of 1 A g^{-1} at a scan rate of 10 mV/sec in the potential window. The electrode retains capacitance retention of 81.38% after 5000 continuous charge–discharge cycles, demonstrating excellent cycling stability. The enhanced electrochemical performance highlights the potential of the BFO–AC nanocomposite for applications in energy storage devices systems.

Keywords: Bismuthferrite; nanocomposites ; Activated carbon; Energy storage

Construction of a core-shell structured SiC nanowires@nano-carbon hybrid conductive network for supercapacitors and electromagnetic interference shielding

Doctor Huimin Liu[1], Doctor Xuemin Yin[1], Professor Hejun Li[1]
[1]Northwestern Polytechnical University, No.127 West Youyi Road, China
Session 08 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 10:45 AM - 12:10 PM

To ensure that the electronic devices can work normally under electromagnetic interference, it is feasible to integrate the electromagnetic interference (EMI) shielding function into the energy storage device. Herein, we propose a core-shell structure design strategy to construct hybrid conductive networks based on SiC nanowires (NWs) arrays grown in situ on carbon fabric, decorated with three different nano-carbon materials of carbon nanotubes (CNTs), vertical graphene nanosheets (VGNs), and pyrolytic carbon (PyC). Each forms a hybrid conductive network with multistage heterogeneous interfaces, yet exhibits distinct performance characteristics. SiCNWs@CNTs forms a highly conductive, large-surface-area network. The resulting SiCNWs@CNTs electrode delivers a high areal capacitance of 53.53 mF/cm2 at 0.2 mA/cm2 with outstanding cycle stability (107.1% retention after 5000 cycles), and achieves an EMI shielding effectiveness (EMI SE) of 47.99 dB in the X-band. VGNs grow vertically on SiCNWs, creating hierarchical open channels. The SiCNWs@VGNs electrode shows a remarkable EMI SE of 56.09 dB at only 0.4 mm thickness, which can be further increased to 108.27 dB at 1.2 mm, while maintaining a specific capacitance of 26.42 mF/cm2 (185% of pure SiCNWs) and a supercapacitor cycling retention of 120.06% after 5000 cycles. PyC forms an ultrathin (~5 nm) uniform shell, preserving gradient pores and superhydrophilicity. The SiCNWs@PyC electrode achieves an areal capacitance of 32.48 mF/cm2 (227.58% of pure SiCNWs) at 25 °C and retains 28.09 mF/cm2 even at 60 °C, demonstrating excellent wide-temperature operability. This comparative study reveals that these nano-carbon materials optimize capacitance and durability, enable thickness-tunable EMI shielding, and maintain stable performance across a broad temperature range. Our work provides a versatile design roadmap for SiCNWs-based multifunctional nano-materials for next-generation electronic devices that require both energy storage and EMI protection.

July 16, 2026 | 11:40 AM

Multi-stimulus responsive anisotropic slippery surfaces

junhao sang[1]

[1]Shandong University Of Technology, No. 266, Xincun West Road, Zhangdian District, Zibo City, Shandong Province, China

Session 08 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 10:45 AM - 12:10 PM

Recently, stimuli-responsive slippery surfaces with controllable wettability have attracted considerable interest due to their potential applications in diverse fields such as droplet manipulation, microfluidics, and self-cleaning. However, most existing anisotropic slippery materials are limited to a single response mode, often failing to address the practical requirements for dual or synergistic stimulation in complex environments. A key challenge also lies in achieving in situ adhesion modulation and sophisticated droplet manipulation. Here, we report the design of a responsive anisotropic solid-liquid switching slippery surface (RASWS) is designed and fabricated by utilizing ultrafast laser-induced graphene (LIG) as the structural framework, which is subsequently infused with a paraffin-based ferrofluid. Droplets experience nearly an order of magnitude lower sliding resistance on pitcher plant-mimetic gradient surfaces. Notably, both in situ adhesion modulation and droplet manipulation are ach ieved using only light or thermal stimulus. Furthermore, droplets can be driven to slide against gravity on the anisotropic surface under magnetic actuation. Moreover, applying thermal or light stimuli enables in situ switching from solid to liquid lubrication, leading to a marked enhancement in friction-reduction performance. Therefore, this work not only overcomes critical challenges of single-response limitations and multifunctional integration but also paves the way for a new paradigm in developing intelligent interfaces with integrated stimuli-responsiveness, anisotropic lubrication, and programmable droplet control.

Wet-chemical-assisted 3D printing of functionalized comb structures for efficient and scalable fog harvesting

Shen Yu[1]

[1]Shandong University Of Technology, Zhangdian District, Zibo City, Shandong Province, China, China

Session 08 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 10:45 AM - 12:10 PM

Freshwater shortage and water pollution are major challenges facing the world, highlighting the urgent need for efficient,scalable and low-cost atmospheric water harvesting solutions. In this study, a novel three-dimensional fog harvesting comb (FHC) structure was developed, evolving from the traditional two-dimensional comb geometry to a three-dimensional cone structure. The FHC was fabricated using a photopolymer-based stereolithography (SLA) 3D printing technique and subsequently functionalized using a wet chemical masking process to selectively deposit hydrophilic (HL-SiO_2) or hydrophobic (HB-SiO_2) coatings to tune the surface wettability. The effects of key parameters (including cone angle, surface wettability, spherical protrusion density and geometry, and windward orientation) on the fog harvesting performance were systematically investigated through experimental and theoretical analysis. The optimized FHC structure (4.5° taper, hydrophilic surface, 65 spherical protrusions, upright orientation) achieved a maximum fog collection rate of 253.6 mg·cm2·h1. Surface characterization by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and XPS, as well as durability evaluations including UV irradiation, droplet impact, cyclic condensation and chemical attack, confirmed the chemical stability, antifouling and long-term functionality of the coating under actual environmental conditions. To enhance the practical application value, an integrated fog water collection device(IFHD) was constructed using FDM 3D printing technology to accommodate nine modular FHC units. Water collection in three hours outdoors reaches 3060 mg. The device is equipped with a manual angle adjustment mechanism and a microporous funnel to reduce water evaporation, which can effectively reduce evaporation and achieve a seven-day outdoor water retention rate of up to 99.4%. This study demonstrates an integrated strategy combining functional structural design with additive manufacturing and surface modification, providing a robust, adaptable and scalable platform for sustainable fog water collection in arid and resource-poor environments

July 16, 2026 | 1:30 PM

Two-nozzle Electrospinning-Derived Dual-Fiber TVDF@GPU Nanofibrous Scaffolds for Piezoelectric Nanogenerator Sensors

Yunlong Li[1]

[1]Shandong University Of Technology, No. 266, Xincun West Road, Zhangdian District, Zibo City, Shandong Province, China

Session 09 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 1:30 PM - 2:25 PM

Flexible piezoelectric nanogenerators (PENGs) based on poly(vinylidene fluoride) (PVDF) are promising for wearable energy harvesting and sensing applications but are often limited by low β-phase content and poor mechanical durability. Herein, a two-nozzle counter-jet electrospinning strategy was developed to fabricate hybrid dual-fiber TVDF@GPU nanofibrous scaffolds by simultaneously depositing PDA@Tur-doped PVDF fibers and GR-doped TPU fibers. The dual-functional design significantly increases the β-phase content, resulting in an enhanced piezoelectric coefficient (d_{33}) of 26 pC/N compared to 16 pC/N for pristine PVDF@TPU. The optimized PENG achieves an open-circuit voltage of 35 V, a rapid response time of 22 ms, and a peak power density of 11.4 μW cm^{-2}. Furthermore, the device maintains stable output under continuous bending and tapping for over 10,000 cycles, demonstrating excellent flexibility and durability. This work provides a simple and scalable strategy for the design of high-performance, multifunctional PVDF-based piezoelectric nanogenerators, offering promising potential for next-generation wearable sensing and human–machine interface applications.

Dual-layer coated flaky carbonyl iron powder with enhanced high-temperature oxidation resistance and microwave absorption performance

Yuchen Zan[1], Keyi Liu[1], Qian Guo[1], Wenting He[1], Jie Xiao[1], Professor Hongbo Guo[1]

[1]School of Materials Science and Engineering, Beihang University, No. 37 Xueyuan Road, China

Session 09 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 1:30 PM - 2:25 PM

This study addresses the challenge that conventional carbonyl iron powder (CIP) wave absorbing systems are prone to oxidation at elevated temperatures, leading to performance degradation and inability to meet long-term service requirements at 300 °C. We propose a core-shell structure (FCIP@Co@Silane) fabricated through dual-layer coatings of cobalt and silane on flaky carbonyl iron powder (FCIP), aiming to simultaneously enhance its high-temperature oxidation resistance and microwave absorption properties. FCIP@Co@Silane was prepared via electroless cobalt plating followed by KH550 silanization. The dual coating layers effectively prevent the formation of conductive networks, reducing electrical conductivity and permittivity, thereby improving impedance matching and significantly boosting wave-absorption performance. Results demonstrate that FCIP@Co@Silane achieves a minimum reflection loss (RL) of -43.43 dB at 17.65 GHz with a thickness of only 1.1 mm, and an optimal effective absorption bandwidth (EAB) of 5.08 GHz (11.52-16.60 GHz) at 1.3 mm. The coatings also provide exceptional oxidation protection, delaying the onset oxidation temperature to 414 °C. After 10 h of isothermal oxidation at 300 °C, the weight gain percentage is only 3.50%. Remarkably, the oxidized FCIP@Co@Silane exhibits superior wave-absorption performance compared to oxidized pristine FCIP, achieving a minimum RL of -29.86 dB at 11.88 GHz with a thickness of 1.7 mm and an EAB of 4.29 GHz (11.70-15.99 GHz) at 1.5 mm. This work provides valuable insights for the design of wave absorbing materials with both excellent absorption properties and high-temperature oxidation resistance.

Electronic and Transport Properties of Doped GeSe Nanoribbons: A First-Principles Analysis

Ms. Banti Yadav[1], Prof. Pankaj Srivastava[1]

[1]ABV-Indian Institute of Information Technology and Management Gwalior (M.P.) India, Department of Engineering Sciences, Morena link road, ABV-IIITM Gwalior, India

Session 09 - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Sentosa - Level 3, July 16, 2026, 1:30 PM - 2:25 PM

The family of layered group-IV monochalcogenides MX (where M = Ge, Sn, and X = Se, S) has a similar puckered structure and geometry to phosphorene, which has attracted significant research interest [1]. A group IV-VI compound, germanium sulfide (GeS) monolayer, is a p-type semiconductor with potential applications as a photovoltaic material for solar cells due to its band gap of 1.65 eV [2]. Their experimental synthesis of single-crystal colloidal nanosheets of GeS and GeSe [3] was already reported. Several studies show that experimentally, graphene nanoribbon (GNR) has been synthesized by using various techniques [4]. However, in the case of GeSeNR, no study has yet been conducted on doping at the center. Because of the similarity between GeSeNR and phosphorene nanoribbons' structure, the doping at the Ge-center by a Ga-atom and the Se-center by an As-atom may keep the ribbon geometry and shape. In this research work, on the basis of a first-principles approach, we have explored the stability of the structure, other properties, including electronic and transport of zigzag/armchair GeSeNR by doping at the center of Ge and Se with Ga and As atoms, respectively.

The calculated formation energies indicate that all doped configurations are thermodynamically stable. However, the Se-center As-doped configuration of the zigzag germanium selenide nanoribbon is thermodynamically more stable. Additionally, the density of states and band structure are calculated to study electronic properties. The doped configurations become metallic, unlike their pristine counterparts, which is an essential requirement for designing metal interconnects. Finally, the calculation of transport properties based on the two-probe standard device model to analyse the crucial performance parameters such as: (RQ, LK, CQ). The lowest value of RQ (6.45 KΩ), LK (4.17 nH/μm), and CQ (4.00 pF/cm) for the Se-center As-doped ZGeSeNR, making it a promising candidate for the nanoscale interconnect.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Eu-doped Tourmaline@MOF-ZnO Core-Shell Nanocomposites: Enabling UV-Activated Room-Temperature and Ppb-level n-Butanol Sensing

Mr. Lingchao Wang[1], Ms. Nianci Guan[1], Prof. Yun Guo[1], Ms. Xiaofan Li[1], Mr. Hui Guo[1], Ms. Yinzhong Liu[1], Mr. Xiaotao Zhu[1], Mr. Yiyu Qiao[1], Prof. Xuechun Yang[1]

[1]Shanghai University, , China

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Achieving gas sensors that exhibit excellent sensitivity, selectivity, and rapid response to volatile organic compounds (VOCs) is critically important for effective environmental monitoring applications. In this research, a novel Eu-doped Tourmaline@MOF-ZnO core-shell nanocomposite was designed and fabricated, integrating a MOF-derived porous ZnO shell, a spontaneously polarized Tourmaline core, and rare-earth Eu doping. The gas sensing properties of the sensors were systematically investigated across three different test scenarios: (i) at high temperature in the dark, (ii) at high temperature with UV enhancement, and (iii) at room temperature with UV activation. The optimized 0.08 wt% Eu-5 wt% TML-ZnO sensor achieved an exceptional response of 536 to 100 ppm n-butanol at room temperature under UV activation. The response value exceeds that of the pristine MOF-ZnO sensor by a factor of 14.78. Furthermore, the sensor exhibited rapid response/recovery times (39 s and 23 s, respectively), outstanding selectivity and long-term stability, superior detection capability for ultra-low gas concentrations (LOD = 23.35 ppb). This study pioneers a synergistic UV-activated rare-earth doping strategy for Tourmaline@MOF-ZnO core-shell nanostructures, enabling room-temperature ppb-level VOCs sensing.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Potential-modulated SERS profiling via GLAD-fabricated Ag nanorod arrays for ultrasensitive and label-free spectroelectrochemical sensing

Mr. Lakshay Bhardwaj[1], Prof Jitendra Singh[2]

[1]Indian Institute of Technology Delhi, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, India, [2]Indian Institute of Technology Delhi, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, India

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Routine analysis of food adulterants and pharmaceutical additives at the point of care is crucial for food safety and environmental protection. Surface-enhanced Raman spectroscopy (SERS)-based sensing has gained significant importance in various scientific and technological domains, including analytical chemistry, biomedical diagnostics, forensic science, drug discovery, environmental monitoring, and food safety. Electrochemical SERS (EC-SERS) enhances the technique by regulating surface charge, adsorption, desorption dynamics, and redox processes, improving signal intensity and selectivity. Despite having advantages, developing EC-SERS sensors for field applications remains constrained by the limited availability of robust and reproducible SERS-active electrochemical substrates. This study introduces a cutting-edge portable EC-SERS platform, leveraging silver (Ag) nanorods engineered onto screen-printed electrodes via a thermal evaporation-based glancing angle deposition (GLAD) technique. This innovative approach ensures exceptional signal enhancement, outstanding sensitivity, and remarkable reproducibility, making it a powerful tool for high-precision molecular detection. Potential-modulated SERS profiling of p-aminothiophenol, 1,2-bis-(4-pyridyl) ethylene, and melamine was carried out at various electrochemical potentials. Additionally, the maximum signal enhancement was achieved at an optimized potential (Vmax), enabling the detection of melamine with a remarkable limit of 10 pM, surpassing previously reported substrates. The results highlight the promise of GLAD-fabricated AgNRs@SPE as a sensitive, label-free, reusable, and portable EC-SERS platform. This platform will present significant improvements in detecting analytes relevant to analytical chemistry, pharmaceutical industries, and drug control.

Intrinsic and Extrinsic Toughening in Transition Metal Diboride Coatings

Mgr., Phd. Tomáš Fiantok[1], Mgr., PhD. Branislav Grančič[1], Assist Prof., Dr. Nikola Koutná[2], Assoc.Prof. Davide Sangiovanni[3], Assoc. Prof., Dr techn. Tomáš Roch[1], RNDr., PhD. Martin Truchlý[1], Ing., PhD. Peter Švec[4], Assoc. Prof. Dipl.Ing.Dr. Rainer Hahn[2], Mgr., Csc. Vitalii Izai[1], Mgr., PhD. Viktor Šroba[1], Mgr., PhD. Marek Vidiš[1], Assoc. Prof. Marián Mikula[1]

[1]Centre for Nanotechnology and Advanced Materials,Faculty of Mathematics, Physics and Informatics, Comenius University, Mlynská dolina, 842 48, Slovakia, [2]Institute of Materials Science and Technology, TU Wien, Getreidemarkt 9, 1060 Vienna, Austria, Austria, [3]Department of Physics, Chemistry, and Biology (IFM), Linköping University, Linköping, Sweden, Olaus Magnus väg, 583 30 Linköping, Sweden, Sweden, [4]Institute of Physics Slovak Academy of Sciences (SAS), Bratislava, Slovakia, Dúbravská cesta 9, 845 11 Bratislava, Slovakia, Slovakia

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Transition metal diborides (TMB_2) are widely recognized for their exceptional properties, including extremely high melting temperatures, excellent thermal and chemical stability, and high hardness. These characteristics make TMB_2-based coatings promising for demanding environments such as aerospace and nuclear applications. However, their broader use is limited by intrinsic brittleness and low fracture toughness, which reduce resistance to mechanical loading, thermal shock, and impact.
In this work, we present three controllable strategies to mitigate the brittleness of transition metal diboride thin films, using zirconium diboride (ZrB_2) as a model system. The first strategy exploits crystallographic anisotropy as an intrinsic toughening mechanism. ZrB_2 coatings were deposited by High Target Utilization Sputtering (HiTUS), enabling independent control of ion energy and flux. By changing the preferred growth orientation from (0001) to (10-10), the hardness increased from 38 GPa to 46 GPa, while the fracture toughness remained nearly constant (~3 $MPa \cdot m^{1/2}$), demonstrating that orientation-induced hardening does not compromise crack resistance.
The second strategy employs superlattice architectures composed of periodically repeated nanoscale layers. Computational screening identified promising binary TMB_2 systems for superlattice formation. Experimentally, an optimized bilayer period induced a superlattice effect, leading to simultaneous improvements in hardness and fracture toughness.
The third approach involves aluminum alloying of ZrB_2 coatings prepared by conventional magnetron sputtering. Increasing Al content improved toughness but

reduced hardness, highlighting the trade-off between extrinsic and intrinsic toughening mechanisms.

Overall, crystallographic anisotropy, superlattice engineering, and controlled alloying provide effective and tunable pathways for tailoring the mechanical performance of ZrB_2 and related TMB_2 coatings.

Acknowledgment: This work was supported by APVV (APVV-21-0042, APVV-24-0038), VEGA (1/0473/24), COLOSSE (101158464, HORIZON-WIDERA-2023-ACCESS-04), and OPII (ITMS 313011AUH4). Computational resources were provided by NAISS at NSC, funded by the Swedish Research Council (2022-06725).

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Synergistic Interface and Defect Engineering in Ga2O3 Thin Films via Thermal-Oxidized Buffer Layers and Mixed Atmosphere Annealing

Yibin Wang[1,2], **Haofei Huang**[1,2,3], Ke Tang[1,2,3], Jian Huang[1,2,3], Linjun Wang[1,2,3]
[1]State Key·Laboratory·of Materials for Advanced Nuclear Energy, 99 Shangda Road, China, [2]School of Materials Science and Engineering, Shanghai University, 99 Shangda Road, China, [3]Zhejiang Institute of·Advanced Materials, SHU, 1588 Huaxiang Street, China

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Driven by its ultra-wide bandgap and intrinsic solar-blindness, gallium oxide (Ga2O3) has rapidly emerged as a frontrunner for next-generation, harsh-environment solar-blind ultraviolet optoelectronics. However, the performance of cost-effective sputtered Ga2O3 devices is fundamentally bottlenecked by severe interfacial lattice mismatch and high concentrations of bulk oxygen vacancies induced during thermal treatments.
Here, we demonstrate a highly effective dual-step engineering strategy to synergistically optimize Ga2O3 thin films. First, an innovative naturally graded buffer layer is formed via the in-situ thermal oxidation of an ultra-thin metallic Ga film, providing a high-quality, strain-relaxed template. Second, a tailored thermodynamic buffering approach utilizing a mixed N2/O2 atmosphere is implemented during rapid thermal annealing. Through this ambient, nitrogen substitution effectively passivates deep-level recombination centers without triggering severe carrier compensation. These underlying microstructural dynamics are comprehensively validated through HR-XRD, HRTEM, XPS, and PL spectroscopy, which confirm the interface transition, phase evolution, and drastically suppressed defect concentrations. Ultimately, Ga2O3 films prepared via this synergistic process exhibit superior crystalline quality, which establishes a robust, controllable pathway for the phase and defect engineering of wide-bandgap semiconductor thin films.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Scalable Ag-Ag2S Nanostructures for Energy-Efficient Neuromorphic Applications

Ms. Shreepooja Bhat[1], Dr. Gurumurthy S.C[1]

[1]Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, India

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Developing energy-efficient artificial synaptic devices is essential for advancing neuromorphic computing systems. In this study, Ag–Ag2S nanostructures were synthesized through a chemical reduction method and explored for artificial synaptic applications. The obtained nanostructures showed a uniform spherical morphology with an average diameter of approximately 6 nm, indicating controlled nanoscale formation. Devices fabricated in a simple two-terminal configuration exhibited stable resistive switching behavior, with a threshold voltage of approximately 400 mV and current compliance below 1 mA. The switching characteristics were consistent over repeated cycles, indicating reliable device operation. In addition, the devices demonstrated key synaptic functions, including short-term plasticity and long-term plasticity under low-voltage electrical stimulation, which are essential for mimicking biological synaptic behavior. The observed low operating power, controlled morphology, and reproducible synaptic response suggest that Ag–Ag2S nanostructures are promising materials for energy-efficient artificial synaptic devices and future neuromorphic computing technologies.

Developing Polymer–CNT Buckypaper Composites for Superior Mechanical Flexibility and Structural Performance

Syed Waleed Nazim[1]

[1]National Centre For Physics, Islamabad, Pakistan, , Pakistan

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Syed Waleed Nazim*, Dr. Nisar Ahmad1

waleed.nazim@ncp.edu.pk*, nisar.ahmadkhan@ncp.edu.pk1

Abstract

Lightweight and porous nanostructured complied materials are carbon nanotube (CNT) Bucky paper
that possesses high surface area and good electrical conductivity. Nevertheless, the superb intrinsic
mechanical characteristics of single CNTs are frequently overcome by macroscopic Bucky paper films
being brittle and with low mechanical strength because of a small inter-tube van der Waals forces and
aggregation of nanotubes. These constraints limit their high industrialization uses. This research will
work towards creating and optimizing polymer Bucky paper composites using CNT to improve on
mechanical flexibility and the structural performance. Bucky paper will be produced through Vacuum

filtration of carbon nanotubes that are multi-walled as MWCNTs, and then polymer will be added
through solution processes. To enhance interfacial bonding and stress transfer, polymers such as
polyvinylidene fluoride (PVDF), polyaniline (PA) and Polypyrrole (PY) will be incorporated at different
levels (5%, 10% and 20%). FTIR, XRD, SEM, TEM, BET, TGA, and tensile tests will be used to carry out
structural, mechanical and thermal characterizations. Statistical analysis will be done to compare the
differences in performance of composite formulations. The desired result is the creation of standard

polymer reinforced Bucky paper made of CNTs that are much better in terms of tensile strength,

flexibility and thermal stability. The study will deliver a useful contribution to the understanding of the
relationship between structure and property and enable the development of high-performance CNT
based materials in the form of composites to be used in flexible electronics, aerospace structures,

filtration membranes, and energy storage systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Room temperature MOF-ZnO gas sensors based on RE(Eu,Er) incorporation for ppb-level n-butanol sensing

Mr. Hui Guo[1], Yinzhong Liu[1], Prof. Yun Guo[1], Mr. Lingchao Wang[1], Ms. Xiaofan Li[1], Mr. Xiaotao Zhu[1], Mr. Yiyu Qiao[1], Ms. Xuechun Yang[2]

[1]Shanghai University, School of Materials Science and Engineering, 200444, China, [2]Shanghai University, Key Laboratory of Organic Compound Pollution Control Engineering, Ministry of Education, 200444, China

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The rapid advancement of industrialization has led to the emission of a growing number of volatile organic compounds (VOCs) into the atmosphere, posing significant threats to human health and the environment. Among these VOCs, n-butanol is recognized as a particularly harmful one. Herein, we present a MOF-ZnO n-butanol gas sensor doped with rare earth elements (Eu, Er), synthesized via a homogeneous co-precipitation method. The as-prepared samples were comprehensively characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), Brunauer-Emmett-Teller (BET) analysis, and ultraviolet-visible (UV-vis) spectroscopy to evaluate their morphological, structural, and physicochemical properties. In comparison to the pure MOF-ZnO sample and the MOF-ZnO samples individually doped with 0.08 wt% Eu and 0.06 wt% Er, the MOF-ZnO sample co-doped with 0.04 wt% Eu 0.03 wt% Er exhibited the highest oxygen vacancy concentration and the largest specific surface area, as well as the optimal response, selectivity and long-term stability toward n-butanol. Notably, at room temperature, the 0.04 wt% Eu 0.03 wt% Er co-doped ZnO sensor achieved a response value of 555 toward 100 ppm n-butanol, which is 13.88 times higher than that of pure MOF-ZnO (40). Furthermore, the sensor also displayed a fast response time (33 s) and recovery time (27 s) for n-butanol detection, offering a versatile and highly promising strategy for constructing high-performance VOC sensors.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Enhanced H_2 Sensing Performance of Pt/Pd-Decorated ZnO Nanorod Sensors via O_3 Surface Activation

Yuyeon Lee[1], Jun-Young Lee[1], Ye-Won Song[1], Jeonghye Yoon[1], Jeongmin Lee[1], Suncheon Lim[2], Hyeongyeong Gu[2], Kyoung-Kook Kim[1,2]
[1]Department of Semiconductor Engineering, and Research Institute of Advanced Convergence Technology, Tech University of Korea, , , [2]Department of Semiconductor Engineering, Tech University of Korea, ,
Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

As hydrogen (H_2) emerges as a critical clean energy carrier, the demand for high-performance gas sensors with rapid response and high sensitivity is escalating for safety monitoring in hydrogen-based infrastructures. Among various sensing materials, metal oxide semiconductors (MOS), such as Zinc Oxide (ZnO), have been widely investigated due to their excellent chemical stability and structural tunability. However, achieving high sensitivity at lower operating temperatures remains a challenge, necessitating advanced surface functionalization strategies.

In this study, we propose a dual-functionalization strategy to enhance H_2 detection performance by combining Pt/Pd-decorated ZnO nanorod (NR) with ozone (O_3) surface activation. ZnO NRs were grown via hydrothermal synthesis to maximize the reactive surface area. Platinum (Pt) and palladium (Pd) thin films were deposited by sputtering and subsequently transformed into uniformly distributed nanoparticles (NPs) through thermal annealing to serve as catalytic sites. To further optimize the surface properties, O_3 surface activation was employed to modulate surface oxygen vacancies and increase the density of adsorbed oxygen species (O^-, O^{2-}), thereby widening the initial depletion region of the ZnO NRs.

The integration of Pt/Pd NPs facilitates the dissociative adsorption of H_2 via the spillover effect, while the O_3 surface activation significantly optimizes the baseline resistance and electronic properties. Our results demonstrate that this synergistic modification provides superior sensing sensitivity and faster recovery time compared to pristine ZnO NRs. These findings suggest a promising strategy for developing next-generation H_2 sensors for industrial safety applications.

This research was partly supported by the Institute of Information & Communications Technology Planning & Evaluation(IITP)-ICAN(ICT Challenge and Advanced Network of HRD) grant funded by the Korea government(Ministry of Science and ICT) (IITP-2026-RS-2022-00156326, 50) and Carbor alized Graduate Program through

the Korea Environmental Industry & Technology Institute(KEITI) funded by the Ministry of Climate, Energy and Environment(MCEE).

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Flexible and Robust Graphene/MXene@Carbon Fiber Composite Films with Highly All-weather Anti-icing/deicing Efficiency

Dr Zhang Zhengdong[1], Dr Zhang Zhen[1], Professor Li Zhipeng[1]

[1]University Of Science And Technology Beijing, Xueyuan Road, Haidian District,, China

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The development of flexible and robust materials combining efficient photothermal/electrothermal conversion with high environmental stability remains a critical challenge for anti-/de-icing under extreme cold conditions. Here, we introduce a laser ablation-assisted strategy that simultaneously achieves reduction and microstructure engineering to fabricate a hierarchical reduced graphene oxide/MXene@carbon fiber composite film. This process overcomes key limitations of MXene, such as insufficient photothermal efficiency, environmental instability, and brittleness. Nd:YAG nanosecond laser ablation enables dual in situ functionalities: near-complete reduction of GO (92% C=O bond conversion) and creation of hydrophobic micro-protrusions, yielding a water contact angle of 135.5° with self-cleaning ability. A dense reduced graphene oxide overlayer enhances environmental stability, improving corrosion resistance by an order of magnitude versus pristine MXene. The film shows a 230% increase in mechanical toughness over pure MXene and exhibits rapid thermal response—reaching 85 °C in 180 s at 2 V and 120 °C in 60 s under one-sun irradiation. These properties enable efficient all-weather de-icing, delaying ice formation for 356 s at –15 °C and melting ice within 57 s via photothermal–electrothermal synergy. This work demonstrates an innovative synchronous reduction and structuring approach for advanced anti-icing/deicing materials.

Formulation of SnO2 Nanoparticle-Based Inks for Reliable Inkjet Printing of Chemiresistive Gas Sensing Thin Films

Ms Anagha Vijayan[1], Dr Poornesh P[1]

[1]Manipal Academy Of Higher Education, Manipal Institute of Technology, Manipal,, India

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Inkjet printing has appeared as a promising route for the scalable fabrication of functional metal oxide thin films for gas sensing applications. However, device performance remains limited by insufficient control over material structure, defect levels and film morphology, while achieving controlled nanoparticle assembly, stable dispersions and uniform film formation continues to be a critical challenge. This work presents the formulation of nanoparticle-based SnO_2 inks, with emphasis on controlling nanoparticle growth and surface characteristics to understand how processing influences the structure and final performance of inkjet-printed thin films for chemiresistive gas sensing applications.

SnO_2 nanoparticles are synthesized via a hydrothermal method under controlled conditions to tailor particle size and defect density, which can influence sensing performance. Systematic optimization of ink composition, including solvent selection, additives, and rheological properties, improves dispersion stability and suppresses agglomeration-induced clogging. This approach ensures reliable jetting and droplet formation in a piezoelectric drop-on-demand system (DMP 2850) and promotes uniform nanostructured film deposition on glass substrates. Low-temperature post-processing is explored to preserve nanostructural features, thereby enabling future integration with flexible devices.

Ongoing work focuses on evaluating gas sensing performance and extending the approach to doped SnO_2 systems to enhance sensitivity and selectivity. This study establishes a pathway toward fully inkjet-printed gas sensors by integrating sensing layers with printed interdigitated electrodes using conductive inks, providing a foundation for next-generation printed functional devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Universal cell membrane camouflaged nanoprodrugs with right-side-out orientation adaptingfor positive pathological vascular remodeling in atherosclerosis

Xian Qin[1]

[1]Chongqing University Three Gorges Hospital, , China

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

A right-side-out orientated self-assembly of cell membrane-camouflaged nanotherapeutics is crucial for ensuring their biological functionality inherited from the source cells. In this study, a universal and spontaneous right-side-out coupling-driven ROS-responsive nanotherapeutic approach, based on the intrinsic affinity between phosphatidylserine (PS) on the inner leaflet and PS-targeted peptide modified nanoparticles, has been developed to target foam cells in atherosclerotic plaques. Considering the increased osteopontin (OPN) secretion from foam cells in plaques, a bioengineered cell membrane (OEM) with an overexpression of integrin a9b1 is integrated with ROS-cleavable prodrugs, OEM-coated ETBNPs (OEM-ETBNPs), to enhance targeted drug delivery and on-demand drug release in the local lesion of atherosclerosis. Both in vitro and in vivo experimental results confirm that OEM-ETBNPs are able to inhibit cellular lipid uptake and simultaneously promote intracellular lipid efflux, regulating the positive cellular phenotypic conversion. This finding offers a versatile platform for the biomedical applications of universal cell membrane camouflaging biomimetic nanotechnology

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Solar-driven degradation of methylene blue using tin sulfide–decorated silicon nanowire heterostructures

Pravesh Negi[1], Deepika Singh[1], Monika Pathak[1], Arup Samanta[1,2]

[1]Indian Institute of Technology Roorkee, Quantum/Nano-science and Technology Lab, Department of Physics, Indian Institute of Technology Roorkee, Roorkee 247667, Uttarakhand, India, India, [2]Indian Institute of Technology Roorkee, Centre for Nanotechnology, Indian Institute of Technology Roorkee, Roorkee 247667, Uttarakhand, India, India

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study presents the development of a heterostructured photocatalyst comprising tin sulfide (SnS) nanoparticles integrated with silicon nanowires (SiNWs) for solar-assisted degradation of dye pollutant. Vertically aligned SiNWs were prepared using a metal-assisted chemical etching technique, followed by the deposition of SnS nanoparticles through a spin-coating method to form a stable and substrate-supported heterojunction system. Upon exposure to solar light, the SnS–SiNWs photocatalyst demonstrated markedly improved degradation efficiency, achieving approximately 86% removal of Methylene blue (MB) dye within 240 minutes, whereas pristine hydrogen-terminated SiNWs showed only 69% degradation under similar conditions. The reaction kinetics revealed that the degradation rate constant of the heterostructure was about 1.7 times higher than that of the bare SiNWs. This enhanced photocatalytic performance is mainly attributed to the synergistic effects of broadened light absorption spanning the UV to near-infrared region and more effective separation of photogenerated electron–hole pairs, facilitated by the favorable band alignment at the SnS/SiNWs interface, as supported by ultraviolet photoelectron spectroscopy analysis. Notably, the degradation process occurs without the need for additional oxidizing agents, underscoring its eco-friendly nature. Further investigation using ultra-high-performance liquid chromatography–mass spectrometry confirmed that the dye degradation proceeds through sequential pathways involving demethylation, hydroxylation, and eventual ring cleavage, yielding smaller molecular intermediates. Overall, this work highlights the potential of SnS–SiNWs heterostructures as efficient and sustainable photocatalysts for solar-driven treatment of organic dye contaminants.

A Polydimethylsiloxane-SiO2 water-repellent coating for conservation of Adobe (Volcanic Tuff) Stones

Mr. Lanz Gius Villanueva[1], **Dr. Mary Donnabelle Balela**[1]
[1]University Of The Philippines, , Philippines

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Adobe, or volcanic tuff, is one of the most widely used building materials in heritage structures in the Philippines. These adobe structures have to be protected against degradation factors, the most significant of which is water, which can cause loss of strength and decay acceleration, among other factors. Existing lime plaster treatments tend to significantly change the color of the adobe stone, which may be aesthetically or conservationally unacceptable for some people. Thus, a composite treatment based on polydimethylsiloxane (PDMS, Sylgard 184) and SiO2 particles is evaluated as an alternative treatment, which should possess transparent and water-repellent properties but remain vapor-permeable. The concentration of SiO2 and the amount of coats applied on the surface were varied, and the effects on the respective properties were studied. All treatments applied on the stones via brushing exhibited enhanced hydrophobicity, with static water contact angles ranging from 129.30° to 151.20°. The treated adobe samples also showed a reduced water capillary absorption of up to 29.43% of its original value after 3 hours. Likewise, changes in the water vapor permeability were within the acceptable threshold change of 20%. However, some SiO2-containing treatments exceeded the allowable color change due to the increased white cast. Lastly, all the treatments exhibited mechanical durability by maintaining an enhanced hydrophobic surface after conducting tape peeling cycles. Using VIKOR, a multiple criteria decision-making method, the best treatment is 3 coats of 20 w/w% SiO2:PDMS, which fulfills all of the criteria measured in this study.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Ultrafast Laser Surface Treatment Enabling High-Quality and High-Efficiency Machining of Crystalline semiconductors

Yuliang Zhang[1], **Mr. Qihao Guo**[1], Prof. Yingchun Guan[1,2]

[1]School of Mechanical Engineering & Automation, Beihang University, , China, [2]National Engineering Laboratory of Additive Manufacturing for Large Metallic Components, Beihang University, , China

Poster Session - S09: Nanostructures, Nanocomposites & Nanoparticles (NNN), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Semiconductor materials are widely used in advanced electronic and power devices, whereas their high hardness, brittleness, and chemical stability pose substantial challenges to high-efficiency and high-quality machining. Ultrafast laser processing has attracted increasing attention in semiconductor surface engineering because of its excellent flexibility and capability for precise surface modification. Existing studies have shown that ultrafast laser surface treatment can effectively reduce surface defects introduced by mechanical machining, decrease surface roughness, remove oxide layers, regulate surface morphology and preserve electrical performance. Recent findings further indicate that it can improve material removal behavior and reduce machining-induced damage. Our research offers critical guidance for the high-quality, high-efficiency machining of semiconductor materials.

Thermally robust organic photovoltaic devices based on a low content of amorphous donor polymers

Prof Mats Andersson[1]

[1]Flinders University, Flinders Institute for Nanoscale Science & Technology, College of Science & Engineering, Australia

Session 01 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

Polymer solar cells have attracted significant interest over the past decades. In recent years, their photovoltaic performance has improved rapidly, achieving high power conversion efficiencies in laboratory-scale devices. This work focuses on the design and synthesis of novel materials, with particular emphasis on the thermal stability of polymer solar cells. Thermal stability is critical for long-term device reliability, as solar cells are frequently exposed to elevated temperatures during both fabrication and operation. Our study includes device stability measurements and investigations of morphological stability using dynamic mechanical thermal analysis (DMA). DMA is a highly sensitive technique for probing the thermal transitions of the materials employed.

Several fully amorphous indacenodithiophene-based polymers with varied side-chain architectures were synthesised and employed in solar cells in combination with the Y6 acceptor. Low donor-to-acceptor (D:A) ratios are generally considered less efficient than the conventional 1:1.2 ratio. However, several devices in this study achieved peak power conversion efficiencies exceeding 11% at significantly lower D:A ratios. Surprisingly, increasing the polymer content led to a decline in photovoltaic performance. A similar trend was observed for nanoparticles composed of the same materials and applied in photocatalytic hydrogen evolution, with optimal performance at a D:A ratio of 1:6.7. Notably, thermal stability tests revealed a substantial enhancement in device stability at 85 °C for low D:A ratios (1:10), with these devices surpassing commercial high-performance polymer systems in efficiency after 30 days of continuous stability measurements.

Impact of Metal–Electron Transport Layer Interfacial Reactions on Electron Collection in Organic Photovoltaics

Prof Hiroyuki Yoshida[1]

[1]Chiba University, 1-33 Yayoi-cho, Inage-ku, Japan

Session 01 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

In organic and organic–inorganic hybrid photovoltaic cells, inserting an electron transport layer (ETL) at the cathode/semiconductor interface markedly enhances electron collection efficiency. However, the underlying mechanism has remained elusive because direct observation of lowest unoccupied molecular orbital (LUMO) alignment at organic/metal interfaces has been challenging. We recently developed low energy inverse photoelectron spectroscopy (LEIPS) [1,2], which enables precise and direct measurement of LUMO levels in organic semiconductors. This technique provides unique access to unoccupied interfacial states, allowing detailed investigation of electron injection mechanisms at semiconductor/electrode interfaces [3,4].

Here, we focus on three widely used ETLs: PDINO, PFN Br, and PNDI F3N Br. Using LEIPS, we determined their electron affinities (EAs) to be 3.67 eV (PDINO), 1.86 eV (PFN Br), and 3.64 eV (PNDI F3N Br). In contrast, the EAs of acceptor materials commonly used in organic photovoltaic cells, such as C_{60}, PCBM, ITIC, and Y6, are in the range of 3.5–4.0 eV [5], indicating a large electron collection barrier at the ETL/acceptor interface. This apparent contradiction is resolved by considering interfacial reactions between the metal and ETLs, which can lower the LUMO level toward the Fermi level and thereby enable efficient electron injection [4].

These results elucidate the interfacial electronic mechanisms of ETLs and highlight the critical role of interface reactions in facilitating efficient electron collection in organic electronic devices.

[1] H. Yoshida, Chem. Phys. Lett. 539–540, 180 (2012).
[2] H. Yoshida, J. Electron Spectrosc. Relat. Phenom. 204, 116 (2015).
[3] H. Yoshida, K. Yoshizaki, Org. Electron. 20, 24 (2015).
[4] H. Yoshida, J. Phys. Chem. C 119, 24459 (2015).
[5] A. Sugie, K. Nakano, K. Tajima, I. Osaka, H. Yoshida, J. Phys. Chem. Lett. 14, 11412 (2023).

July 14, 2026 | 11:30 AM

Organic Solar Cells: From Low Band-gap Materials to Mechanism Study

Professor Ke Gao[1]

[1]Shandong University, 72 Binhai Road, Jimo, China

Session 01 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

The talk will start with design and synthesis of a series of low band-gap porphyrin-based donor materials in OPV. Then it will be focused on the verification of multi-length scale morphology, which clarifies the direction of device optimization. Then the deep physical mechanism for energy loss will be presented. Finally, it will be focused on the applications of porphyrin based donor materials in different kinds of organic solar cells, such as, tandem cell, ternary cell, flexible cell, semitransparent cell, some of which have achieved some record performance. Furthermore, it validates that such class of porphyrin based materials are the best low band-gap donor materials to date.

Enhancing the Performance of Organic Photovoltaics through Spatial Control of Spontaneous Orientation Polarization

Seita Kyogoku[1], Haruto Jibiki[1], Masahiro Ohara[2], Taku Oono[3], Takahisa Shimizu[3], Takeshi Okada[4], Nobumichi Arai[4], Hisao Ishii[1], Hirohiko Fukagawa[1]

[1]Chiba University, 1-33 Yayoi-cho, Inage-ku, Japan, [2]The University of Osaka, 1-3 Machikaneyama-cho, Japan, [3]NHK Science & Technology Research Laboratories, 1-10-11 Kinuta, Setagaya-ku, Japan, [4]Tosoh Corporation, 2743-1 Hayakawa, Japan

Session 01 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

Further improvement in the performance of organic photovoltaics (OPVs) requires precise control of charge separation and recombination at the donor/acceptor (D/A) interface. Recently, control of local internal electric fields using interfacial dipole layers has emerged as an effective strategy. Among these approaches, spontaneous orientation polarization (SOP), originating from the spontaneous alignment of polar molecules, is particularly promising because it can generate internal electric fields without external doping or special electrode design. However, in conventional bulk heterojunction devices, the intrinsic role of SOP in photovoltaic operation remains unclear because of the effects of morphology and trap states.

In this study, we fabricated an ideal planar heterojunction OPV in which only SOP was controlled while keeping the energy level structure constant. HN-D2 was used as the donor, and M2PT and M4PT were used as acceptors. These acceptor materials have similar molecular backbones and nearly identical electron affinities, but different SOP magnitudes. Rotary Kelvin probe measurements showed that M2PT had no appreciable SOP, with a surface potential gradient of −1.3 mV/nm, whereas M4PT exhibited pronounced SOP with a gradient of 60 mV/nm. By stacking these materials, we independently controlled the position and magnitude of the SOP-induced internal electric field.

Device evaluation revealed that introducing an ultrathin (<15 nm) M4PT layer at the HN-D2/M2PT interface promoted charge separation and improved power conversion efficiency by about 1.5 times. In contrast, thickening the M4PT layer (>15 nm) caused a potential drop of several hundred millivolts, leading to hole accumulation at the HN-D2/M4PT interface in the low-voltage region. Displacement current measurements showed that the accumulated charge induced exciton–polaron quenching (EPQ), resulting in marked performance deterioration. Ultimately, we establish that the precise spatial control of SOP—localizing an ultrathin layer exactly at the charge

generation interface—is a universal design rule to maximize charge separation while thoroughly suppressing EPQ.

Suppressing Static and Dynamic Disorder for High-Efficiency and Stable Thick-Film Organic Solar Cells via Synergistic Dilution Strategy

Doctor Zhen Fu[1], Professor Xiao-Tao Hao[1]

[1]Shandong University, , China

Session 01 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 10:50 AM - 12:20 PM

Despite the progress made in organic solar cells (OSCs) in recent years, their widespread commercial implementation remains challenging. The transformative potential of OSCs lies in their ability to combine high efficiency and stability, which is crucial for enabling large-scale and cost-effective implementation. Additionally, the limitation of the active layer thickness is an obstacle to large-scale implementation of OSCs, currently constrained between 80 and 120 nm for high-efficiency devices. Few studies and optimization strategies for stable thick-film OSCs, and the mechanism of the degradation of device efficiency caused by aging and increasing film thickness remain elusive.

In this study, we modified ZnO with Polymethyl Methacrylate (PMMA) to introduce a synergistic dilution strategy, reduce oxygen defects, and form a suitable work function. Furthermore, the modified transport layer demonstrated a surface energy comparable with that of the acceptor, facilitating precise control of the vertical phase distribution of the donor/acceptor within the active layer when operating under inverted conditions. We found that static disorder was responsible for the decrease in device parameters owing to increased film thickness, whereas dynamic disorder was predominant during thermal aging. In synergistically diluted devices, the dynamic disorder is reduced by suppressing electron-phonon coupling, whereas intermolecular interactions are enhanced to optimize molecular stacking, thereby mitigating static disorder.

July 14, 2026 | 1:20 PM

All-Perovskite Tandem Solar Cells - Sn(II) oxidation and suppression

Professor Dewei Zhao[1]

[1]Sichuan University, , China

Session 02 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 1:20 PM - 3:10 PM

Tandem solar cells using all metal-halide perovskite thin films show great promise for next-generation solar cells in terms of reduced cost, flexibility, and high efficiency, an effective way to break the Shockley-Queisser limit of single-junction cells. Low-bandgap mixed tin (Sn)-lead (Pb) and wide-bandgap perovskite solar cells, as the key to make highly efficient all-perovskite tandem solar cells, have been gaining extensive interest due to their appropriate bandgaps and promising application to build efficient all-perovskite tandem cells. Growth process of perovskites plays a crucial role in the formation of high-quality perovskites. We will present perovskite crystallization regulation strategies such as universal close space annealing (CSA) and buried interface-assisted growth, etc to increases grain size, enhances crystallinity, and prolongs carrier lifetimes in low-bandgap (~1.25 eV) and wide-bandgap (~1.75-1.80 eV) perovskite films, leading to high-quality perovskite absorber layers. We will then present the Sn(II) oxidation routes and suppression strategies. We will also present new self-assembly monolayer (SAM) materials for efficient wide-bandgap perovskite subcells and their mechanisms for reducing interfacial charge non-radiative recombination losses. We will also discuss the design and optimization of interconnecting layers for all-perovskite tandems.

July 14, 2026 | 1:40 PM

Lattice-Reservoir Semiconductors for next generation optoelectronic applications

Dr Xiaoming Wen[1]

[1]RMIT University, 124 La Trobe Street, Australia

Session 02 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 1:20 PM - 3:10 PM

Metal halide perovskites (MHPs) have redefined the limits of solution-processed photovoltaics, yet their unique behavior—spanning femtosecond to hour- Non-Equilibrium Dynamics — defies classical semiconductor frameworks. This work introduces the term Lattice-Reservoir Semiconductors (LRS) to describe a class of functional matter where the crystal lattice acts as an active energy reservoir rather than a static backdrop for charge transport.

Central to this concept is the Lattice Energy Reservoir (LER), which governs the strong, time-dependent coupling between charge carriers, phonons, lattice and ions. We demonstrate that LRS characteristics underpin dynamic defect tolerance: a holistic, reversible process where light illumination "charges" the reservoir, triggering lattice relaxation and ionic redistribution that physically heal non-radiative recombination centers. Unlike the static defect models used for covalent semiconductors, the LRS framework accounts for the metastable enhancement of carrier lifetimes and photoluminescence efficiency observed under operational conditions.

Furthermore, we discuss the transition from LRS theory to practical devices via Lattice Battery Solar Cells (LBSC), which exploit the reservoir's capacity to store and release potential energy. By framing MHPs as Lattice-Reservoir Semiconductors, we provide a unified explanation for their outstanding performance and inherent instability. This paradigm shift moves the field beyond static figures of merit, offering a roadmap for designing "smart" materials capable of real-time structural self-optimization and integrated energy storage for next-generation optoelectronics.

July 14, 2026 | 2:00 PM

Organic Photocatalytic and Photoelectrochemical Systems for Sustainable Hydrogen Production

Prof Han Young Woo[1]

[1]Korea University, , South Korea

Session 02 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 1:20 PM - 3:10 PM

Hydrogen (H_2) is widely regarded as a sustainable energy vector owing to its high gravimetric energy density, ease of transport, and carbon-free utilization. Among various green hydrogen production strategies, photocatalytic approaches are attractive because of their conceptual simplicity and low cost; however, their practical implementation is still hindered by limited efficiency. Therefore, the development of next-generation photocatalytic materials is essential to improve hydrogen evolution activity and reduce system-level costs.

In parallel, the rapid expansion of solar energy technologies has stimulated intensive research on photoelectrochemical (PEC) cells for direct solar-to-fuel conversion. In this context, organic semiconductors have gained increasing attention as photoelectrode materials due to their molecular tunability and strong light-harvesting capability. Despite these advantages, their application in aqueous PEC environments remains challenging because of inefficient interfacial charge transfer and insufficient film stability.

In this presentation, we report a newly developed class of photoactive materials designed to address these limitations. Their optical properties and hydrogen evolution performance in both photocatalytic and PEC configurations will be discussed. Furthermore, we will highlight recent insights into how molecular design governs material functionality and device behavior, providing design guidelines for achieving efficient solar-driven hydrogen production.

July 14, 2026 | 2:20 PM

Interface and Morphology Engineering for Organic and Perovskite Solar Cells

Professor Chih-ping Chen[1]

[1]Ming Chi University of Technology, 84 Gungjuan Rd., Taishan Dist., Taiwan, ROC

Session 02 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 1:20 PM - 3:10 PM

Organic photovoltaics (OPVs) and perovskite solar cells (PSCs) have progressed rapidly, yet their practical deployment still hinges on simultaneously improving efficiency, operational stability, and process tolerance. Here, we report a unified interface–morphology engineering strategy that enables high-performance OPVs and PSCs by combining (i) non-volatile solid additive control in bulk heterojunctions and (ii) robust self-assembled interlayers for carrier-selective contacts. For OPVs, we demonstrate that solid-state additives can provide durable morphology regulation beyond conventional volatile processing aids. In a PM6 system, the incorporation of a ferrocene-based solid additive yields a power conversion efficiency (PCE) of greater than 19.5% with balanced charge generation and suppressed recombination, indicating enhanced nanoscale organization and improved electronic coupling. Furthermore, in all-polymer ternary OPVs, composition-guided phase separation control delivers an excellent thermal durability, maintaining ~80% of the initial efficiency after 1500 h aging at 120 °C, highlighting the benefit of thermally resilient morphology. For PSCs targeting indoor energy harvesting, we develop a self-assembled hole-selective interlayer integrated with NiOx to reduce interfacial losses and stabilize contact energetics. We further used additive and electron selective layer to promote the performance of PSC. Devices exhibit indoor efficiencies exceeding 40% under 1000 lux WLED illumination while retaining performance over extended storage/operation (e.g., >700 h) without encapsulation under ambient conditions. Collectively, these results underline the pivotal role of interfacial energetics and morphology stabilization in advancing both OPVs and PSCs, and provide practical guidelines for designing scalable, high-efficiency photovoltaic platforms spanning outdoor and indoor applications.

July 14, 2026 | 2:40 PM

High Performance 2D/3D Tin-Lead Perovskite Solar Cells Achieved by Phenethylamine Acetate Post-Treatment

Xiangyu Xue[1], yuying hao[2], shiqi li[3]

[1]Taiyuan University Of Technology, 79 Yingze West Street, Taiyuan, China, [2]Taiyuan University Of Technology, 79 Yingze West Street, Taiyuan, China, [3]Taiyuan University Of Technology, 79 Yingze West Street, Taiyuan, China

Session 02 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 1:20 PM - 3:10 PM

Environmentally friendly hybrid Sn-Pb-based perovskite solar cells (PCSs) have made great progress recently. However, the serious Sn(II)/I vacancy defects within perovskite film due to poor thermodynamic stability and strong reaction activity of Sn(II) still limit the efficiency and stability of Sn-Pb-based PSCs. In this work, we proposed a PEAAc post-treatment method to mitigate successfully this problem. Sn-Pb-based perovskite films were post-treated by phenethylamine acetate (PEAAc) to form a 2D layered structure on the surface of 3D perovskite film, which passivate the defects on the surface and at grain boundary of 3D perovskite and block the erosion of water and oxygen. In addition, the coordinate energy of Ac- with Sn2+/Pb2+ is larger than I-, which effectively inhibits the oxidation of Sn2+ and suppresses the ionic migration. Besides, the introduction of PEAAc also modify the band energy alignment at the perovskite interface. Benefiting from these roles of PEAAc, the photovoltaic performance and long-term stability of device are largely improved. As a result, the best device after PEAAc passivation achieves the open circuit voltage (VOC) of 0.79 V, the short-circuit current density (JSC) of 29.31 mA/cm2 and the fill factor (FF) of 0.75, and thus the PCE of 18.36% (the champion PCE of control device is only 14.75%). In addition, the PSCs treated by PEAAc can still maintain 60% of the initial efficiency stored in nitrogen after 700 hours.

Uncovering the Origin of Fullerenes Superiority as Electron Transport Layers in Perovskite Solar Cells

Mr Ryota Tozaki[1], Dr Masato Iwasawa[2], Mr Aruto Akatsuka[1], Prof Hiroyuki Yoshida[1]
[1]Chiba University, 1-33 Yayoi-cho, Inage-ku, Japan, [2]Nissan Chemical Corporation, 2-10-1 Tsuboi-nishi, Japan

Session 02 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 1:20 PM - 3:10 PM

Fullerene derivatives, such as C60, are widely used as electron transport layers (ETLs) in inverted perovskite solar cells, enabling high power conversion efficiency (PCE). In principle, materials with an electron affinity EA of 3.7–4.2 eV provide favorable energy-level alignment with the perovskite layer; however, only fullerene derivatives achieve superior PCE, and the origin of this effect remains unclear. In this study, we address this issue by comparing C60 (EA 4.0 eV) with PTCDA (4.2 eV), a representative organic semiconductor with a similar electron affinity.

Previous studies show that fullerenes penetrate $MAPbI_3$ and passivate defects, and that halide ions migrate into the fullerene layer, inducing charge transfer. These interfacial structural changes likely contribute to device performance. In this work, we deposited 10 nm-thick C60 and PTCDA layers on $MAPbI_3$ and tracked the time evolution of the surface composition using metastable atom electron spectroscopy (MAES). We find that interfacial structural changes also occur in PTCDA, but proceed more rapidly and prominently in C60.

In parallel, we evaluate thickness-dependent energy levels of the ETL using ultraviolet photoelectron spectroscopy (UPS) and low-energy inverse photoelectron spectroscopy (LEIPS). We observe that both materials form band bending from the $MAPbI_3$ to the ETL, favoring electron collection and hole blocking.

These results indicate that the performance difference originates from the extent of interfacial structural modification rather than simple energy-level alignment. C60 penetrates $MAPbI_3$ and interacts with halide ions, simultaneously inducing p-type doping in $MAPbI_3$ and n-type doping in C60, thereby forming an extended band bending region. As a result, it enhances electron collection.

July 14, 2026 | 3:30 PM

High-Performance p- and n-Type Organic Single-Crystal Semiconductors

Prof. Toshihiro Okamoto[1]

[1]Institute of Science Tokyo, 4259-G1-7 Nagatsuta, Midori-ku, Japan

Session 03 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

The advancement of organic electronics hinges on the development of high-performance organic semiconductors (OSCs) that possess high carrier mobility, excellent chemical stability, and robust processability. Our group has established innovative molecular design strategies to meet these demanding requirements for both p-type and n-type OSCs. A key innovation for p-type materials is the introduction of a novel "bent" π-core architecture. This specific molecular geometry effectively enhances intermolecular orbital overlap while suppressing molecular vibrations, leading to exceptionally high carrier mobility. We have also developed high-performance n-type OSCs through a distinct strategic approach. This presentation will detail our rational design principles, covering everything from synthesis and fundamental properties to the solid-state packing and device performance of our materials in single-crystal thin-film electronics.

Optoelectronic clusters for film devices

Professor Hui Xu[1]

[1]Heilongjiang University, Room 1125, Chemical Experimental Building, China

Session 03 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Molecular clusters are emerging as one kind of luminescent materials holding a promising for diverse optoelectronic applications. However, in additon to inefficient electrical properties, their cluster-centered triplet excited states (3CC) render nonradiation, therefore, reducing optoelectronic efficiencies. It is shown that charge transfer state properties of the clusters are crucial for improving excited-energy harvesting. Our group have reported a series photoluminescent (PL) and electroluminescent (EL) and responsible clusters, which realized top-rant quantum efficiencies. Through introducing donor groups in organic ligands to enhance ligand-centered excited states, we realized the first cluster-based sky-blue-emitting device with the record-high luminance and external quantum efficiency up to ~7000 nits and ~8%, respectively.It is shown that the electron-donating effect of donor groups can enhance ligand-centered charge transfer and locally excited states, and thoroughly suppress cluster-centered excited states through delocalizing the molecular transition orbitals from cluster unit to ligand. Recently, we reported two biphosphine chelated Cu4I4 clusters with asymmetric modification and electron-donating effect of acridine groups, leading to iodine-to-ligand charge transfer (ILCT) predominant excited states of the clusters, which feature thermally activated delayed fluorescence (TADF) with markedly improved singlet radiative rate constants and reduced triplet nonradiative rate constants. As a result, in comparison to parent cluster, acridine-modified [DPACDBFDP]2Cu4I4 achieved 16-fold increased PL (81%) and 20-fold increased EL (19.5%) quantum efficiencies. With the host engineering, the efficiencies can be further improved to the theoretical limit of ~30%. These results made optoelectronic clusters reaching the state-of-the-art performance of all kinds of optoelectronic materials.

Anisotropic polaronic nature of band structure in rubrene single crystal

Dr. Keisuke Fukutani[1,2], Dr. Daijiro Okaue[3], Prof. Ken-ichi Fukui[3], Prof. Hiroyuki Ishii[4], Prof. Kiyohisa Tanaka[1,2], Prof. Satoshi Kera[1,2]

[1]Institute for Molecular Science, , Japan, [2]The Graduate University for Advanced Studies , , Japan, [3]Osaka University , , Japan, [4]Tsukuba University, , Japan

Session 03 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

As the sustainability of our global resources and energy-harvesting rapidly becomes a central issue in navigating our technological advancements, the development of quantum devices made of organic molecular materials, characterized by their low fabrication cost and high bio-degradability, is of paramount importance. Among such organic molecular materials, rubrene (C42H28) has been known to exhibit exceptionally high carrier mobility [1], and is considered as a promising material for the next-generation electronics. However, despite these superiorities, the microscopic charge transport mechanisms, which must serve as the fundamental building blocks for the future strategic developments, still remain elusive.

In order to elucidate these aspects of organic materials, angle-resolved photoelectron spectroscopy (ARPES) has been utilized for rubrene and directly unveiled the dispersive band structure for HOMO-derived electronic states [2] and the polaron formations caused by the interactions of electrons with molecular vibrations, in our recent work [3]. These works revealed the importance of the competition between coherent conductions of itinerant charge carriers and effects of molecular vibrations that impede such ideal transport even in single-crystalline materials (or domains).

While these studies demonstrated the presence of polaronic effects, the macroscopic number of charge carriers in real crystalline materials are each characterized by different energies and momenta. Consequently, the full understanding of the polaronic conductions in organic semiconductor materials must involve the knowledge of polaronic interactions in the entire phase space. Thus, aiming to understand such complexity of polaronic effects, we take rubrene as a model case, and performed the comprehensive ARPES study on its quasiparticle spectra. The results illuminate on the yet unexplored natures of momentum-dependent polaronic effects in organic semiconductor materials.

J. Takeya et al., Appl. Phys. Lett. (2007). [2] S. Machida et al., Phys. Rev. Lett. (2010). [3] F. Bussolotti et al., Nat. Commun. (2017).

July 14, 2026 | 4:30 PM

The Surface and Interface Physics of Novel Organic-Inorganic Hybrid Semiconductor Optoelectronic Devices

Dr Jia Zhang

Session 03 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Organic-inorganic hybrid perovskite materials have demonstrated immense potential in optoelectronic applications, such as light-emitting diodes and solar cells. Unlike the characteristics of inorganic semiconductor single crystals or the amorphous nature of organic semiconductors, hybrid organic-inorganic semiconductor materials typically exist within thin films in polycrystalline—or even microcrystalline—forms; consequently, their surface and interface properties exert a significant influence on the performance of optoelectronic devices. To further enhance the performance of perovskite materials in the optoelectronic field and facilitate their practical implementation, in-depth investigation into their surface and interface physics is of paramount importance. Through the study of surface and interface physics:

1. We elucidated the mechanism of surface P-type doping-induced electroluminescence, thereby breaking through traditional theories of defect passivation and clarifying the mechanism by which high injection barriers can coexist with high quantum efficiencies [1]. We discovered the mechanism of electroluminescence originating from interfacial charge-transfer states, thereby expanding the dimensions available for optoelectronic modulation [2]. Furthermore, we challenged the entrenched notion that "transport layers degrade optical gain," thereby contributing to the resolution of critical challenges associated with low-threshold electrically pumped laser devices [3].

2. We pioneered a "uniform mixing" design strategy, innovatively resolving the issue of charge accumulation—a problem typically constrained by crystallization kinetics—and boosting charge transport efficiency by two orders of magnitude [4]. Additionally, by designing symmetric device architectures, we realized the world's first AC-driven perovskite light-emitting diode, achieving a significant leap in energy efficiency alongside enhanced operational stability [5].

References:
[1]Nature Materials, 2025, 10.1038/s41563-025-02123-y
[2]Nature Communications 11, 2618, 2020
[3]Advanced Materials 35, 2300922, 2023
[4]Joule 3, 3061, 2019

[5]Nano Energy 79, 105413, 2021

Modulation of carrier dynamics via (4-(Trifluoromethyl) benzohydrazine

for high-efficiency Sn-Pb perovskite solar cells

Na Yang[1], WenHui Guo[2], YuYing Hao[3]

[1]Taiyuan University Of Technology, Taiyuan 030024, China, China, [2]Taiyuan University Of Technology, Taiyuan 030024, China, China, [3]Taiyuan University Of Technology, Taiyuan 030024, China, China

Session 03 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Sn-Pb perovskites, with the advantages of low toxicity and ideal bandgap, demonstrate significant potential for fabricating high-efficiency perovskite single/tandem solar cells (PSCs). However, the performance of Sn-Pb PSCs is often limited by a high trap-state density and unbalanced charge carrier transport. To solve this problem, we proposed an effective additive of (4-(trifluoromethyl) benzohydrazine (4-3FBH) to regulate the carrier dynamic process in Sn-Pb perovskites. The results demonstrated that 4-3FBH improved the perovskite film crystallinity and formed the strong Sn-O/Pb-O coordination bonds and the H-I hydrogen bonds with the perovskite, and thus reduced the defect state density of perovskite. The strong passivation effects of 4-3FBH on the IPb, VI and ISn defects enabled the significantly reduced bulk trap-mediated recombination rates, defect scattering events and carrier capture cross sections, and achieved the balanced electron and hole transport. Moreover, the intermolecular π-π interaction and intramolecular charge redistribution of 4-3FBH also promoted the charge transfer at grain boundaries. Attributed to the increased carrier transport and the inhibited nonradiative recombination, the 4-3FBH-treated Sn-Pb PSCs attained the PCE of 18.52%, outperforming the control device (16.11%). The Pb-based PSCs with 4-3FBH-treatment also exhibited the enhancement of PCE from 22.10% to 24.30%, confirming the universality of 4-3FBH additive.

Carbazole SAM Interfaces and NFAs for Organic Photovoltaics

Professor Ergang Wang[1]

[1]Chalmers University Of Technology, Kemivagen 10, Sweden

Session 04 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Printed non-fullerene acceptor (NFA) organic photovoltaics (OPVs) are approaching record efficiencies, yet interfacial losses and instability at the transparent electrode remain key barriers to robust large-area processing. Carbazole–phosphonic acid self-assembled monolayers (SAMs) are widely used as buried hole-selective contacts on ITO, but incomplete coverage, interfacial disorder, and thicknessdependent transport limitations can compromise both performance and scale-up. Building on recent molecular-level studies that clarify how (i) monosubstituent chemistry in 1X-2PACz (X = F, Cl, Br, I, CF3) and (ii) alkyl spacer length in chlorinated nPACz derivatives control packing, work-function alignment, and tunneling distance, we establish a design–assembly framework for printed and stable NFA OPVs. In monosubstituted SAMs, Cl/Br/I substitutions favor dense packing and interfacial energetics, enabling up to 19.03% in PM6:L8-BO and 20.12% in D18:L8BO devices, whereas F and CF3 increase interfacial disorder. In spacer-engineered SAMs, structural and spectroscopic analysis show that shorter spacers enhance intermolecular interactions and ITO coverage while reducing series resistance; conversely, longer spacers increase the hole-tunneling barrier and degrade fill factor and Voc, with best performance reported for 2Cl-2PACz (up to 18.95%). Guided by these insights, we introduce a co-assembled multilayer SAM (coSAMu) strategy tailored for scalable processing by combining 2PACz and a longer-spacer chlorinated analogue (2Cl-4PACz) via blend casting and sequential casting. The resulting layered interface comprises a 2PACz-rich chemisorbed bottom layer that primarily sets the ITO work function and a 2Cl-4PACz-enriched upper layer that fills voids and passivates defects. This defect-filling architecture suppresses trapassisted recombination, improves charge extraction, and delivers 20.1% efficiency (0.042 cm2) with fill factors above 81%.

References:

1. Q. Chen, & E. Wang, ACS Energy Lett. 2025, 10, 5584–5595.
2. Q. Chen, & E. Wang, Adv. Sci. 2025, 12, 2410277.
3. J. Wu & E. Wang, Layered Defect-Filling Co-Assembled Carbazole-Based SAMs Deliver 20% Organic Solar Cells and 17% Mini-Modules. Manuscript.

Organic Diodes Bridging Electroluminescence and Photovoltaic Conversion: Interfacial Engineering of MR-TADF Thin Films for Full-Color Devices

Prof. Hirohiko Fukagawa[1], Taku Oono[2], Tsubasa Sasaki[2], Takuji Hatakeyama[3], Takahisa Shimizu[2]

[1]Chiba University, 1-33, Inage-ku,, Japan, [2]NHK Science & Technology Research Laboratories, 1-10-11, Kinuta, Setagaya-ku,, Japan, [3]Kyoto University, Sakyo-ku, , Japan

Session 04 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Bridging electroluminescence and photovoltaic conversion within a single organic diode represents a formidable challenge, yet it is essential for the realization of self-powered wearable optoelectronics. Previous photoelectric interconversion (PI) devices have suffered from a severe trade-off between the external quantum efficiency for electroluminescence (EQE_EL) and the power conversion efficiency for photovoltaic operation (PCE_PV), with their operational spectra largely restricted to the red-to-orange regions.

Here, we report the realization of highly efficient, full-color PI devices by utilizing multi-resonance thermally activated delayed fluorescence (MR-TADF) materials [1]. Leveraging their strong light absorption and high photoluminescence efficiency, we successfully fabricated thin-film PI devices exhibiting bright emission across the entire visible spectrum, including white. Remarkably, our green- and orange-emitting devices achieved excellent EQE_EL values exceeding 8.5% alongside a PCE_PV of ~0.5%. Conversely, blue-, red-, and white-emitting devices demonstrated a moderate EQE_EL (~2%) but a notably high PCE_PV exceeding 1%.

The key to simultaneously enhancing these conflicting metrics lies in the precise interfacial engineering of the device architecture. By systematically tuning the charge-transfer (CT) state energy and electronic coupling at the interface between the MR-TADF donor and electron-accepting molecules, we effectively optimized the delicate balance between radiative recombination and charge separation. Furthermore, the strategic selection of the electron injection layer and electrode materials critically contributed to the overall performance.

This work demonstrates the unprecedented coexistence of strong full-color visible emission and meaningful photovoltaic conversion in organic PI devices. During the talk, we will discuss the fundamental thin-film design strategies and interfacial energetics that pave the way for next-generation, energy-harvesting displays and self-powered sensors.

[1] T. Oono and H. Fukagawa et al., 26, 17, 694.

July 15, 2026 | 11:30 AM

Semitransparent Organic Solar Cell based on Nonfullerene Photocharge Generation

Dr. Han Yan[1]

[1]Xi'an Jiaotong University, Xianning West Road No. 28, China

Session 04 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Transparent organic solar cells represent an important direction for the commercialization of this emerging photovoltaic technology. To address the trade-off between high transmittance and high power conversion efficiency, I will introduce our recent progress on this challenge based on the concept of photo-charge generation within a single non-fullerene acceptor (NFA). Through n-type doping, photo-charge generation within NFA can partially compensate for the photo-charge originally generated at the donor/acceptor heterojunction. By leveraging p-type doping, discontinuous hole transport pathways in the donor can be supplemented by the acceptor. The presentation will discuss the underlying mechanisms as well as the resulting enhancements in power conversion efficiency.

Mitigating Energy Loss in Organic Solar Cells through Solid-State Emissive Molecular Design

Dr. Yingze Zhang[1], Prof. Lei Zhu[2], **Dr. Sai Ho Pun**[1]
[1]The Hong Kong University Of Science And Technology, , Hong Kong, [2]Shanghai Jiao Tong University, , China
Session 04 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

Organic solar cells (OSCs) have achieved remarkable progress in recent years, largely driven by the development of non-fullerene acceptors. Despite these advances, non-radiative recombination associated with interfacial charge-transfer (CT) states remains one of the most fundamental limitation, leading to significant open-circuit voltage loss and restricting further efficiency improvements. In high-performance donor–acceptor systems, CT excitons are typically weakly emissive and predominantly decay through non-radiative pathways.

Here, we present a photophysical strategy to mitigate energy loss by introducing thermally accessible radiative pathways via solid-state emissive molecular design. By incorporating emissive acceptor components into a high-performance host system, we engineer an energetically resonant landscape between localized excited (LE) states and interfacial CT states. This alignment enables thermally activated back-transfer of CT excitons to LE states, followed by efficient energy transfer to emissive species, thereby opening an indirect yet effective radiative recombination channel.

Spectroscopic characterization combined with theoretical calculation reveals that this CT–LE coupling facilitates enhanced radiative decay without compromising charge generation or transport. As a result, devices exhibit significantly improved electroluminescence efficiency and substantially reduced non-radiative voltage loss, reaching values as low as 0.142 eV. Importantly, this strategy is compatible with high-performance device architectures, enabling power conversion efficiencies exceeding 21% in single-junction OSCs.

This work establishes solid-state luminescence-enabled CT–LE coupling as a general and effective approach to suppress non-radiative recombination. Unlike conventional strategies that rely primarily on morphology or energetic offset optimization, this design introduces a new degree of freedom for minimizing energy loss, offering broad implications for the development of next-generation high-efficiency OSCs.

July 15, 2026 | 12:05 PM

Origin of Annealing Induced Work Function Changes in PEDOT:PSS

Kaito Ban[1], Yuki Furukawa[1], Hiroyuki Yoshida[1]
[1]Chiba University, 1-33 Yayoi-cho, Inage-ku, Japan
Session 04 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 10:50 AM - 12:20 PM

PEDOT:PSS is a conductive polymer and widely used as a hole transport layer in organic semiconductor devices. Because PEDOT:PSS is a heavily doped polymer, the work function (WF) is a key factor relevant to device applications, as it governs the interface energy level alignment and carrier injection/collection efficiencies at the PEDOT:PSS/semiconductor interface. It has been reported that WF of PEDOT:PSS changes upon annealing [1,2]. For Al4083, a representative PEDOT:PSS, the WF is approximately 5.24 eV immediately after film preparation. Upon annealing at 100 °C in vacuum, the WF increases to about 5.34 eV and further rises to approximately 5.50 eV after returning to room temperature. This behavior has been attributed to the desorption of water from the film [1].
In this study, the two types of PEDOT:PSS, Al4083 and HIL1.5, were examined. WF was measured using three different methods, Kelvin probe (KP), ultraviolet photoelectron spectroscopy (UPS), and low energy electron transmission (LEET). After spin-coating under the same conditions as in a previous study [1], we examined WF changes upon annealing. It is found that WF depend on the measurement methods; no apparent change was detected by KP, whereas clear changes were observed using UPS and LEET. This result suggests that the injection of electron/hole is the origin of WF changes.
[1] A. E. Mansour, et al., Adv. Electron. Mater., 6, 2000408 (2020).
[2] N. Koch, et al., Appl. Lett., 90, 043512 (2007).

July 15, 2026 | 1:20 PM

Toward Stable and High-Performance Sn Halide Perovskite Electronics: Thin-Film Transistors and NIR Photodetectors

Prof. Hui Joon Park[1]

[1]Hanyang University, 222, Wangsimni-ro, Seongdong-gu,, South Korea

Session 05 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Tin (Sn) halide perovskites have attracted growing interest as promising semiconductor materials for high-performance p-channel thin-film transistors (TFTs). Their small hole effective masses and relatively weak carrier scattering enable efficient hole transport, while their narrow bandgaps also make them attractive for near-infrared (NIR) photodetection. Despite these advantages, their practical implementation remains limited by chemical and structural instability, which often results in nonuniform films and high defect densities. In the first part of this presentation, I will discuss strategies for realizing stable, high-performance TFTs, with particular emphasis on controlling crystal formation through the regulation of nucleation and growth kinetics, as well as on compositional design approaches that stabilize the three-dimensional (3D) FASnI3 structure. In the second part, I will present a strategy for stabilizing the 3D MASnI3 structure for efficient NIR photodetectors. Taken together, these studies establish a promising framework for Sn halide perovskite electronics that combine outstanding device performance with improved operational stability, thereby expanding their potential for next-generation semiconductor technologies.

Chiral-perovskite optoelectronics

Prof. Guankui Long[1]

[1]Nankai University, No.38 Tongyan Road, Jinnan District, China

Session 05 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Recently, chiral hybrid organic-inorganic perovskites (HOIPs) have emerged as promising materials for chiroptoelectronics, spintronics and ferroelectrics. In this talk, I will report our latest advances in constructing chiral HOIPs through both traditional “bottom-up” synthetic approach and unconventional “top-down” nanofabrication, and compare the advantages and disadvantages of both approaches. I will demonstrate the specific benefits of combining chirality with the superior optic, electric and spintronic properties of perovskite, and their potential applications in chiral optoelectronic and spintronic devices, and conclude with our perspective on the future opportunities for chiral HOIPs.

Reference:

[1] Shao, T.; Zhao, W.; Niu, X.; Lu, H.; Zeng, X.; Wang, H.; Wang, Z.; Liu, W.; Sun, B.; Zhang, H.-L.; Chen, Y.; Long, G.; Angew. Chem. Int. Ed. 2026, 65: e16078

[2] Wang, Z.; Zeng, X.; Zhao, W.; Miao, Y,; Lu, H.; Wang, H.; Shao, T.; Niu, X.; Gull, S.; Qiao, T.; Sun, B.; Liu, X.; Zhang, H.-L.; Chen, Y.; Long, G.; J. Am. Chem. Soc. 2025, 147: 37771

[3] Niu, X.; Lu, H.; Zhang, B.; Shao, T.; Zhang, Y.; Wang, H.; Wang, Z.; Qiao, T.; Zhao, W.; Sun, B.; Xie, Y.; Chang, Z.; Lai, S.; Zhang, H.-L.; Long, G.; Nano Lett., 2025, 25: 14420

[4] Niu, X.; Li, Y.; Lu, H.; Wang, Z.; Zhang, Y.; Shao, T.; Wang, H.; Gull, S.; Sun, B.; Zhang, H.-L.; Chen, Y.; Wang, K.; Du, Y.; Long, G.; Nat. Commun., 2025, 16: 2525

[5] Shi, C.-M.; Lu, H.; Wang, J.-Y.; Long, G.; Xu, L.-J.; Chen, Z.-N.; Nat. Commun. 2025, 16: 1505

[6] Gull, S.; Zhao, W.; Wang, Z.; Zhang, Y.; Lu, H.; Niu, X.; Qiao, T.; Wang, H.; Shao, T.; Liu, W.; Sun, B.; Zhang, H.-L.; Chen, Y.; Long, G.; Angew. Chem. Int. Ed. 2025, 64: e202502029

Lateral Heterogeneity of 2D Ruddlesden-Popper Perovskite Films and Its Impact on Photovoltaic Performance

Dr. Fei Zheng[1]

[1]Ningbo University, 818 Fenghua Road, China

Session 05 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Abstract

2D Ruddlesden-Popper phase perovskites (2D RPPs) are potential candidate materials for next generation photovoltaics due their high intrinsic stability compared to their 3D perovskite counterparts. However, the structure of 2D RPP films favored for solar cell applications is highly heterogeneous in both phase distribution profile and energy landscape. To further improve the performance of 2D RPP-based solar cells (2D-PSCs), an in-depth knowledge of the structure of 2D RPP films and its impact on photovoltaic performance is essential.[1] The lateral heterogeneity of 2D RPP films on the tens of micro-meters scale and sub-grain scale are reported here based on the multi-modal investigations. It was found that the generally formed Brownian tree-shaped crystalline dendrites are detrimental to charge extraction by introducing empty voids at the buried interface, the elimination of which is promising for improving the power conversion efficiency of 2D-PSCs.[2] On the sub-grain scale, we have revealed that a lateral phase gradient across the grain generates a funnel-like energy landscape, which induces detrimental carrier relaxation toward the grain center before extraction.[3] This intragrain lateral funneling is identified as a direct and previously overlooked loss channel that affects the open-circuit voltage (VOC). Our work highlights the critical role of lateral phase uniformity and underscores the importance of regulating lateral phase heterogeneity for high-performance 2D-PSCs and RPP optoelectronics.

Reference

1. F. Zheng, D. Angmo, C.R. Hall, S. Rubanov, F. Yuan, J.S. Laird, M. Gao, T.A. Smith, K.P. Ghiggino, Adv. Mater. Interfaces 2022, 9 (13), 2102231.
2. F. Zheng, S. Rubanov, C. R. Hall, J. Liu, M. Gao, T. A. Smith, D. Angmo, K. P. Ghiggino, Adv. Mater. Interfaces 2025, 12 (13), 2401012.
3. B. Yang, F. Zheng,* Y. Hou, P. Wang, L. Sheng, X. Chen, S. Shafique, Z. Zhao, K. P. Ghiggino, Z. Hu, Nano Letters 2026, Accepted.

Guideline for Carbazole-based Hole-Collecting Monolayers in p-i-n Perovskite Solar Cells from the Viewpoint of Energy Level Alignment

Koki Sawai[1], Aruto Akatsuka[1], Hiroyuki Yoshida[1]

[1]Chiba University, 1-33 Yayoi-cho, Inage-ku, Japan

Session 05 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Hole-collecting monolayers (HCMs) have attracted significant attention as hole transport layers in p-i-n perovskite solar cells. Compared with previously used polymer based hole collecting layers, HCMs offer advantages in both device efficiency and operational lifetime. The hole collection efficiency of HCMs is inherently governed by the energy level alignment at the electrode/HCM/perovskite interface.

We have previously proposed a comprehensive model to describe interfacial energy level alignment based on semiconductor heterojunction theory [1]. In this model, the hole-collection efficiency is primarily determined by the interface energy barrier and the band bending at the HCM/perovskite interface, which originate from differences in the work function (WF) and ionization energy (IE), respectively.

In this study, we focus on carbazole-based HCMs, including Me-2PACz, Me-4PACz, 2PACz, MeO-2PACz, and 3PATAT-C3, and discuss the energy level alignment at the electrode/HCM/perovskite interface within the framework of this model. The WF and IE of these HCMs were measured using ultraviolet photoelectron spectroscopy (UPS). The results indicate the following trend in WF and IE:MeO-2PACz < 3PATAT-C3 < Me-2PACz ≈ Me-4PACz < 2PACz. This trend is further supported by molecular orientation information obtained from UPS and metastable atom electron spectroscopy (MAES), as well as by dipole moments and vertical IEs calculated using density functional theory (DFT) at the B3LYP/6-31G(d) level.

Based on these results, we discuss practical guidelines for selecting appropriate HCMs for a given perovskite layer.

1. A. Akatsuka, M. A. Truong, A. Wakamiya, G. Kapil, S. Hayase and H. Yoshida, J. Mater. Chem. A, DOI: 10.1039/D5TA04749H.

July 15, 2026 | 2:35 PM

Phase Stabilization and Defect Passivation in Lead Halide Perovskite Films

Handong Jin[1], Elke Debroye[2], Shihe Yang[3], Johan Hofkens[2], Xiaotao Hao[4]

[1]Shandong Jiaotong University, 5001 Haitang Road, Changqing District, China, [2]KU Leuven, Celestijnenlaan 200F, Belgium, [3]Peking University, 2199 Lishui Road, Nanshan, China, [4]Shandong University, 27 shanda road, Licheng, China

Session 05 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

Over the past few years, there has been growing interest in lead halide perovskites as promising materials for photovoltaics, light-emitting diodes (LEDs), X-ray detection, and catalysis applications, owing to their appropriate bandgaps, strong light absorption, defect tolerance, and long carrier diffusion lengths. However, conversion efficiencies and long-term stability remain two major hurdles preventing the widespread commercialization of perovskite-based devices. The primary challenges stem from the inevitable formation of harmful lattice defects during crystal growth and the susceptibility to phase transitions under external stimuli. To address these issues, defect passivation through doping and post-treatment strategies have been employed to enhance material performance. Phase stability represents a critical concern for the optoelectronic applications of all-inorganic lead halide perovskites. This presentation will introduce a novel strain engineering approach to achieve a stable photoactive perovskite phase. Finally, various perovskite applications, including photodetectors, LEDs, X-ray detectors, and photocatalysis, will be discussed.

July 15, 2026 | 2:50 PM

Perovskite Crystallization Regulation via Antimonene Quantum Sheets for Highly Efficient and Stable Solar Cells

Kangning Li[1], Yuying Hao[2], Chenxi Zhang[3], Min Zhao[4]

[1]Taiyuan University of Technology, No. 79 West Yingze Street, Wanbailin District, China,
[2]Taiyuan University of Technology, No. 79 West Yingze Street, Wanbailin District, China,
[3]Taiyuan University of Technology, No. 79 West Yingze Street, Wanbailin District, China,
[4]Taiyuan University of Technology, No. 79 West Yingze Street, Wanbailin District, China

Session 05 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 15, 2026, 1:20 PM - 3:05 PM

The two-step deposition method offers significant advantages in the production of high-performance planar perovskite solar cells (PSCs). Nevertheless, there are still numerous challenges in regulating perovskite crystallization during the two-step process. In this work, two-dimensional (2D) material antimonene quantum sheets (AMQSs) as an additive are introduced to regulate the crystallization process of perovskite. As a result, perovskite films with high crystalline quality and vertical growth orientation are obtained by AMQSs providing heterogeneous nucleation sites with the penetration of a mixture solution of AMQSs and FAI into the PbI2 layer. Also, the influence mechanism of AMQSs on the crystallization of perovskite film is analyzed in details. At the same time, due to the chemical interaction between antimonene and the uncoordinated Pb2+, the defects in the perovskite are efficiently passivated. In addition, the energy level at the perovskite/SnO2 interface becomes more matched, leading to improved charge transport and extraction with the incorporation of AMQSs. Benefiting from the versatile AMQSs, the power conversion efficiency (PCE) of PSCs made by PbI2 + FAI:AMQSs is improved from 20.65 to 22.31% with the vastly enhanced Jsc and Voc. The ambient and operational stability of the unencapsulated PSCs fabricated using the PbI2 + FAI:AMQSs method were significantly improved, retaining 80% of the original PCE after being stored in a dark environment at a relative humidity of 30–40% for 18 days and 83% of the original PCE following continuous AM 1.5G illumination for 200 h.

July 16, 2026 | 8:30 AM

Realization of Blue-Emissive Perovskite Nanocrystals Via Size Control and Post-Treatment of Organic Ligand

Dr. Chang-Lyoul Lee[1]

[1]Gwangju Institute of Science And Technology (GIST), 123 Cheomdangwagi-ro, Buk-gu, South Korea

Session 07 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 8:30 AM - 10:20 AM

Halide perovskite nanocrystals (PNCs) have garnered significant attention due to their excellent opto-electronic properties. Blue emissive PNCs can be realized via either size reduction or halide exchange. Low-temperature synthesis or ligand engineering can reduce the particle size of PNCs, resulting in blue emission. However, these methods cause low PLQY and structural degradation. To overcome these limitations, a novel fabrication method that changes the precipitation solvents during LARP (ligand-assisted reprecipitation) was developed. In addition, post-treatment of PNCs with an organic ligand was developed to achieve blue-emitting PNCs. The post-treatment of PNCs using an organic ligand increased PLQY by passivating halide defects and realized blue emission by Br-Cl halide exchange.

July 16, 2026 | 8:50 AM

Revealing Spin and Charge States in Thin Film Semiconductor Devices via Operando Electron Spin Resonance

Ph.D. Kazuhiro Marumoto[1]

[1]Department of Materials Science, Institute of Pure and Applied Sciences, University of Tsukuba, , Japan, [2]Research Center for Organic-Inorganic Quantum Spin Science and Technology (OIQSST), University of Tsukuba, , Japan, [3]Tsukuba Research Center for Energy Materials Science (TREMS), University of Tsukuba, , Japan

Session 07 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 8:30 AM - 10:20 AM

Thin-film semiconductors such as organic materials and organic-inorganic hybrid perovskites have been actively studied because they are lightweight and flexible, and exhibit functionality and high performance not found in conventional semiconductors. They can be easily fabricated by a solution method, and they are also attracting attention in terms of applications for large-area and low-cost production. In this talk, we will introduce the world's first electron spin resonance (ESR) method for thin-film semiconductor devices in the device operating state (operando state) and our research results. The ESR method is characterized by its ability to study electron spin states in materials and devices from a microscopic viewpoint at the atomic and molecular level with high sensitivity and accuracy. First, the development history and application examples of the operando ESR method for organic thin-film transistors and organic thin-film solar cells will be described. Then, the recent results of operando ESR studies on organic thin-film solar cells and perovskite solar cells will be presented.

July 16, 2026 | 9:10 AM

Tailoring spontaneous orientation polarization in organic thin-film devices for improved performance

Yutaka Noguchi[1], Mr. Mihiro Takeda[1], Mr. Masaki Yono[1], Mr. Yuki Fujisawa[1]
[1]Meiji University, 1-1-1 Higashimita, Tama-ku, Japan
Session 07 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 8:30 AM - 10:20 AM

Spontaneous orientation polarization (SOP) has been frequently observed in organic semiconductor films, particularly in materials used for organic light-emitting diodes (OLEDs). SOP arises from the partial alignment of permanent dipoles during vacuum deposition and induces polarization charges at the interfaces of stacked multilayer devices, which can strongly affect carrier distribution and device operation. Since SOP commonly occurs in many organic semiconductor films, understanding and tailoring its effects are essential for rational thin-film device design.

We have previously proposed “dipolar doping” as a strategy to engineer interfacial charge accumulation in OLEDs. Although this method can induce SOP even in intrinsically nonpolar films, such as hole transport layers (HTLs), it often deteriorates charge transport because of the dipolar disorder effect. To address this issue, we systematically examined dipolar-doped HTLs and identified material combinations, such as TPBi:NPB and OXD-7:TAPC, that enable SOP induction while maintaining charge transport characteristics. These results indicate that appropriate material selection allows effective tuning of SOP without significantly compromising transport properties, providing a practical strategy for improving the performance of OLED stacks and related thin-film devices.

We will also briefly introduce our recent efforts to understand the thermal stability of SOP in multilayer structures. Our results suggest that SOP stability is influenced not only by the polar layer itself but also by the thermal properties of adjacent layers. These findings highlight the importance of considering both the formation and stability of SOP in the design of practical organic thin-film devices.

July 16, 2026 | 9:30 AM

An Insight in the Role of Dopamine Acted in the Electroless Deposition Process using Surface and Interface Force Spectroscopy

Accociate Professor Xiaomin Kang[1]

[1]University Of South China, , China

Session 07 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 8:30 AM - 10:20 AM

Polydopamine (PDA) as a versatile coating material has attracted broad interest in the application of electroless deposition (ELD) due to its facile fabrication and abundant resources. The cross-linking density of PDA has an important effect on surface binding properties. Due to the complexity of cross-linked networks, however, it is still difficult to directly detect the cross-linking degree of polymers at a microscopic level. In this study, PDA coatings are measured at the single-molecule level by means of atomic force microscopy (AFM)-based single-molecule force spectroscopy (SMFS). The obtained single peak (S-type) and multiple peak (M-type) force curves are used to define the typical force-extension (F-E) curves of the linear polymers with single chain and the cross-linked polymers with multiple chains, respectively. Furthermore, the as-prepared Cu plating PDA deposited PP substrate also exhibits excellent metallic conductivity in the deposition of DA for 16 h at the concentration of 0.02 M, which is in accordance with those from the SMFS results. Attributed to the scanning electron microscopy (SEM), fourier transform infrared spectrum (FTIR) and some other measurements, it further indicates that PDA with different cross-linking degrees using SMFS has proven the role as both reductive sites and binder in the ELD of Cu on polymer substrate. Besides, it is expected that AFM-based SMFS can be used as a general method to study different cross-linked polymers in the ELD and other surface modification processes.

New hole-transporting materials based on the NPB and m-MTDATA skeletons for optoelectronics

Dr. Audrius Bucinskas[1], dr. Oleksandr Bezvikonnyi[1], dr. Dmytro Volyniuk[1], prof. Pavlo Stakhira[2], dr. Khrystyna Ivaniuk[2], PhD student Ehsan-Ullah Rashid[1], dr. Stepan Kutsiy[2], prof. Juozas Vidas Grazulevicius[1]

[1]Kaunas University of Technology, K. Donelaicio st. 73, Lithuania, [2]Lviv Polytechnic National University, S. Bandera 12, Ukraine

Session 07 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 8:30 AM - 10:20 AM

OLED-based displays are gaining popularity because of their excellent luminous efficiency, impressive contrast ratio, quick response time, and capability to create flexible screens, among other advantages. Organic light-emitting diodes (OLEDs) generally have a sandwich structure with four to six electroactive layers between the electrodes. Each layer plays a specific role in the optoelectronic device. For example, the light-emitting layer serves as a recombination site for electrons and holes to produce visible light, and the hole or electron-transporting layer plays an important role in the respective charge transportation. In this work, we focused mainly on hole-transporting layer (HTL) materials. There are several commercially available HTL materials, such as N,N′-di(1-naphthyl)-N,N′-diphenyl-(1,1′-biphenyl)-4,4′-diamine (NPB) and 4,4’,4”-tris(N-3-methylphenyl-N-phenyl-amino) triphenylamine (m-MTDATA), which are well known and widely used in optoelectronics and photovoltaics [1, 2]. Our aim is to tune the NPB and m-MTDATA skeletons by introducing methoxy, ethoxy, or N,N-dimethylamine groups. As a result, ten new compounds were obtained using a simple two-step synthesis. All targeted derivatives, as well as m-MTDATA and NPB, demonstrated high thermostability with 5% weight loss temperatures exceeding 385 oC. Owing to the incorporation of electron-donating (methoxy and dimethylamine) groups into the aromatic system, the target derivatives possess lower ionization potentials with IP values lower than those of commercial counterparts (NPB and m-MTDATA). Additionally, the new derivatives were employed in OLED structures to investigate their potential in devices. The optoelectronic properties showed an increase in the efficiency of OLEDs based on the novel derivatives.

The main synthesis routes of the new derivatives and a comparison of their photophysical, morphological, and optoelectronic properties will be presented.

[1] S. Jhulki, J.N. Moorthy, J. Mater. Chem. C. 6 (2018) 8280–8325.

[2] S. Shahnawaz, S. Sudheendran Swayamprabha, M.R. Nagar, R.A.K. Yadav, S. Gull, D.K. Dubey, J.H. Jou, J. Mater. Chem. C. 7 (2019) 7144 -7158.

July 16, 2026 | 10:05 AM

Electronic structure of an organic Mott insulator β'-(BEDT-TTF)$_2$ICl$_2$ observed by angle-resolved photoelectron spectroscopy

Dr. Ryotaro Nakazawa[1], Dr. Keisuke Fukutani[2], Mr. Yuto Ishida[1], Mr. Seiji Makita[2], Dr. Kiyohisa Tanaka[2], Dr. Takuya Kobayashi[3], Dr. Horomi Taniguchi[4], Dr. Kazuyoshi Yoshimi[5], Dr. Junya Otsuki[6], Dr. Satoshi Kera[2]

[1]Chiba University, 1-33, Yayoi-cho, Inage-ku, Japan, [2]Institute for Molecular Science, 38, Saigonaka, Myodaiji-machi, Japan, [3]Hokkaido University, Kita 13, Nishi 8, Kita-ku, Japan, [4]Saitama University, 225, Shimo-Ohkubo, Japan, [5]University of Tokyo, 5-1-5, Kashiwanoha, Japan, [6]Okayama University, 3-1-1, Tsushimanaka, Kita-ku, Japan

Session 07 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 8:30 AM - 10:20 AM

Molecular crystals of strongly correlated systems have attracted interest because they exhibit a variety of quantum phases, such as superconductivity, spin-liquid states, Mott insulating phases, and topological phases. While the origins of these quantum phases are largely encoded in the electronic structures, their momentum-resolved pictures are not fully understood, i.e., they have been primarily investigated using theoretical calculations. In this study, we focused on the single crystal of an organic Mott insulator β'-(BEDT-TTF)$_2$ICl$_2$ and observed the valence band electronic structure using angle-resolved photoelectron spectroscopy (ARPES).

ARPES measurements were performed at BL7U in UVSOR. ARPES photoemission intensity plot and the second-derivative plot reveal the bandgap and two band structures in the valence band top region, e.g., the dispersed band width along the short crystal axis (c-axis) is about ~20 and ~140 meV at binding energy of ~0.5 and ~0.7 eV, respectively. Since the observed band periodicity corresponds to that of the Brillouin zone, we have successfully observed itinerant electrons in this material. Other high-symmetric momentum directions are measured to confirm the characteristics of the electronic structure by ARPES. We revealed the electronic properties of this material, particularly from the perspective of Mott insulating behavior, based on a series of ARPES experimental results and calculated electronic structures from density functional theory+dynamical mean field theory.

Organic chiral spin materials

Wei Qin[1]

[1]Shandong University, 27# Shandanan Road, China

Session 08 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 10:45 AM - 12:20 PM

From a traditional perspective, organic materials without 3d electrons are difficult to exhibit room temperature ferromagnetism. Since the last century, people have tried to prepare organic ferromagnets (including organic small molecules and polymers), but most organic materials with ferromagnetism can only show ferromagnetism at low temperatures. In recent 5 years, we have carried out the preparation of new organic room temperature ferromagnetic crystals and the study of the magneto-optical effect of organic crystals. By designing the special structure between polymer crystals and small molecules, the necessary factors of room temperature ferromagnetism are summarized as: 1. the charge transfer system breaks the original closed shell structure into open shell structure; 2 the crystal structure provides a long ordering of spin; 3. designed donor and acceptor molecular configuration; 4 donor and acceptor with different electron-phonon coupling coefficients. Subsequently, the room temperature ferromagnetic crystals with chirality were prepared by designing the organic crystals into helical structures and introducing the orbital angular momentum induced by the helical structures. In this chiral ferromagnetic crystal, circularly polarized light can effectively regulate the orbital angular momentum induced by the helical structure, and then affect the overall magnetization. At present, by changing the orbital angular momentum by external electric field, the related work of exploring the regulation of electron spin polarization by circularly polarized light photons on organic ferromagnetic crystals has been carrying out.

[1] Wei M., Yang Y., Song K., Huang Q., Tian Y., Hao X., Qin W.*, Organic multiferroic magnetoelastic complexes, Adv. Mater., 2020, 32: 2003293.
[2] Hu, R.; Lu, X; Hao, X.; Qin, W.*, Circularly Polarized Light Detecting, Adv. Mater., 2023, 35: 2003293
[3] Gao, M.; Lu, X.; Yang, Y.; Qin, W.*, Adv. Mater., Photon–Dipole–Spin Interactions, 2024, 36: 2405024

July 16, 2026 | 11:05 AM

Intrinsically Stretchable Polymer Semiconductors for Polarimetric Organic Photodetectors

Professor Byoung Hoon Lee[1]

[1]Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, South Korea

Session 08 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 10:45 AM - 12:20 PM

Intrinsically stretchable polymer semiconductors are promising materials for wearable electronics, as they can conform to soft and dynamically deforming surfaces while maintaining stable electronic and optoelectronic performance. However, simultaneously achieving high charge carrier mobility and stretchability remains a major challenge due to the trade-off between molecular ordering and mechanical compliance. In this talk, I will present our recent advances in intrinsically stretchable polymer semiconductors that exhibit both high charge carrier mobility (>0.1 cm^2/V-s) and stretchability (>200%). Mechanical stretching induces controlled molecular orientation in polymer thin films, leading to pronounced anisotropic optoelectronic properties with a polarization dichroic ratio approaching 4.0. This intrinsic anisotropy enables polarizer-free polarization-sensitive organic photodetectors, overcoming the optical loss and sensitivity limitations of conventional polarizer-based devices. Finally, I will briefly highlight wearable sensing applications enabled by these devices, including motion-tolerant photoplethysmography monitoring.

Intentional Reduction of Charge-Carrier Density in Conducting Polymer Films for Organic Transistors

Dr. Felix Sunjoo Kim[1]

[1]Chung-ang University, Heukseokro 84, Dongjakgu, South Korea

Session 08 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 10:45 AM - 12:20 PM

Thin films of conducting polymers, whether they function as electronic or ionic conductors, are typically doped to attain high charge-carrier densities and, consequently, high conductivity. However, for certain applications, low conductivity is often more desirable. Such cases include both a channel of organic transistors and an electrolyte of electrochemical memory devices. In this talk, we present our recent work on intentional reduction of charge-carrier densities in electronic conducting polymer films and in ionic conducting polymer films. By chemically dedoping conducting polymers, we can decrease both off-state current and threshold voltage in organic transistors, demonstrating enhancement-mode operation. The dedopants can embedded in the transistor structure to simplify the fabrication. We can also change the ionic concentration of solid-state electrolyte films to modulate ion-conducting properties and to impart memory functionalities to the transistor-type devices for spiking neural networks. The device-level analysis can reveal the operation mechanism.

Ion-Regulated Flexible Thin-Film Devices for Biomimetic Actuation and Intelligent Sensing

associate professor Sha-Sha Wang[1]

[1]Nanjing University Of Posts And Telecommunications, , China

Session 08 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 10:45 AM - 12:20 PM

Precise regulation of ion transport represents a fundamental scientific challenge for achieving biomimetic actuation and intelligent sensing in flexible thin-film devices. This report presents a series of advances from our group in material design and the development of integrated sensing-actuating devices, unified by the theme of ionic regulation. For actuation devices, molecular engineering of Type-A nanograting structures was employed to modulate the nanophase distribution in PEDOT:PSS films, yielding a 40% enhancement in ion-electron coupling efficiency and a bending angle exceeding 100°. Building upon this, an ion-anchoring electrolyte membrane was constructed based on a Zn-TPP anionic framework, achieving a displacement retention rate of 99.7% under variable-frequency electric field stimulation, effectively replicating the contraction mechanism of the human achilles tendon. Furthermore, ionic perovskite materials were incorporated into PEDOT:PSS electrode layers, wherein the anchoring effect of the anionic framework on electrolyte cations induces ionic migration hysteresis, enabling the functional coupling of synapse-like plasticity and activity-dependent actuation enhancement within a single device architecture—offering a novel strategy for autonomous control in soft robotics. To overcome the challenge of monolithic sensing-actuating integration, we introduce an A type grid with supramolecular hindrance and nanoconfinement into the electrolyte layer. This leverages the Arrhenius temperature dependence of ion migration to precisely modulate ion transport, achieving high ionic conductivity, enhanced capacitance, and reduced activation energy. The device delivers actuation (0.74% strain at ±1.0 V) and temperature sensing (8.99 %/°C) simultaneously. Voltage controlled decoupling enables closed loop remote (700 km) human–machine interaction with adaptive temperature response. Collectively, these studies establish a coherent technological pathway from molecular engineering to system integration through multiscale structural regulation of ionic thin films, laying a material and device foundation for the advancement of embodied intelligent robotics.

Direct Observation of the Conduction Band Structure of Crystalline Pentacene by Angle-Resolved Low-Energy Inverse Photoemission Spectroscopy

Issei Ishimori[1], Haruki Sato[1], Hiroyuki Yoshida[1]
[1]Chiba University, 1-33 Yayoi-cho, Inage-ku, Japan
Session 08 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 10:45 AM - 12:20 PM

Electron mobility in organic semiconductors is significantly lower than hole mobility, which remains a major unresolved issue and a long-standing mystery in the research community. Understanding the conduction band structure, namely the energy–momentum dispersion of electrons, is essential for elucidating electron transport mechanisms and providing insights into this problem.
We developed low-energy inverse photoemission spectroscopy (LEIPS) in 2012 [1] and extended it to angle-resolved LEIPS (AR-LEIPS) [2]. Using this technique, we observed the conduction band structure of an organic semiconductor for the first time [3]. By examining the conduction bandwidth of polycrystalline pentacene thin films, we demonstrated polaron formation and proposed a partially dressed polaron model to address the inferior electron mobility [3]. However, due to the polycrystalline nature of the films, it was difficult to accurately determine the band dispersion near the Brillouin zone boundary.
In this study, we employ epitaxially grown pentacene multilayers on Cu (110) to investigate the conduction band structure. The LUMO-derived band was measured along the Γ–X, Γ–Y, and Γ–M directions, enabling observation of the band dispersion along the crystal axes [4]. Furthermore, we recently improved the energy resolution of the AR-LEIPS system by incorporating an electron energy analyzer [5] into the electron source, resulting in an improvement from 0.24 eV to 0.10 eV. This advancement enables a more precise determination of the conduction band structure.

References
[1] H. Yoshida, Chem. Phys. Lett. 539-540, 180 (2012)
[2] Y. Kashimoto, et al., Rev. Sci Instrum,94, 063903 (2023)
[3] H. Sato, et al., Nat Mater. 21, 910 (2022)
[4] H. Sato, Ph.D. thesis, Chiba University (2023)
[5] H. Ibach, et. al., Rev. Sci. In strum, 94, 043908 (2023)

July 16, 2026 | 1:30 PM

HTL- & ETL-free Metal-Semiconductor-Metal Structure Organic Solar Cells

Prof. Shinuk Cho[1]

[1]University of Ulsan, 93 daehak-ro Nam-gu, South Korea

Session 09 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

In high-performance organic solar cells (OSCs), electron transport layers (ETLs) and hole transport layers (HTLs) play critical roles in facilitating efficient extraction and transport of charge carriers from the photoactive layer to the corresponding electrodes. However, the incorporation of ETLs and HTLs introduces additional complexity and remains a key challenge in OSC research. In this study, we present a fabrication strategy that eliminates both ETL and HTL, enabling structural simplification while preserving high performance through simple interfacial modifications at the active layer–electrode interfaces. To realize a Metal–Semiconductor–Metal (MSM) architecture without ETL and HTL, we explored three approaches: Type-I employed a self-assembled monolayer (SAM) at the anode interface and a salt-based interlayer at the cathode; Type-II utilized distinct salt-based treatments at both anode and cathode interfaces; and Type-III involved co-depositing hole-transport-capable molecules with the active layer to spontaneously form a hole-extraction interface, while modifying the cathode with amine salts for efficient electron collection. All three approaches successfully produced high-performance MSM-type OSCs, achieving power conversion efficiencies exceeding 18%, comparable to those of conventional devices employing ETLs and HTLs. These results demonstrate that device complexity can be substantially reduced without compromising performance, suggesting a practical pathway toward more scalable and manufacturable organic photovoltaic technologies.

Molecular and Electronic Structural variations in semiconducting polymers for organic photovoltaics

Dr. Kyohei Nakano[1]

[1]RIKEN CEMS, 2-1, Hirosawa, Japan

Session 09 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Semiconducting copolymers are widely used as electron-donating materials in organic photovoltaics (OPVs). Despite rapid progress toward power conversion efficiencies (PCEs) exceeding 20%, batch-to-batch variability in polymer performance remains a critical challenge for large-scale manufacturing. A given polymer batch can yield high PCE, whereas others show significantly lower performance.

In this talk, I will discuss two types of variations in copolymers—molecular structural variations and electronic structural variations—and their impact on OPV performance. We have recently developed a methodology to precisely quantify the ratio of donor (D) and acceptor (A) units in copolymers using X-ray photoelectron spectroscopy (XPS) [1]. Our analysis reveals the presence of small amounts of homo-coupled segments (-D–D- and -A–A-), which originate from non-ideal polymerization reactions.

These structural imperfections act as defects that broaden the density of states (DOS) of the highest occupied molecular orbital (HOMO) [2]. This increased energetic disorder reduces charge carrier mobility [3], ultimately leading to a degradation in OPV performance. Our findings highlight the critical role of subtle structural deviations in determining the electronic properties and device performance of semiconducting polymers.

References

[1] K. Nakano, Y. Kaji, R. Suzuki, and K. Tajima, “Quantifying unit ratios in semiconducting copolymers and effect of structural deviations on photovoltaic performance,” Commun. Mater. 6(1), 1–9 (2025).

[2] K. Nakano, Y. Kaji, and K. Tajima, “Highly sensitive evaluation of density of states in molecular semiconductors by photoelectron yield spectroscopy in air,” ACS Appl. Mater. Interfaces 13(24), 28574–28582 (2021).

[3] K. Nakano, Y. Kaji, and K. Tajima, “Impact of narrowing density of states in semiconducting polymers on performance of organic field-effect transistors,” Small 19(3), e2205570 (2023).

July 16, 2026 | 2:10 PM

Quinoxaline-based Nonfullerene Acceptors for Highly Efficient Organic Solar Cells

Feng Liu[1]

[1]Shanghai Jiao Tong University, 800 Dongchuan RD. Minhang District, China

Session 09 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Organic solar cells (OSCs) possess inherent advantages such as lightweight, flexibility, semi-transparency, and large-area roll-to-roll printing capability, making them highly promising for high-value applications in autonomous IoT devices and building-integrated photovoltaics. The emergence of fused-ring electron acceptor, exemplified by ITIC, marks a pivotal transition in organic photovoltaic technology from conventional fullerene-based systems to high-performance non-fullerene acceptors. However, the power conversion efficiency (PCE) of OSCs still lags significantly behind that of inorganic counterparts, primarily constrained by high non-radiative recombination energy loss and photon loss. The current bottleneck for advancing OSC performance lies in achieving efficient charge dissociation under ultralow energy loss conditions while maximizing short-circuit current density. Through the development of a series of quinoxaline-based nonfullerene electron acceptors, we have precisely tailored their electronic and aggregation structures, coupled with device engineering to effectively manage carrier and photon losses, thereby achieving high-performance OSCs with a PCE of ~21%.

July 16, 2026 | 2:30 PM

Engineering Exciton Dissociation Pathways for Efficient and Stable Organic Photovoltaic Devices

Associate Professor Kangning Zhang

[1]Shandong University, , China

Session 09 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

Benefiting from the synergistic development of material design, device engineering, and the mechanistic understanding of device physics, the certified power conversion efficiencies (PCEs) of single-junction non-fullerene organic solar cells (OSCs) have already reached a very high value of exceeding 20%. However, in addition to PCEs, the poor stability is now a challenging obstacle for commercial applications of organic photovoltaics (OPVs). Herein, recent progress made in exploring operational mechanisms, anomalous photoelectric behaviors, and improving long-term stability in non-fullerene OSCs are highlighted from a novel and previously largely undiscussed perspective of engineering exciton and charge carrier pathways. Considering the intrinsic connection among multiple temporal-scale photocarrier dynamics, multi-length scale morphologies, and photovoltaic performance in OPVs, this review delineates and establishes a comprehensive and in-depth property-function relationship for evaluating the actual device stability. Moreover, this review has also provided some valuable photophysical insights into employing the advanced characterization techniques such as transient absorption spectroscopy and time-resolved fluorescence imagings. Finally, some of the remaining major challenges related to this topic are proposed toward the further advances of enhancing long-term operational stability in non-fullerene OSCs.

July 16, 2026 | 2:50 PM

Critical length screening enables high-performance thick-film organic solar cells

Yuan Meng[1], Hang Yin[1]

[1]Shandong University, School of Physics, State Key Laboratory of Crystal Materials,, China

Session 09 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 1:30 PM - 3:05 PM

The commercialization of organic solar cells (OSCs) requires thick-film active layers, yet current thick-film-compatible acceptor selection based on zero-field mobility is unreliable due to methodological inconsistencies in experimental protocols, fitting models, and single-carrier device configurations. Existing literature indicates that the zero-field mobility in high-performance thick-film devices shows negligible differences compared to thin-film counterparts, thereby invalidating its significance as a selection criterion. This study introduces a protocol identifying critical length - an intrinsic property distinct from zero-field mobility - as the decisive factor for thick-film OSC performance. Comparative studies reveal that enlarged acceptor domains with high critical length yield increased hopping frequency, improved charge mobility and reduced field-dependent, collectively enhancing performance. Applying this criterion, we identify BTP-eC9 as a general acceptor, which significantly improves the device performance of thick-film OSCs. This work not only demonstrates the fabrication of high-performance thick-film OSCs, but fundamentally advances material screening methodology specifically tailored for thick-film-compatible organic semiconductors.

High-Performance All-Polymer Solar Cells

Prof. Yanming Sun[1]

[1]Beihang University, , China

Session 10 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 3:45 PM - 5:05 PM

In recent years, with the rapid development of non-fullerene small molecule acceptors, the efficiency of organic solar cells has been continuously improved. However, small molecule acceptors have disadvantages, such as easy crystallization, poor photothermal stability and stretchability. In contrast, polymer acceptors can compensate for these shortcomings of small molecule acceptors. The all-polymer solar cells prepared have excellent stability and mechanical flexibility, showing great potential in wearable and flexible stretchable devices. The all-polymer system, with its high solution viscosity and good leveling performance, is very suitable for the preparation of large-area printed devices. Therefore, all-polymer solar cells have more advantages in commercial applications. Although the all-polymer system has many advantages, the research on all-polymer solar cells is relatively limited and the performance is relatively low. This report will systematically introduce the recent research progress of our research group in the field of all-polymer solar cells, including the design of high-performance polymer receptor materials, morphology control of all-polymer systems, device stability research, and green large-area processing.

Effect of Intramolecular Vibrations on Electron and Hole Transport in Organic Semiconductors

Prof. Hiroyuki Ishii[1]

[1]Department of Materials Science, University of Tsukuba, 1-1-1 Tennodai, Japan

Session 10 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 3:45 PM - 5:05 PM

Organic semiconductors attract attention as low-cost printable thin film materials, because the hole mobilities exceed 10 cm^2/Vs. For practical applications, electron mobilities comparable to hole mobilities are required; however, the electron mobility in most organic semiconductors remains an order of magnitude lower than the hole mobility. Understanding of charge (electron and hole) transport mechanisms is essential to develop the new organic molecules with higher electron mobility. In recent studies, it has been believed that the mobility is restricted by the "dynamic disorder" induced by the molecular vibrations. However, the dynamic disorder picture is hard to explain the origin of low electron mobility. Recently, Yoshida et al. developed angle-resolved low-energy inverse photoemission spectroscopy and succeeded in measurement of the conduction band structures of organic semiconductors, pentacene. As a result, we revealed the formation of "partially dressed polaron"[1] generating the difference between electron mobility and hole mobility.

In this study, we systematically investigated the mobilities of several p-type and n-type organic semiconductors using the time-dependent wavepacket diffusion (TD-WPD) method [1,2]. The TD-WPD method enables us to study transport of charge coupled with molecular vibrations, considering the partially dressed polaron formation and dynamic disorder in a unified way. Our results indicate that a low-frequency intramolecular vibration, such as a molecular stretching mode, is strongly coupled with electron than hole, resulting in significant difference between hole and electron mobilities. In this presentation, we will show how to unify the partially dressed polaron picture and dynamic disorder picture, then provide a detailed analysis of the results. We also present a theoretical interpretation to understand difference between electron-molecular vibration coupling strength and hole-molecular vibration one using a simple quantum well model.

[1] H. Sato, H. Ishii, H. Yoshida, et al., Nature Mat. 21, 910 (2022). [2] H. Ishii, et al., Phys. Rev. B 98, 235422 (2018).

Self-Assembled Electret Thin Films: From Spontaneous Orientation Polarization to Charge-Free Vibrational Energy Harvesters

Yuya Tanaka[1]

[1]Gunma University, 1-5-1 Tenjin-cho,, Japan

Session 10 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 3:45 PM - 5:05 PM

The long-term deployment of wireless sensor nodes requires a sustainable power source. Vibrational energy harvesters are attractive because mechanical vibrations are widely available in natural and engineered environments. Among the available approaches, electret-based devices offer high open-circuit voltages and are compatible with microelectromechanical systems (MEMS) processing. However, conventional electrets generally require an additional charging step, complicating manufacturing and device integration. An alternative route is provided by self-assembled electrets based on thin films of polar organic semiconductors. Owing to spontaneous orientation polarization (SOP), these films develop a built-in surface potential by vacuum deposition, eliminating the need for dedicated charging. In this talk, particular emphasis is placed on patterned self-assembled electret thin films prepared through through-hole patterning and their application in charge-free vibrational energy harvesters. Kelvin probe and scanning Kelvin probe measurements show that the average surface potential of patterned tris(8-hydroxyquinolinato)aluminum films originates from SOP and can be controlled by the effective average film thickness, pattern density, and aperture ratio. Because the electret layer can be deposited after the fabrication of the movable electrode, this approach is compatible with scalable processing. These results demonstrate the potential of SOP-based thin films as practical electret layers for next-generation self-powered transducers and related organic electronic interfaces.

July 16, 2026 | 4:45 PM

Revealing the influence of the dispersion property of charge transport on the stability of organic solar cells

Professor Hang Yin[1]

[1]Shandong University, , China

Session 10 - S10: Organic Electronics and Photonics (OEP), Seletar3 - Level 3, July 16, 2026, 3:45 PM - 5:05 PM

Charge transport is an important property that influences the stability of organic solar cells (OSCs). For example, the average charge mobility usually decreases during device degradation, which is naturally considered an essential factor reducing device stability. Importantly, the charge transport property of organic semiconductors has two important aspects: one is the average charge mobility and the other is the dispersion parameter of charge transport. While the average charge mobility is widely studied and discussed, the dispersion property of charge transport is often overlooked. The dispersion parameter characterizes the dispersion of transit times in charge transport. A high dispersion parameter typically indicates a significant population of slow charge carriers in OSCs, which could introduce more charge recombination and ultimately compromise device stability. In this work, we establish that the dispersion parameter, along with charge carrier mobility, significantly affects device stability, and demonstrate that the initial morphology of the active layer plays a crucial role in their degradation. In specific, our findings indicate that branched crystalline domains tend to stabilize the charge carrier mobility, while clustered crystalline domains suppress degradation of the dispersion parameter during the thermal aging. This work not only establishes a morphology-transport stability framework for enhancing the charge transport stability, but also discovers the significance of sustaining a balanced mobility-dispersion property for ensuring the long-term stability of OSCs.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Semitransparent Organic Solar Cell based on Nonfullerene Photocharge Generation

Dr. Han Yan[1]

[1]Xi'an Jiaotong University, , China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Human eye transparency is one of the most attractive merits for potential application of organic solar cells. To solve the core challenge of ‘photovoltaic-transparency’ dilemma in donor-poor photoactive layer, we propose to develop the bulk photo-charge generation pathway in non-fullerene acceptors. The heterojunction independent photo-charge generation and bipolar charge transporting within non-fullerene acceptor help to overcome in morphology defects in donor-poor blend. We utilize n-type molecular doping to maximize the photo-charge yield and p-type molecular doping to enhance bipolar transporting in non-fullerene acceptors.

Sonication-induced J-aggregation in nonhalogenated solvents boosts exciton delocalization for high-efficiency organic solar cells

Dr. Mingxu Zhou[1], Prof. Xiaotao Hao[1]

[1]Shandong University, 27 Shanda Nanlu, China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The commercialization of organic solar cells (OSCs) requires eliminating halogenated solvents. However, the disordered molecular aggregation of nonfullerene acceptors (NFAs) in nonhalogenated solvents hinders achieving high power conversion efficiencies (PCEs). Herein, this problem is addressed using an external physical field modulation strategy involving the sonication of NFA solutions to induce a transformation from disordered molecular aggregation to ordered J-aggregation via microstreaming and shear stress. The aggregation is effectively preserved within films, enhancing π-π stacking interactions. Moreover, sonication promotes the conversion of localized excitons to intra-moiety delocalized excitons and suppresses molecular vibrations. The PCEs of PM6:L8-BO-based binary and ternary devices fabricated using o-xylene are 19.43% and 20.41% (certified 19.84%), ranking among the highest values reported for nonhalogenated solvent-processed OSCs. The binary devices also exhibit high thermal stabilities (T80 lifetime > 10000 h). This universally applicable strategy effectively controls disordered aggregation in NFA solutions, thus paving the way for practical industrial applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Non-Contact Dipole Moment Electric Modulation Achieving High Performance Near-Infrared Organic Photodetectors

Xue Shi[1], Xiaotao Hao[1]

[1]Shandong University, 27 Shanda South Road, China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Near-infrared (NIR) detectors, serving as critical technological nodes bridging microscopic molecular recognition and macroscopic intelligent perception, meet the demands of cutting-edge technologies such as multispectral imaging. Organic semiconductor materials demonstrate unique advantages for NIR organic photodetectors due to their precisely tunable bandgaps, solution processability, flexibility compatibility, and biocompatibility. However, the narrow-bandgap intrinsic characteristics required for NIR response inevitably lead to carrier concentration surge that exponentially increases dark current, while hot carriers undergo phonon scattering relaxation that suppresses carrier collection. In this work, we overcome the inherent limitations of narrow-bandgap polymer materials through a contactless direct current external electric field (EEF). The PTB7-Th:COTIC-4F device achieves an outstanding detectivity of 2.45×10^{13} Jones at 1100 nm, ranking among the highest values reported in the NIR spectral range. The applied EEF modulates both orientation and magnitude of electric dipole moments in acceptors, inducing ordered face-to-face molecular stacking, enhancing π-π interactions, and promoting J-aggregation, thereby facilitating fibrous network formation. Consequently, the optimized film morphology effectively suppresses energetic disorder and electron-phonon coupling, while simultaneously inhibiting exciton recombination and promoting exciton dissociation to achieve high-efficiency carrier transport. This non-contact external field modulation strategy establishes a novel pathway for developing high-performance NIR organic photodetectors.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Photon-induced isomerization enables high-performance polymer solar cells

Hanzhi Wu[1], Xiaotao Hao[1]

[1]School Of Physics, Shandong University, 27 Shanda South Road, China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The introduction of isomeric components into the active layers demonstrates effective mitigation of morphological defects arising from thermodynamic immiscibility in all-polymer solar cells (all-PSCs). Nevertheless, conventional isomerization methods for donor and acceptor materials remain complex and challenging to implement for intensifying photovoltaic performance. To overcome this limitation, we propose a photo-isomerization strategy involving ultraviolet laser irradiation of polymer materials in solutions. Structural and photophysical characterizations reveal that neat polymer films present enhanced crystallinity, prolonged exciton lifetime, and extended exciton diffusion length through the isomeric component incorporation. These benefits further synergistically strengthens intermolecular π-π stacking interaction and optimizes vertical distribution gradient in the active layers fabricated via layer-by-layer deposition, delivering an ideal bicontinuous interpenetrating network morphology. Notably, the refined morphology of the active layers increases the proportion of local excitons converting into charge transfer states to facilitate exciton dissociation, improves charge transport, and suppresses charge recombination. Ultimately, the laser-processed PM6:PY-IT devices achieve a promising power conversion efficiency of 18.21% and ameliorated stability including both thermal stability and photostability. This work confirms that ultraviolet laser irradiation can serve as a facile and effective approach for inducing isomerization of organic photovoltaic materials, offering a photochemical perspective toward efficient and stable PSCs.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Control of Spin Transition and Resonance by Chiral Phonons

Xiangping Zhao[1], Wei Qin[1]

[1]Shandong University, Shandong University Central Campus, China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Chiral phonons possessing angular momentum are closely associated with phonon modes that exhibit circular lattice vibrations. When considering chiral phonons in organic chiral materials, the interactions between the phonon angular momentum and the spin angular momentum are highly diverse. In this study, organic chiral enantiomers were prepared with different chiral asymmetry factors. Chiral phonons were observed using a circularly polarized Raman setup. As the asymmetry factor decreases, the chiral phonons gradually disappear. The coupling between the angular momentum of the chiral phonons and the electron spins becomes more pronounced at larger asymmetry factor values. Furthermore, the electrons present a broader array of pathways to enhance recombination, satisfying the principle of conservation of angular momentum. In addition, the electron spin resonance signals of the chiral samples exhibit differential responses to left- and right-handed circularly polarized light with identical intensities. Overall, chiral phonons with nonzero angular momentum in chiral systems are strongly coupled with electron spins to modulate effectively the spin transition and spin resonance, thereby enhancing the potential application of chiral phonons in optophononic-spintronic devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Luminescence Regulation of Rare Earth Liquid Crystal Composite Films

Prof. Xu Sang[1]

[1]Shandong Jiaotong University, Haitang Road 5001, Changqing University Science Park, China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Rare earth (RE) ion-doped luminescent materials are becoming increasingly mature, and they are widely used in various fields such as biological imaging, quantum storage, and optical cryptography. Liquid crystals (LCs) possesses unique optical and electrical properties and are widely used in the fields of lighting and display. To further expand the application scope of RE ion-doped luminescent materials, our research combined RE luminescent materials with LCs to obtain RE/LC composite films. These films not only possess the electro-optic properties of LCs but also the luminescent properties of RE luminescent materials, demonstrating multi-dimensional response capabilities to voltage and light. At the same time, we have conducted theoretical and experimental studies on the luminescence mechanism and optical properties of these films, deeply analyzing the cooperative relationship between RE and LCs, and clarifying the luminescence mechanism of RE/LC composite films. This work has opened the door to the study of the photoluminescence properties of RE/LC composite films.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Enhance Photo-Stability of Up-Scalable Organic Solar Cells: Suppressing Radical Generation in Polymer Donors

Mengfei Xiao [1] , Xiaoyan Du [1]

[1]Shandong University, China

Poster Session - S10: Organic Electronics and Photonics (OEP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Currently, the power conversion efficiency (PCE) of single-junction organic solar cells (OSCs) has been beyond 20%. The large-scale upscaling from laboratory research to industrial production has garnered increasing attention from researchers worldwide. Beyond achieving high PCE using scalable manufacturing methods and processing conditions, simultaneously attaining high stability is paramount for advancing the industrialization of this technology. In this study, we systematically investigated the stability of active layers with broad thickness ranges processed in ambient air using halogen-free solvents. Under light and thermal stress, thick active layer devices exhibited greater losses in short-circuit current density (JSC) compared to their thinner counterparts. Devices featuring active layers with reduced crystalline phases per unit thickness demonstrated accelerated generation of deep-level trap states, slower carrier transport, and substantially diminished charge collection efficiency. Through comprehensive photochemical, photophysical, and morphological characterization during aging processes, we identified that rapid radical generation on the polymer donor PM6 in predominantly amorphous active layer structures constitutes the primary mechanism driving device degradation. This research demonstrates that enhancing the crystallinity of active layer films to suppress radical formation in polymer donors is critical for improving the photothermal stability of devices with wide-thickness-range active layers processed under ambient conditions.

Transparent Materials for Extreme Environments

Prof. Liangge Xu[1], Sam Zhang, Jiaqi Zhu
[1]Harbin Institute of Technology, , China

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

Transparent components are critical elements offering structural-functional integration within optoelectronic precision guidance and search-and-track systems of aerial vehicles. During service, these components are exposed to increasingly severe extreme environments, characterized by intense aerothermodynamic loads, complex electromagnetic interference, high-temperature thermal radiation, and high-intensity illumination. These conditions lead to failures such as coating delamination and sensor blinding or destruction, thereby compromising the survivability of the vehicle.
Under combined extreme thermal, mechanical, optical, and electrical conditions, the performance limits and evolution mechanisms of transparent materials remain insufficiently understood. Consequently, developing high-performance materials capable of withstanding such environments presents a formidable challenge. There is an urgent need to elucidate the aerothermodynamic failure mechanisms of infrared domes and propose effective mitigation strategies. Furthermore, breakthroughs are required in extending the range of infrared-transparent conductive materials from short-wave to mid- and long-wave infrared, fabricating high-quality large-size single-crystal diamond windows, and achieving compatibility between on-demand visible transparency and microwave modulation. The ultimate goal is to establish a comprehensive technology system for transparent materials in extreme environments that integrates material design, preparation processes, equipment manufacturing, and application verification. This will enhance the operational performance of aerial vehicles under extreme conditions and facilitate the generational evolution of aerospace platforms.

July 15, 2026 | 11:10 AM

Particle Swarm Optimization-Driven Intelligent Design of Multilayer Thin-Film Structures for Multispectral Infrared Stealth Applications

Shijie Chen[1,2], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiagi Zhu*[1,2]

[1]School of Astronautics, Harbin Institute of Technology, Harbin, China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, Zhengzhou, China

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

This study proposes a hybrid design method that integrates particle swarm optimization (PSO) with concepts from genetic algorithms for multilayer thin-film structures, targeting high reflectance in the 3–5 μm and 8–14 μm atmospheric windows and enhanced emissivity in the 5–8 μm band for multispectral infrared camouflage and thermal regulation. The algorithm optimized a six-layer structure using six candidate materials (Ge, SiO_2, Pt, ZnS, SiOx, Si) over 10,000 iterations. The optimized design achieves reflectance values of 0.85, 0.27, and 0.81 in the respective bands, corresponding to a figure of merit (FOM) of 0.79, outperforming existing simulation models. Simulations confirm good optical stability under varying incident angles and thickness deviations. Fabry–Perot resonances contribute to spectral selectivity, particularly in the 5–8 μm range. Compared to conventional approaches, the PSO-based method demonstrates faster convergence and enhanced global search capability, offering an efficient and effective strategy for designing multispectral infrared camouflage structures with integrated spectral control and thermal management functionality.

Phase-Change Optical Thin Films Synergized with Graphene Electrical Tuning for Broadband Reconfigurable Metasurface Absorbers

Dr Pingping Min[1], Dr Chenyang Cui[2], Dr Zhibo Zhang[1], Prof. Jiaqi Zhu[2], Dr Chi Zhang[3]
[1]Zhengzhou Advanced Research Institute of Harbin Institute of Technology, No. 26, Longyuan Dongqi Street, Zhengdong New District, Zhengzhou City, China, China, [2]Harbin Institute of Technology, 92 West Dazhi Street, Nangang District, China, [3]Hangzhou Institute for Advanced Study, University of Chinese Academy of Sciences, Xiangshan Branchong No. 1, Xihu District, China

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

Conventional optical thin-film absorbers are typically constrained by a fixed operating bandwidth and a single absorption state, rendering them unsuitable for dynamic optical applications. Here, we present a reconfigurable metasurface based on a multilayer optical thin-film architecture that synergistically integrates the non-volatile optical property modulation of phase-change thin films with the volatile electro-optic tunability of a graphene layer, enabling multi-dimensional optical absorption control. Two representative phase-change materials, vanadium dioxide and germanium antimony telluride, are employed. Central to this design is a staged thermal control strategy that leverages their distinct phase-transition temperatures: the insulator-to-metal transition of vanadium dioxide at 68°C and the amorphous-to-crystalline transition of germanium antimony telluride at 160°C. Combined with a patterned graphene layer, this approach enables the construction of a layered thin-film stack that allows precise tailoring of the equivalent optical admittance. This temperature-sequenced activation mechanism endows the optical thin-film device with reconfigurable optical absorption characteristics across the C, X, and Ku bands spanning from 4 to 18 GHz, achieving average absorption rates of 93.6%, 96.5%, and 94.8%, respectively. Furthermore, by adjusting an external bias voltage to alter the Fermi level of graphene, the system gains a real-time amplitude modulation capability that is decoupled from operating band switching, yielding tuning depths of 61%, 66% and 54.3%across the three bands. By extending the optical thin-film design paradigm into the microwave frequency regime and incorporating a multi-dimensional tunability mechanism, this work overcomes the performance limitations of conventional optical thin-film absorbers and provides a novel platform for cross-band adaptive optical coatings and smart optical stealth applications.

July 15, 2026 | 11:40 AM

Chemical Composition Modulation and Synergistic Enhancement Mechanisms of the Opto-Mechanical Properties of YOxNy Thin Films for High-Performance Infrared Windows

Zheqiu He[1]

[1]Harbin Institute Of Technology, , China

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

Zinc sulfide (ZnS) serves as a cornerstone material for mid-to-far infrared (IR) windows; however, its inherent mechanical vulnerability and suboptimal chemical stability significantly constrain its operational reliability in extreme environments. Yttrium oxynitride (YOxNy) thin films have emerged as a highly promising integrated protective and anti-reflective coating for IR windows, offering both superior mechanical hardness and broadly tunable optical constants. In this work, YOxNy thin films were deposited via magnetron sputtering, with a primary focus on investigating the influence of the nitrogen-to-argon (N2/Ar) flow ratio on the micro-composition, structural evolution, and the resulting performance modulation of the ZnS window system. The results demonstrate that precise control over nitrogen incorporation facilitates a structural transition from oxide-like to nitride-like phases, revealing the modulation laws of the stoichiometric ratio on the refractive index (n) and extinction coefficient (k) within the infrared spectrum. Experimental data indicate that an optimized N2/Ar ratio not only enhances the transmittance of the ZnS window in the target waveband but also significantly bolsters the surface nano-hardness. Furthermore, by effectively mitigating internal residual stresses, a synergistic unity between high transparency and robust protective performance was achieved. This study provides critical experimental guidance for the development of next-generation infrared window systems that demand both high-toughness mechanical backgrounds and exceptional optical characteristics.

Thickness Control and Thermal Stability of Large-diameter Mo/Si Multilayers

Dr. Zhe Zhang[1], Ms. Xiangyue Liu, Mr. Dianxiang Yao, Prof. Qiushi Huang, Prof. Zhanshan Wang

[1]Tongji University, No.1239 Siping Road, China

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

The Mo/Si multilayer mirror has been widely used in EUV astronomy, lithography, microscopy and other fields because of its high reflectivity at the wavelength around 13.5 nm. Mo/Si multilayers are often applied to large aperture reflectors, requiring thickness control on the large curved substrate and high thermal stability. In this study, Mo/Si multilayers thickness control on large curved substrate was achieved by the shadow mask in magnetron sputtering and changing the speed profile of substrate motion in ion beam sputtering; the thermal stability of Mo/Si multilayers was enhanced by introducing the C barrier layer.

With the correction of the shadow mask in magnetron sputtering, the periodic thickness at each location can be achieved within ±0.3% of the expected thickness on the 200mm diameter curved substrate. By changing the speed profile of substrate in ion beam sputtering, the deviation of the period thickness on the 300 mm diameter curved substrate can be achieved within ±0.4% compared with expected period thickness. Under both methods of preparation, it was found that the layer microstructure including interface width, surface roughness, layer crystallization and the reflectivity were barely affected and a high accuracy of the layer thickness gradient can be achieved. The thermal stability of Mo/Si multilayers was investigated after inserting the C barrier layer. The results show the thermal stability of Mo/C/Si/C multilayers is better than that of Mo/Si multilayers, the Mo/C/Si/C multilayers has only 1.8% reflectivity loss after annealing at 300°C for 2h.

July 15, 2026 | 12:10 PM

Medium-entropy to high-entropy sesquioxide X_2O_3 infrared transparent ceramics

Wenqi Li[1,2], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiaqi Zhu*[1,2]

[1]School of Astronautics,Harbin Institute Of Technology, Harbin, China, [2]Zhengzhou Research Institute,Harbin Institute Of Technology, ZhengZhou, China

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

Fabricating infrared-transparent materials with high surface hardness and strength for extreme environments remains an ongoing challenge. Multi-principal element ceramics have attracted wide interest due to their unique properties and multifunctional features, yet the influence of elemental differences on the performance of multi-principal transparent ceramics has not been fully understood. In this study, different oxides were mixed in equimolar ratios, with the addition of 3 at.% ZrO_2 and 10 at.% La_2O_3 as sintering aids. Via pressureless pre-sintering to complete the solid-state reaction, followed by hot isostatic pressing, novel single-phase cubic-structure medium-entropy $(Y_{0.25}Gd_{0.25}Lu_{0.25}Er_{0.25})_2O_3$, $(Y_{0.25}Gd_{0.25}Lu_{0.25}Ho_{0.25})_2O_3$ transparent ceramics and high-entropy $(Y_{0.2}Gd_{0.2}Lu_{0.2}Ho_{0.2}Er_{0.2})_2O_3$ transparent ceramics were obtained. For all samples pressureless pre-sintered at 1500–1600 °C and then subjected to hot isostatic pressing, analysis reveals uniform elemental distribution within the grains, a concentrated and relatively fine grain-size distribution, and very limited pore dispersion, which are key reasons for their high transparency in the mid-infrared range (3–5 μm). The effect of elemental differences on dislocation density was investigated through high-resolution transmission electron microscopy observations. The differentiated roles of Er and Ho elements in the medium and high-entropy systems on optical transmission, flexural strength, and surface hardness are discussed. By studying the newly fabricated medium and high-entropy transparent ceramics, this work illustrates the influence of elemental differences on macroscopic properties, providing insights for the development of infrared-transparent materials intended for extreme service conditions.

July 15, 2026 | 12:25 PM

Ultra-Fine Fractal Silver Meshes via Laser Direct Writing for High-Performance Transparent Electrodes with Suppressed Moiré

Wen-Yen Chang[1], Du-Cheng Tsai[1], Ming-Che Cheng[1], Wan-Chang Hsu[1], Shih-Lung Lee[1], Fuh-Sheng Shieu[1]

[1]National Chung Hsing University, 145 Xingda Rd., South Dist., Taichung City 40227, Taiwan, Taiwan

Session 04 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 10:50 AM - 12:40 PM

This study develops ultra-fine silver (Ag) fractal-patterned metal meshes with line widths of 1–5 μm, designed to achieve high optical transmittance and excellent electrical conductivity for use in displays and transparent heaters. Conventional grid structures often suffer from Moiré interference with display pixels and an inherent trade-off between conductivity and transparency. To address these challenges, we employed a fabrication process integrating laser direct writing lithography, radio-frequency (RF) magnetron sputtering, and lift-off techniques. Experimental results demonstrate that the fractal mesh design enhances localized line density and node connectivity with minimal loss in transmittance, significantly reducing sheet resistance. A figure of merit (FoM) of 143.24 $m\Omega^{-1}$ was achieved for the 200 μm pitch mesh, indicating superior optoelectronic performance. Furthermore, the 400 μm pitch series exhibited an average visible haze of only 4.2–4.6%, offering the optical clarity required for high-end touch applications. Regarding visual invisibility and stability, the 1–5 μm line width effectively reduces the fill factor and optical contrast, successfully suppressing Moiré patterns. Angle-dependent measurements confirm stable transmittance at low incident angles, with a decline occurring only beyond 50° due to Fresnel reflection and reduced effective projected area. With its low haze, Moiré suppression, and high conductivity, this ultra-fine fractal Ag mesh holds significant potential for next-generation transparent electrodes and heating devices.

July 15, 2026 | 1:20 PM

Coatings for space observations in the far ultraviolet

Dr. Juan I. Larruquert[1], Dr. Paloma López-Reyes[1], Dr. Nuria Gutiérrez-Luna[1], Mr. Carlos Honrado-Benítez[1], Mr. Alejandro García-Cañas[1], Ms. Ana Iglesias-Moreno[1]
[1]Instituto De Optica-CSIC, , Spain

Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

The sky hides precious information for astrophysics, solar physics, and atmosphere physics that awaits novel optical coatings to disclose it. The far ultraviolet (FUV, wavelengths within 100-200 nm) encompasses spectral lines of key components of the universe (H, He, C, N, O, Si, ...) in which the above three communities are challenged to perform demanding observations. The strong absorption of FUV light, including normal air, requires that such observations are performed from space. The interest for FUV coatings extends to other fields, like the semiconductor industry (projection lithography), along with plasma diagnostics, harmonics-selection lasers, and free-electron lasers.

The above space-observation communities show a surge of interest for new and improved FUV coatings, the most prominent of which is NASA's flagship space observatory for the 2030s-2040s called Habitable Worlds Observatory (HWO).

Our group is devoted to the development of innovative FUV optical coatings. The main FUV coating materials include aluminum along with various metal fluorides. FUV coatings with highest quality are deposited by thermal evaporation techniques.

The presentation will display the most recent advances in FUV coatings mostly for space applications.

Enabling Scalable Manufacturing of Diffractive Micro-/Nano-Optical Devices for AR/VR Applications

Engineer Sheng Cai, **Research Professor Wali Zhang**[1]
[1]YongJiang Laboratory, No. 1519, Xinghai South Road, Zhenhai District, China
Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

The rapid evolution of augmented reality (AR) systems from bulky head-mounted displays to lightweight, all-day wearable glasses is driving a fundamental transition in optical architectures—from conventional geometric optics to diffractive waveguide-based solutions. Among various approaches, surface relief grating (SRG) waveguides have emerged as a promising candidate due to their compact form factor, high integration capability, and compatibility with semiconductor manufacturing technologies.

However, the scalable fabrication of high-performance diffractive optical devices remains a critical bottleneck for the commercialization of AR/VR systems. In particular, advanced materials such as silicon carbide (SiC), with high refractive index and excellent thermal and mechanical properties, offer significant advantages for next-generation waveguides, while posing substantial challenges in patterning fidelity, etch selectivity, and profile control.

This talk presents a systematic overview of key enabling technologies for scalable manufacturing of diffractive micro-/nano-optical devices. The discussion covers large-area nanopatterning using nanoimprint and DUV lithography, high-selectivity hard-mask strategies, and plasma etching of hard materials including SiC, TiO_2, and Ta_2O_5. Special emphasis is placed on profile engineering of vertical, slanted, and multi-level gratings through advanced techniques such as reactive ion beam etching (RIBE) and multi-step lithography-etch integration.

Representative results, including sub-110 nm patterning, high-aspect-ratio SiC etching, and large-area stitching with nanometer-scale overlay control, will be presented. Finally, the talk introduces the integrated fabrication capabilities and process design kit (PDK) development at Yongjiang Laboratory, highlighting a one-stop platform for micro-/nano-optics prototyping and scalable manufacturing.

July 15, 2026 | 2:00 PM

Study on Tribological and Mechanical Properties of CNx Deposited by HiPIMS and Outlook on Optical Properties of CNx/YCeZrO Thin Films

Mr. Zhaoyang Xing[1], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiagi Zhu*[1,2]

[1]School of Astronautics, Harbin Institute of Technology, , China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, , China

Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

Zinc sulfide (ZnS), the first-generation infrared optical window, exhibits outstanding transmittance in the mid-wave (3–5 μm) and long-wave (8–12 μm) infrared atmospheric windows, yet its low hardness (~2.6 GPa) and fragile mechanical properties render it susceptible to surface scratches induced by high-speed impact of micro-particles like sand grains and raindrops. Moreover, the bare ZnS only delivers an infrared transmittance of 50–70%. Sapphire, the second-generation optical window, suffers from saturated thermal radiation interference and performance degradation under aerodynamic thermal loads. According to Wien's Displacement Law, blackbody radiation energy density concentrates in the 3–5 μm band at temperatures above 500 °C, mandating infrared materials to possess low emissivity for mitigating self-thermal radiation interference at high temperatures. High-entropy oxide ceramics, benefiting from the unique high-entropy effect, integrate superior solid-solution strengthening and infrared optical transmittance, emerging as promising third-generation infrared optical windows. Coating technology is an effective approach to enhance substrate strength, optimize transmittance and reduce emissivity. Hence, depositing oxide ceramic thin films with excellent infrared transmittance and mechanical properties on optical windows via magnetron sputtering exhibits great application potential. In this work, La- and Er-co-doped Y_2O_3 films were prepared by magnetron sputtering, and the effects of radio frequency power on doping content, microstructure, structural evolution, infrared transmittance and mechanical properties were systematically investigated. The experimental results verify that optimized sputtering parameters realize the synergy between infrared transmittance and mechanical performance of the ZnS window, providing critical experimental guidance for the development of next-generation infrared window protective layers.

July 15, 2026 | 2:15 PM

Effect of Dilute Y_2O_3 Co-doping on the Lattice Structure and Properties of Al-doped ZnO Thin Films

Assistant Professor Yi-Yen Chen[1], Associate Professor Chia-Hsun Chen[2], Assistant Professor Shu-Bai Liu[3], Mr. Chih-Wei Tsai[1], Mr. Cheng-Chia Chien[1]

[1]Department of Materials Science and Engineering, National Formosa University, No. 64, Wenhua Rd., Taiwan, [2]Department of Electro-Optical Engineering, National Formosa University, No. 64, Wenhua Rd., Taiwan, [3]Department of Electrical Engineering, National Kaohsiung University of Science and Technology, No. 415, Jiangong Rd., Taiwan

Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

Transparent conducting oxides (TCOs) have been widely used in optoelectronic devices such as thin-film solar cells, thin-film transistors (TFTs), and light-emitting diodes (LEDs). Among various TCO materials, aluminum-doped zinc oxide (AZO) has attracted considerable attention due to its high optical transmittance in the visible region, low electrical resistivity, abundant raw materials, and non-toxic characteristics. However, the substitution of smaller Al^{3+} ions for Zn^{2+} ions, together with the presence of oxygen vacancies, inevitably induces lattice distortion in AZO films. The resulting lattice strain may adversely affect their optical and electrical properties. To alleviate this issue, introducing additional dopants with larger ionic radii into AZO films has been considered an effective strategy for relaxing the lattice strain.

In this study, ~100 nm thick YAZO thin films with various Y contents were deposited on glass substrates by co-sputtering using AZO and Y2O3 targets. After annealing at 600 °C under an Ar + 5% H_2 ambient, all YAZO films exhibited significantly reduced electrical resistivity and improved optical transmittance in the visible region compared with the as-deposited films. In addition, Y incorporation enhanced the optical transmittance near 550 nm relative to undoped AZO films. Among all samples, the YAZO film with approximately 0.7 at% Y exhibited the optimum optoelectronic performance, showing a low resistivity of 5.8x10-4 Ω·cm, a high average optical transmittance of 93.3%, and a figure of merit (FOM) of 9.2x10-3 $Ω^{-1}$. Structural analysis revealed that increasing Y content resulted in an increase in the c-axis lattice constant and a decrease in the a-axis lattice constant, indicating lattice relaxation toward bulk ZnO. These results demonstrate that dilute Y incorporation effectively improves the structural and optoelectronic properties of AZO films, suggesting that YAZO thin films are promising candidates for transparent front electrodes in thin-film solar cells.

July 15, 2026 | 2:30 PM

High-entropy design of new zirconate transparent ceramics with synergistic enhancement of mechanical and optical properties

Xuanyu Wang[1,2], Associate Professor Liangge Xu[1,2], Professor Sam Zhang[1,2], Professor Jiaqi Zhu[1,2]

[1]School of Astronautics,Harbin Institute of Technology, Harbin, China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, ZhengZhou, China

Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

In response to the urgent demand for the comprehensive material properties of key components such as the fairing of high Mach number aircraft and infrared windows under extreme environments, it is crucial to develop materials that possess excellent mechanical load-bearing capacity and wide-band infrared transmittance. Traditional single-component transparent ceramics often struggle to achieve the best balance in mechanical and optical properties. Through the high-entropy design concept, this study successfully synthesized a high-entropy transparent ceramic based on the multi-component strontium salt ((YLuGdSmYb)2Zr2O7) system. Multi-component nanopowders were synthesized using a high-temperature solid-state reaction method, and then densified through pre-sintering combined with hot isostatic pressing. The research results show that the high-entropy effect effectively stabilizes the cubic fluorite crystal structure of the material, significantly inhibits abnormal grain growth, and achieves a microstructure with fine and uniform grains and very few defects. This high-entropy transparent ceramic exhibits excellent mechanical properties, significantly superior to traditional fluorite-structured ceramics; at the same time, it shows good optical transparency in the 3-5 μm mid-infrared wavelength band (sample thickness 1 mm). The synergistic improvement of these properties is attributed to the lattice distortion strengthening caused by the high-entropy solid solution, the fine-grain strengthening effect, and the nearly complete densification and extremely low porosity achieved through hot isostatic pressing sintering. This study provides a new idea for the preparation of high-performance infrared transparent ceramics suitable for extreme service environments through component and process design.

July 15, 2026 | 2:45 PM

Simultaneous Infrared Camouflage and Effective Multiband Thermal Management

xiangqing teng[1], Doctor Liangge Xu[1], Professor Jiaqi Zhu[1], Professor Sam Zhang[1]
[1]Harbin Institute of Technology, 92 Xidazhi Street, Nangang District, China
Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

The miniaturization, integration, and multiband development of infrared detection equipment have created an increasingly urgent demand for heat radiators capable of infrared camouflage and efficient thermal management. While traditional camouflage methods effectively conceal infrared signatures, their low emissivity typically leads to heat accumulation within the device. This study proposes an eight-layer structure based on the Fabry-Pérot interference effect and the properties of epsilon near zero (ENZ) materials to realize a two-in-one property design. This two-in-one structure achieves exceptional infrared camouflage performance while enabling on-demand regulation of thermal radiation. In the 3-5 μm and 8-12 μm infrared atmospheric windows, this structure exhibits emissivity as low as 0.02 and 0.11 under normal incidence conditions, effectively suppressing infrared signals. Simultaneously, it achieves high emissivity up to 0.98 across all angles in the 5-8 μm non-atmospheric window, ensuring effective radiative heat dissipation. Notably, the structure exhibits angle-dependent ENZ behavior in the 8-12 μm band, achieving an average high emissivity of 0.86 at high angles (80°), demonstrating unique thermal radiation directionality. This study's thermally integrated infrared camouflage structure offers a unique design approach to resolving the inherent conflict between traditional infrared camouflage and thermal management, demonstrating enticing potential for practical applications.

July 15, 2026 | 3:00 PM

Achieving High Transparency and High Wear Resistance in Ceramics: A High-Entropy Strategy Coupled with Advanced Sintering Technology

Peng Wan[1,2], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiaqi Zhu*[1,2]

[1]School of Astronautics, Harbin Institute of Technology, , China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, , China

Session 05 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 1:20 PM - 3:15 PM

Transparent ceramics combine excellent optical transmittance with good wear resistance, demonstrating irreplaceable application potential in key fields such as aerospace, military protection, and biomedicine. However, due to the conflicting regulatory mechanisms of ceramic microstructures (such as grain size, pore distribution, and secondary phase composition) on optical and tribological properties, achieving simultaneous improvement in transparency and wear resistance remains a critical bottleneck restricting their engineering applications. This study, based on a high-entropy design strategy, successfully fabricated (Y0.2Yb0.2Ho0.2Gd0.2Er0.2)2O3 yttrium-based high-entropy transparent ceramics via solid-state reaction combined with spark plasma sintering and hot isostatic pressing post-treatment. The results indicate that the lattice distortion strengthening and grain refinement strengthening induced by the high-entropy effect, synergistically coupled with the high-temperature and high-pressure composite processing, significantly optimized the ceramic microstructure, achieving a dense structure with uniform fine grains and nearly no defects. This endows the ceramic with excellent optical transmittance in the mid-infrared band, as well as good mechanical and tribological properties, with comprehensive performance significantly superior to traditional single-component Y2O3 transparent ceramics. Characterization of the friction interface reveals that the dominant wear mechanism during friction is abrasive wear, and the wear rate exhibits a negative correlation with material hardness. The strategy proposed in this study, combining high-entropy design with composite sintering processes, offers a new idea and feasible technical pathway for preparing highly wear-resistant and highly transparent ceramics. It overcomes the performance optimization bottleneck of traditional transparent ceramics and holds significant theoretical and practical importance for promoting their engineering applications in key areas such as infrared windows.

Morphology-engineered coatings on periodic nanostructures for guided resonances, anomalous reflection, and plasmon canalization

Professor Yi-Jun Jen[1]

[1]National Taipei University of Technology, No. 1, Sec. 3, Chung-Xiao E. Rd. , Taiwan

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Oblique-angle deposition provides a versatile route for tailoring the morphology of thin films on periodic nanostructures, enabling diverse optical functionalities. In this talk, we present a unified framework in which morphology-engineered coatings on nanoimprinted templates evolve from guided resonant structures to functional metasurfaces, ultimately enabling plasmon canalization.

We first demonstrate that, in high-index dielectric coatings on nanogratings, deposition-induced morphological variations strongly modify guided-mode resonance behaviors, including resonance wavelength, polarization dependence, and angular dispersion. These results highlight the critical role of morphology in controlling waveguide–grating coupling in resonant photonic structures.

When extended to ultrathin metallic coatings, obliquely deposited silver films on periodic templates give rise to metasurface-like responses, including anomalous reflection under TM polarization. Such structures can be interpreted in terms of effective electromagnetic responses of a meta-atomic monolayer.

Building upon this transition toward metasurface behavior, we further show that morphology-engineered metallic nanostructures enable control of surface-wave dispersion, leading to broadband plasmon canalization. By tailoring anisotropic effective surface conductivity, diffraction can be suppressed and optical energy can be guided over extended distances with minimal spreading.

These results establish morphology as a key degree of freedom bridging resonant photonic structures and metasurface-based wave transport in nanostructured thin-film systems.

July 15, 2026 | 3:50 PM

p-type conductive infrared transparent Cu2-xSe thin film

Quanming Ding[1]

[1]Harbin Institute Of Technology, No. 92, Xidazhi Street, Nangang District, People's Republic of China

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Copper selenide (Cu2-xSe) has emerged as a promising p-type candidate for infrared transparent conductive materials due to its intrinsically high hole concentration arising from copper vacancies. In this work, we systematically investigate the effect of stoichiometry (x) on the optoelectronic properties of Cu2-xSe thin films, aiming to establish an intrinsic, composition-driven strategy for balancing electrical conductivity and infrared transparency. By precisely tuning the Cu deficiency, the hole concentration can be modulated over a wide range without introducing extrinsic dopants or deep-level recombination centers, as Cu vacancies predominantly act as shallow acceptors. Electrical measurements reveal that the conductivity strongly depends on x, governed by the interplay between carrier concentration and mobility. Optical characterization demonstrates a clear shift of the plasma edge with increasing x, indicating that the infrared transmittance can be effectively controlled through intrinsic carrier modulation. Notably, an optimal non-stoichiometric window is identified, where high conductivity is retained while minimizing free carrier absorption in the infrared region. These results highlight that stoichiometric engineering in $Cu_{2-x}Se$ provides a fundamentally clean and controllable route to tailor plasmonic response and charge transport simultaneously. Compared with conventional extrinsic doping or ternary alloying strategies, this approach avoids additional impurity scattering and phase complexity, offering deeper insight into defect-mediated transport mechanisms. This study establishes $Cu_{2-x}Se$ as a model system for exploring the unified regulation of carrier concentration, optical response, and defect chemistry, and provides guidance for the design of next-generation infrared transparent conductive materials.

July 15, 2026 | 4:05 PM

Medium to high entropy sesquioxide infrared transparent ceramics with high performance

Linbo Wang[1,2], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiaqi Zhu*[1,2]

[1]School of Astronautics, Harbin Institute of Technology, Harbin, China, [2]Zhengzhou Research Institude, Harbin Institute of Technology, ZhengZhou, China

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

This study focuses on sesqui-half rare-earth transparent ceramics for infrared and visible light windows, constructing a ladder-like multi-component system from ternary to octet to test the phase stability, microstructure stability, and performance stability of the high-entropy design. Six formulations with equimolar amounts of $(Y,Lu,Gd)_2O_3$, $(Y,Lu,Gd,Yb)_2O_3$, $(Y,Lu,Gd,Yb,Er)_2O_3$, $(Y,Lu,Gd,Yb,Er,Ho)_2O_3$, $(Y,Lu,Gd,Yb,Er,Ho,Eu)_2O_3$, and $(Y,Lu,Gd,Yb,Er,Ho,Eu,Sm)_2O_3$ were selected, and 1 wt% ZrO_2 was uniformly introduced as a sintering control factor to maintain process comparability. After wet ball milling, drying, pressing, and cold isostatic pressing, the samples were pre-sintered at 1400°C, 1500°C, and 1600°C to establish a closed-pore basic structure. Subsequently, the entire sample underwent hot isostatic pressing for densification and transparency. XRD was used to obtain the main phase structure and lattice evolution. Raman spectroscopy used the full width at half maximum (FWHM) of the main peak to characterize lattice distortion and solid solution levels. EBSD phase maps and KAM were used to analyze grain boundary phase separation and distortion concentration. SEM was combined to quantify porosity, grain size, and elemental homogeneity, and to track Zr grain boundary behavior. In terms of performance, transmittance was measured in the visible to infrared bands, and mechanical hardness and thermal conductivity were tested to distinguish the dominant role of pore densification channels and grain boundary segregation in transparency. This established the stability window and instability mechanism of multi-component sesquioxide transparent ceramics, providing quantifiable criteria for composition and process optimization of high-entropy transparent ceramics.

July 15, 2026 | 4:20 PM

Hard and infrared-transparent HfScTiYZr high-entropy oxide coating

Jingchuan Li[1]

[1]Harbin Institute of Technology, , China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, , China

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Infrared windows are critical components in infrared systems and are typically fabricated from materials such as ZnS and Y_2O_3. However, these materials are unable to simultaneously satisfy the requirements of mechanical robustness and infrared transparency. Depositing hard and transparent coatings on the surface of infrared windows has therefore emerged as one of the most promising strategies to address this limitation.The high-entropy design concept has demonstrated considerable potential in enhancing the mechanical performance of materials and is thus expected to enable mechanical reinforcement of optical materials. In this work, a high-entropy oxide coating containing five elements (Hf, Sc, Ti, Y, and Zr) was synthesized. The effects of oxygen content on the optical and mechanical properties of the coating were systematically investigated.

July 15, 2026 | 4:35 PM

A General Framework for Optical Optimization and Mechanical Property Enhancement of Multilayer Films Based on Deep Learning

Doctor Ateer Bao[1,2], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiaqi Zhu*[1,2]

[1]School of Astronautics, Harbin Institute of Technology, Harbin, China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, Zhengzhou, China

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Conventional trial-and-error approaches to optical thin-film design face limitations in efficiency and adaptability. This study presents a novel, universal framework leveraging deep learning to optimize multilayer thin-film structures within the 0.25–25 μm wavelength range, enabling high-performance infrared camouflage and radiative cooling. A physics-informed neural network is trained on a large dataset of optical responses, allowing rapid prediction and inverse design of layer configurations with desired spectral properties. Unlike traditional methods, this data-driven approach significantly accelerates optimization while enhancing precision. Crucially, a mechanics-enhancement algorithm is integrated into the framework to simultaneously improve mechanical robustness. By optimizing material selection and layer arrangement under stress constraints, the resulting structures maintain excellent optical performance while exhibiting superior strength and durability. The model accounts for interfacial stresses and delamination risks, ensuring structural integrity under practical conditions. Validated through simulation and experimental benchmarking, the designed films achieve targeted emissivity/reflectivity profiles and withstand mechanical loading. This framework bridges optical functionality and mechanical reliability, offering a transformative tool for advanced thin-film applications in stealth, thermal management, and flexible optoelectronics. The method’s generality allows extension to diverse material systems and multifunctional requirements.

July 15, 2026 | 4:50 PM

The fabrication of 3D GaN and 2D WS2 heterostructures by plasma-assisted molecular beam epitaxy

Mr Aminudin Zuhri[1], Mr Ray-Yu Hong[1], Mr Po-Yen Chen[1], Mr Ing-Song Yu[1]

[1]National Dong Hwa University, Building 2, No. 1, Sec. 2, Da Hsueh Rd., ShouFeng, Taiwan

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Gallium nitride (GaN), from bulk to nanostructure, has been studied extensively due to its potential application in electronic and optoelectronic devices. Tungsten disulfide (WS_2) is a two-dimensional (2D) semiconductor for next-generation electronic and optoelectronic devices. Therefore, the semiconductor heterostructures of GaN and WS_2 have high potential for designing novel devices. In the report, 2D layered WS_2 material, grown on c-sapphire by chemical vapor deposition, was used to deposit GaN thin films via the technique of plasma-assisted molecular beam epitaxy (PA-MBE), which presents a significant approach utilizing the low-temperature environment to grow GaN directly onto a 2–3ML WS_2 substrate. Before the growth of GaN, a comparative study was conducted with difference pre-nitridation temperatures on WS_2 at low- and high-temperature conditions (200°C and 700°C, respectively), with a nitrogen plasma equipped with 500W RF power. Reflection high-energy electron diffraction was utilized to in-situ monitor the surface conditions during the growth. After the growth, surface morphology of the samples was studied by scanning electron microscopy and atomic force microscopy, indicating the hexagonal crystalline GaN after 1 hour deposition time at 750°C. Single-crystalline GaN thin films were successfully grown by the characterizations of X-ray diffraction and transmission electron microscopy. The physical properties of GaN and GaN/WS_2 heterostructures were investigated by Raman, photoluminescence, X-ray photoelectron spectroscopies. This report demonstrates a van der Waals epitaxy of single-crystalline GaN onto a 2D WS_2 layer, providing a potential GaN-based devices with heterostructure integration 2D WS_2 layer for future applications.

Periwinkle Petal–Templated Microstructured PDMS for Enhanced Hydrophobicity

Ms. Aneela Perumalla[1], Ms. Aarya Malviya[2], Mr. Tiju Thomas[1], Mr. Sreeram K. Kalpathy[1]

[1]Indian Institute of Technology, Madras, Department of Metallurgical and Materials Engineering, India, [2]Anna University , Department of Printing and packaging, India

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Developing hierarchical nano- to micro-scale structures on polymeric surfaces is indispensable in anti-fouling, anti-corrosion, oil-water separation, and self-cleaning applications. Conventionally, techniques such as photolithography, electron-beam lithography, and chemical etching are employed to pattern surfaces. However, these multi-step processes have limitations in fabricating specific feature geometries, require stringent clean room conditions, and incur high costs, making large-scale production challenging. As an alternative, soft lithography combined with the replication of naturally occurring self-cleaning, superhydrophobic leaf/petal surfaces, such as lotus leaves, rose petals, and periwinkle petals, offers a straightforward and cost-effective approach. We used periwinkle petals as a template to pattern polydimethylsiloxane (PDMS), as these petals had not been explored much despite their microconical lamellae on their surfaces. Firstly, a PDMS master containing inverted petal features was developed by casting the uncured PDMS mixture. Typically, to reduce adhesion between the PDMS master and PDMS cast, the master is exposed to expensive UVO treatment. Here, for the first time, instead of UVO treatment, polyvinyl alcohol (PVA) was spin-coated onto the PDMS master to conform to its topography. The spin coating parameters - spinning speed, duration of spinning, and PVA volume - were optimised to develop a thin conformal layer that preserves the microcavity features of the PDMS master without obscuring them and also to reduce bonding with the PDMS cast. Moreover, when PDMS cast was diluted with an optimal amount of chloroform (CHCl3), mold filling was improved, and superior feature fidelity was achieved. The resulting patterned PDMS films (~400 μm thick) exhibited superhydrophobic water contact angle (150-155°), self-cleaning ability and high transparency (~90%). Thus, PDMS was patterned through a low-cost, scalable fabrication process utilising naturally available, non-toxic, and inexpensive constituents, thereby, opening up avenues in applications wherein a combination of transparent, hydrophobic, self-cleaning properties are required.

July 15, 2026 | 5:20 PM

Degradation Mechanisms of Al/LiF/eMgF2 Thin Films under Low-Energy Proton Irradiation

Doctor Shuangying Li[1,2], Liangge Xu[1,2], Sam Zhang*[1,2], Jiaqi Zhu*[1,2]
[1]Zhengzhou Advanced Research Institute Of Harbin Institute Of Technology, , China, [2]Harbin Institute of Technology, School of Astronautics,, , China

Session 06 - S11: Optical Thin Films (OTF), Sentosa - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Al/LiF-based films are the only practical solution for achieving high reflectivity in the Lyman ultraviolet band (90–120 nm), making them indispensable for space-based far-ultraviolet astronomical observations. However, their long-term stability under low-energy proton irradiation remains a critical concern for next-generation missions.
This work investigates the degradation mechanisms of Al/LiF/eMgF2 multilayer films under 7 keV and 20 keV proton irradiation at fluences ranging from 10^13 to 10^15 protons/cm2. Reflectivity measurements reveal strong dependence on proton energy and fluence, with 7 keV protons causing more severe degradation than 20 keV protons. X-ray photoelectron spectroscopy (XPS) depth profiling shows oxygen diffusion and Al2O3 formation at the Al/LiF interface, while photoluminescence (PL) and electron paramagnetic resonance (EPR) detect increased fluorine vacancy concentration in the LiF layer, both correlating with reflectivity loss. Transmission electron microscopy (TEM) cross-sections confirm the formation of an intermixed layer at the interface. SRIM simulations explain these observations: 7 keV protons deposit most of their energy within the Al/LiF multilayer, whereas 20 keV protons penetrate deeper into the substrate. This difference accounts for the more severe interfacial damage and greater reflectivity degradation observed under 7 keV irradiation. These results elucidate the microscopic damage mechanisms of proton-irradiated Al/LiF/eMgF2 films and offer critical guidance for developing radiation-hardened FUV optical coatings for future long-duration space missions.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Broadband infrared camouflage with synergistic thermal management and mechanical protection

Huaizhi Qu[1,2], Associate Professor Liangge Xu*[1,2], Professor Sam Zhang*[1,2], Professor Jiaqi Zhu*[1,2]

[1]School of Astronautics, Harbin Institute of Technology, Harbin, China, [2]Zhengzhou Research Institute, Harbin Institute of Technology, ZhengZhou, China

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

With the advancement of multispectral reconnaissance technology, traditional camouflage faces the risk of becoming ineffective. Therefore, designing a novel camouflage material that simultaneously meets multispectral concealment requirements and provides mechanical protection in complex environments has become an urgent challenge. This paper proposes an infrared thermal radiation camouflage emitter device integrating wavelength-selective emission, directional thermal radiation, and mechanical protection. Its innovative design enables simultaneous high-temperature infrared camouflage and outstanding mechanical protection across a broad wavelength band of 3-25 μm. It exhibits extremely low emissivity at the mid-infrared (4 μm) and long-wave infrared (11 μm) atmospheric windows (0.07 and 0.15, respectively), achieving outstanding infrared camouflage performance. Concurrently, in the non-atmospheric window (emittance is 0.85 at 5.6 μm) and very-long-wave infrared high emissivity (emittance is 0.92 at 22.5 μm), high emissivity is achieved at a high angle (75°-85°) in the long-wave infrared spectrum, enabling synergistic radiation cooling and camouflage performance. We also introduce the quality factor Fmin to optimize the thickness of wavelength-selective emitter film layers, enabling rapid identification of optimal structural designs. Regarding mechanical properties, the emitter exhibits a 48% increase in microhardness compared to conventional fabrication methods, effectively coupling high-temperature camouflage with mechanical protection. In summary, this work not only offers a novel solution for multifunctional infrared camouflage but also provides a robust technological platform for related applications such as information encryption, radiative cooling, and energy-saving devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

High-Performance Cadmium Zinc Telluride Thick Films Prepared by Electric Field-Assisted Close-Spaced Sublimation

Hengzhi Xing[1], Haofei Huang[1], Wei Zhou[1], Huyu Shen[1], Lei Wu[1], Ke Tang[1], Jian Huang[1], Linjun Wang[1]

[1]Shanghai University, No.99,ShangdaRd, Shanghai, China

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Cadmium zinc telluride (CdZnTe) thick films hold broad and significant application prospects in fields such as radiation detection. However, when fabricating large-area films, the conventional close-spaced sublimation (CSS) method faces notable challenges in precise stoichiometric control, defect management, and microstructural regulation. To overcome these inherent limitations, this work proposes an innovative electric field-assisted close-spaced sublimation (E-CSS) strategy. Initially, Density Functional Theory (DFT) studies are conducted to determine the impact of the electric field on molecular surface dynamics. Subsequently, by introducing an external electric field during the deposition process, the transport of gas-phase components is actively intervened, and surface kinetic behaviors—including adsorption, diffusion, and nucleation—are modulated. Furthermore, parameters such as the electric field strength are adjusted to identify the optimal growth conditions. Finally, a comprehensive analysis of the structural and electrical characteristics of the materials is conducted utilizing X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) measurements. The results demonstrate that, compared to conventional processes, the films prepared under optimized electric field parameters exhibit a significantly reduced defect density alongside superior crystalline quality and electrical properties.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Optimization of Li-Doped NiO Thin Films Deposited by Ultrasonic Spray Pyrolysis for p-Type Transparent Conducting Oxide Applications

Andre Sebastian Garcia Ward[1]

[1]UNAM, Sendero Bicipuma, C.U., Coyoacán, 04510, Mexico

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Lithium-doped nickel oxide (NiO:Li) is a promising p-type transparent conducting oxide for optoelectronic applications; however, obtaining films with a suitable balance between optical transparency and electrical conductivity by simple and low-cost deposition techniques remains challenging. In this work, NiO and Li-doped NiO thin films were deposited by ultrasonic spray pyrolysis using nickel acetylacetonate and lithium acetate dihydrate as precursors, with anhydrous methanol and dimethylformamide as solvent media. A systematic study was carried out in order to establish favorable processing windows by analyzing the effect of Li concentration, solvent type, substrate temperature, and ultrafast post-deposition annealing.

The deposition temperature was varied in the 330–390 °C range for methanol-based solutions and in the 375–435 °C range for dimethylformamide-based solutions, while Li concentration was adjusted to 0, 10, and 20%. The as-deposited films generally exhibited good electrical response, with typical sheet resistance values in the 10E^2–10E^4 Ω/□ range, but poor visible transmittance. SEM cross-section analysis showed film thicknesses on the order of 180–200 nm, while AFM measurements revealed continuous surfaces with relatively low roughness. Hall-effect measurements further supported the p-type character of representative films.

To improve the optical response, ultrafast annealing treatments in air at 500 °C for a few minutes were explored. These treatments produced a substantial increase in visible transmittance, in several cases reaching approximately 70–85%, although accompanied by a partial degradation of the electrical properties. This behavior highlights a clear trade-off between transparency and conductivity; nevertheless, an overall increase in the figure of merit was obtained, with preliminary maximum values in the 0.11–0.12 range under optimized conditions. These results provide practical guidelines for the reproducible fabrication of NiO:Li thin films and support their potential as low-cost p-type transparent conducting oxides.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Modification of Surface Structure and Optical Properties in Titanium Dioxide Films by Ar Ion Irradiation

Mei Qiao[1], Tiejun Wang[1]

[1]Dezhou University, No. 566, University West Road, Decheng District, China

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Titanium dioxide (TiO_2) thin films, as a kind of outstanding wide-bandgap n-type semiconductor material, have significant application prospects in optical devices, food preservation, and biomedicine due to their high refractive index, excellent stability, and non-toxicity. Moreover, their performance is often further expanded through doping and composite methods. In this study, TiO_2 thin films were irradiated with Ar ions of 15 keV and 30 keV at fluences of 5.0×10^{14} ions/cm^2 and 2.0×10^{15} ions/cm^2, respectively, resulting in four conditions. The surface morphology of the films was characterized by atomic force microscopy and scanning electron microscopy. The results indicated that the thickness and roughness of the films could be effectively changed by reasonably regulating the irradiation conditions of Ar ions. Combined with X-ray photoelectron spectroscopy and photoluminescence spectroscopy analysis, it was found that the irradiation treatment affected the binding energy state of the films, induced the generation of defects, and caused changes in the bandgap structure. Raman spectroscopy further revealed the vibration characteristics and electronic structure evolution of the films after irradiation. The research demonstrated that by precisely controlling the irradiation parameters of Ar ions, the microstructure and photoelectric properties of TiO_2 thin films could be effectively modulated, providing a new technical approach for optimizing their application in optoelectronic devices and functional coatings.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

The Near-Surface Structure and Damage Properties of Cu Ion-Irradiated Titanium Dioxide Crystals

Doctor Tiejun Wang[1]

[1]Dezhou University, No. 566, University West Road, Decheng District, China

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Rutile-type titanium dioxide crystals belong to the tetragonal crystal system, with a density of 4.26 g/cm3, and are characterized by high birefringence and refractive index. Rutile-type TiO_2 crystals were irradiated with Cu ions of energies 1.0 MeV and 3.0 MeV and a fluence of 1.0×1015 ions/cm2. The spectroscopic properties of the irradiated samples were investigated using Raman spectroscopy and absorption spectroscopy. The distribution of Cu elements at different depths after ion irradiation was simulated and experimentally verified using the SRIM software and time-of-flight secondary ion mass spectrometry. The structure and damage characteristics at different depths in the near-surface region of the samples were analyzed in detail using atomic displacement ratio, XRD diffraction patterns, RBS/channeling, and HRTEM techniques. It was proved that the lattice damage in TiO2 crystals was attributed to nuclear energy loss effects. The research indicates that by precisely controlling the defect structure introduced by ion irradiation, the physical and chemical properties of TiO2 can be effectively regulated, thereby significantly enhancing its application performance in fields such as photocatalysis, photoelectric conversion, antibacterial, and novel electronic devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Graded-Index Tetrahedral Amorphous Carbon via Filtered Cathodic Vacuum Arc as Multifunctional Anti-reflective Coating

Yutong Chen[1,2], Chong Wei Tan[1,2], Beng Kang Tay[1,2]

[1]Centre for Micro-&Nano-Electronics, School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore, [2]NTI-NTU Corporate Laboratory, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Reflection losses at the air-substrate interface significantly limit the optical efficiency of many optical and photovoltaic systems. To address this limitation and achieve multifunctional coating performance, graded-refractive index tetrahedral amorphous carbon (ta-C) films were designed using the filtered cathodic vacuum arc (FCVA) technique as antireflection coatings. Tunable index is achieved by adjusting depositing substrate bias voltage which shifts the sp2/sp3 bonding ratio and optical bandgap. The study evaluates the optical performance of these graded ta-C coatings through simulation across a broad spectral range from 300 to 1100 nm. Reflectance reduction is analyzed and compared with uniform DLC films and conventional single-layer anti-reflective coatings. The graded-index ta-C structure reduces broadband reflectance effectively which matches the refractive index smoothly at both the air-film and film-substrate interfaces. Beyond the optical performance, this coating is expected to exhibit improved wear resistance and oxidation resistance, also it has the potential for hydrophobic behavior. These results suggest that gradient-index ta-C films deposited by FCVA offer a feasible approach for photovoltaic modules and precision optical surfaces to achieve mechanically robust, hydrophobic, and optically tunable multifunctional antireflection coatings.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Tailoring the phase and stoichiometry of $Cu_{2-x}Se$ thin films as a strategy for the mid- to far-infrared transparent conductors

Dr Issac Nelson P[1], Liangge Xu, Mr Ding Quanming, Prof Jiaqi Zhu, Prof Sam Zhang
[1]School of Astronautics, Harbin Institute of Technology, Harbin 150080, China Zhengzhou Advanced Research Institute, Harbin Institute of Technology, Zhengzhou, 450000, China, , China

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The underexplored and recent advancements in the development of infrared (IR) transparent conductors across the atmospheric windows 3-5 μm and 8-12 μm, has shifted from solely tuning the charge carrier concentration and effective mass.The high frequency or optical dielectric constant is considered and achieved high values with leveraging intermediate metavalent bonding characteristics. The approach extended the plasma edge into the infrared region, enabling such materials to achieve exception transparency over ~ 80 % with balancing the electrical conductivity of ~ 1000 S/cm.It opened pathways for devices to operate across the atmospheric windows and finds applications as charge collectors, transparent heaters, thermophotovoltaics, photodetectors, IoT sensors and electromagnetic shielding.The only option of rhombohedral heavy metal chalcogenide films and n-type conductivity is opened the search for effective p-type transparent conductors remains ongoing, beyond the limitations of metavalent bonding. The current work takes the leaf from metavalent bonding materials exhibiting phonon glass electron crystal (PGEC) concept and evaded the trade-off between the thermal conductivity and electrical conductivity. Thus, exploring an alternative approach with most common displayer of PGEC concept with low lattice thermal conductivity, Cu2-xSe (where x = 0–0.2), exhibits similar soft bonding and phonon scattering observed in MVB materials. The conceptual connections between low lattice thermal conductivity and lattice vibration absorption, with band gap in the visible region, phase identification and stoichiometry tuning of Cu2-xSe thin film structures exhibiting PGEC concept, its infrared (IR) transparent conductor’s characteristics to be explored.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

The Microstructure and Optical Properties of MoS2 Thin Films Deposited at Different Temperatures by RF Magnetron Sputtering

Master student Kuan-Hsun Huang[1], Master student Chih Chao[1], Master student Pin-Syuan Su[2], Professor Po-Hung Wu[2], Professor Ing-Song Yu[1]

[1]Department of Materials Science and Engineering/National Dong Hwa University, No. 1, Sec. 2, Da Hsueh Rd. Shoufeng, Taiwan, [2]Department of Electrical Engineering/National Dong Hwa University, No. 1, Sec. 2, Da Hsueh Rd. Shoufeng, Taiwan

Poster Session - S11: Optical Thin Films (OTF), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Molybdenum disulfide (MoS2) is widely used in various fields such as solid lubrication, transistors, optoelectronic devices, and chemical catalysis. In this study, large-area and continuous MoS2 thin films with 400 nm-thick were grown on 2-inch quartz and silicon substrates by RF magnetron sputtering at different deposition temperatures including 25, 100, 150, and 200 °C, respectively. The purpose of this study was to investigate the effects of deposition temperature on the crystal structure and optical properties of MoS2 thin films. After the deposition, field-emission scanning electron microscopy(FE-SEM), energy dispersive spectroscopy (EDS), Raman spectroscopy, grazing incidence X-ray diffraction (GIXRD), UV-Visible spectroscopy (UV-Vis), photoreflectance (PR) and piezoreflectance (PZR) spectroscopy were employed to analyze the MoS2 thin films. Therefore, the crystallinity of MoS2 thin film is significantly enhanced at a deposition temperature of 150°C, and the increase of deposition temperature promotes crystallization with a prefer orientation of (100) plane, which is vertically oriented plate-like structure on the substrate. The stripe-like surface morphology of thin films becomes denser, but the chemical ratio of sulfur and molybdenum decreases as the temperature increases. The transmittance of the thin film increases beyond a wavelength of 500 nm in the optical spectrum. The energy band gap of MoS2thin films becomes larger as the deposition temperature increases. In short, the optimized deposition temperature of MoS2 thin films by RF magnetron sputtering is 150 °C because of the desulfuration effect at higher temperature.

Keywords: Magnetron sputtering; Molybdenum disulfide; Deposition temperature; Optical properties; Band gap

Transition metal carbide thin films prepared by atomic layer deposition: A new enabler for advanced metallization process

Soo-Hyun Kim[1]

[1]Ulsan National Institute Of Science And Technology, , South Korea

Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

Transition metal carbides (TMCs) and nitrides (TMNs) have attracted significant interest as electrode materials, diffusion barriers and liner for advanced metallization due to their remarkable physical properties, such as high melting points, excellent electrical conductivity, and strong chemical stability. These characteristics not only make them ideal for advanced applications of semiconductor devices but also increasingly important in fields like energy storage, quantum computing etc. Although atomic layer deposition (ALD) processes for TMNs have numerous established processes, those for TMCs are still in their early stages in spite of their better materials properties than those of TMNs counterpart. In this regard, this talk discusses ALD processes for various TMCs thin films developed in the presenter's laboratory, which includes group IV, TiC, ZrC, HfC, group V, TaC, NbC, group VI, WCx, MoCx thin films. The key advantages of ALD are atomic-level controlled and conformal growth of nano-scale thin films on high aspect ratio substrates. It is also discussed how the TMN and TMC can be controllably grown by ALD. Throughout this seminar, the special emphasis on both the rigorous selections of the precursors and process schemes is put for the successful application of ALD technology into the advanced metallization process.

Acknowledgements
This work was supported by the Industrial Strategic Technology Development Program (RS-2024-00509266, Development of next- generation dielectric, electrode process equipment, and core materials for logic 1 nm or less and memory × nm level), funded by the Ministry of Trade, Industry & Energy (MOTIE, Korea). This work was also supported by the Technology Innovation Program (Public-private joint investment semiconductor R&D program (K-CHIPS) to foster high-quality human resources) (RS-2025-02311098).

July 15, 2026 | 1:40 PM

Electronic packaging enhancement engineered by reducing the bonding temperature via modified cure cycle

Professor Seong Su Kim[1], Professor Seong Yeon Park[2]
[1]KAIST, 291 Dahakro, Yuseong-gu, Republic of Korea, [2]Hanbat National University, 125 Dongseo-daero, Yuseong-gu, Republic of Korea
Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

Recently, with the rapid increase in demand of ultra-thin and high-performance electronic devices, the demand for the development of the ultra-thin semiconductor package has been rapidly increasing. Packaging technology is emerging as a core technology for producing the ultra-thin semiconductor package as the reduction technology of materials consisting of the semiconductor package has come to the its end. However, as the ultra-thin semiconductor package reduce the area moment of inertial, the warpage of semiconductor package occurs due to thermal residual stress by coefficient of thermal expansion mis-match during the epoxy molding compound (EMC)’s curing process (packaging process). The reliability of semiconductor package is adversely affected by the delamination of the inside of the semiconductor and crack of parts, etc., caused by the warpage, thus resulted in lowering the production yield, which causes the semiconductor price to rise.

In this work, the development of the curing process for the EMC to reduce warpage in semiconductor packages is focused. The warpage of the semiconductor package according to the bonding temperature, which affects the warpage of the semiconductor package, is analyzed. In addition, novel curing process method is developed using a low-power and high-efficiency surface heating element to reduce energy consumption instead of the conventional hot-press process, which consumes high energy consumption.

July 15, 2026 | 2:00 PM

Advanced Consumables and Processing in Chemical Mechanical Polishing for Semiconductor Packaging

Prof. Sanha Kim[1]

[1]Department of Mechanical Engineering, KAIST, , South Korea

Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

As the More-than-Moore paradigm reshapes the semiconductor manufacturing toward functional integration, materials diversity, and high-precision three-dimensional (3D) architectures, chemical-mechanical polishing (CMP) has evolved from a planarization step into a critical enabler of heterogeneous integration. In this talk, I will discuss our recent advances in CMP consumables and processing approaches for semiconductor packaging. First, I suggest new design and fabrication strategies for polishing pads to mitigate dishing defects in CMP, which affects the mechanical reliability and electrical performance of hybrid bonding interfaces. Second, a CMP-compatible surface processing strategy based on argon (Ar) plasma modification of benzocyclobutene (BCB) is proposed to enable effective planarization of Cu/BCB hybrid bonding interfaces. Lastly, I introduce our newest invention "nano sandpaper", demonstrating superior polishing precision, material removal rate, planarization performance across diverse materials, with outstanding durability and environmental sustainability.

July 15, 2026 | 2:20 PM

Evaporation-Driven Marangoni Control for Uniform and Scalable Nanocomposite Thin Films

PhD. Hyoungsoo Kim[1], Dr. Jeongsu Pyeon[1], Mr. Yoonhyeok Guk[1], Dr. Soon Mo Park[2], Juri Kim[2], Jeong-Hwan Kim[2], Prof. Yong-Jin Yoon[1], Prof. Dong Ki Yoon[2]
[1]KAIST, Department of Mechanical Engineering, Daehakro 291, South Korea, [2]KAIST, Department of Chemistry, Daehakro 291, South Korea
Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

Achieving uniform nanoparticle coatings over large areas remains a fundamental challenge due to evaporation-driven capillary flows that induce the coffee-ring effect. In this study, we present a unified framework for controlling nanoparticle deposition through evaporation-induced interfacial hydrodynamics, with a particular focus on photothermal anti-icing applications. We first demonstrate a one-step fabrication approach that integrates spontaneous self-dewetting with evaporation-induced self-assembly (EISA), enabling the formation of homogeneous cellulose nanocrystal (CNC) matrices with aligned gold nanorods (GNRs) and suppressed coffee-ring patterns. The resulting plasmonic films exhibit enhanced light absorption and efficient heat generation, maintaining above-freezing temperatures under sub-zero conditions and enabling effective anti-icing performance. Building on this understanding, we further develop a scalable blade-coating strategy using a binary solvent system. Selective evaporation generates solutal Marangoni flows that counteract capillary-driven outward transport, leading to uniform nanoparticle distribution across diverse substrates. Notably, this approach enables the formation of ultrathin and optically transparent GNR–CNC composite films over large areas, while preserving uniformity and functionality. These films exhibit consistent photothermal responses and mechanical robustness, making them highly suitable for practical anti-icing and de-icing applications. Together, these results establish evaporation-driven Marangoni control as a general strategy for fabricating uniform, scalable, and functional nanocomposite thin films, bridging fundamental interfacial physics with real-world photothermal anti-icing systems.

Plasma-Enhanced Atomic Layer Etching of Ru via Gas Activation

Jeongmin Oh[1], Hyung-Gu Kang[2], Gunsu Yun[2], Jihwan An[1]
[1]Graduate School of Semiconductor Technology, Pohang University of Science and Technology (POSTECH), , Republic of Korea, [2]Division of Advanced Nuclear Engineering, Pohang University of Science and Technology (POSTECH), , Republic of Korea
Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

Plasma-enhanced atomic layer etching (PE-ALE) has emerged as a promising technique for atomic-scale patterning of ruthenium (Ru), a key material for next-generation interconnects. However, conventional PE-ALE processes often suffer from low process efficiency and limited independent control of surface modification and material removal due to the intrinsic coupling of reactive species and ion bombardment in single-source plasma systems.

In this study, we propose a gas activation strategy to enhance the performance of Ru PE-ALE. Reactive oxygen species are generated using a remote microwave (MW)-based gas activator prior to RF plasma formation, enabling an increased radical flux without a proportional increase in ion energy. This configuration enables efficient surface modification while maintaining controlled, self-limiting removal characteristics.

The effects of gas activation were systematically investigated by varying the total input power (MW + RF) during the modification step over a range of 80–300 W. At low power (80–100 W), the conventional process exhibited negligible etching, whereas the gas-activated process with a fixed MW power of 20 W achieved an etch per cycle (EPC) of ~0.27 Å/cycle, corresponding to more than a fivefold enhancement. At a fixed total power of 200 W, variation of the MW power from 0 to 100 W resulted in a saturated EPC of ~0.32 Å/cycle over a microwave power range of 20–60 W, accompanied by a reduced surface roughness of 0.81 nm. These results demonstrate the formation of a well-defined ALE window enabled through gas activation at reduced RF power, thereby minimizing ion-driven effects and improving energy efficiency.

Overall, gas activation significantly improves both the efficiency and controllability of PE-ALE by enhancing radical utilization while preserving self-limiting etching behavior. This approach provides a practical and energy-efficient pathway for high-performance PE-ALE, with potential applicability to advanced semiconductor patterning.

Artificial Intelligence for Quantifying Stochastic Damage Evolution in Freely-Stretched Ultra-Thin Films

Myoung Song[1], Dr. Seung Jin Oh[2], Prof. Sungho Suh[3], Prof. Tae Yeob Kang[4], Prof. Taek-Soo Kim[1]

[1]Korea Advanced Institute of Science and Technology (KAIST), 291 Daehak-ro, Yuseong-gu, South Korea, [2]Korea Institute of Machinery and Materials (KIMM), 156 Gajeongbuk-ro, Yuseong-gu, South Korea, [3]Korea University, 145 Anam-ro, Seongbuk-gu, South Korea, [4]Ajou University, 206 World cup-ro, Yeongtong-gu, Suwon-si, South Korea

Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

The characterization of damage evolution in ultra-thin polymer films is crucial due to their critical role in ensuring the structural reliability of advanced semiconductor packaging. Owing to the inherently stochastic nature of fracture phenomena in sub-100 nm regimes, traditional analytical methods are often limited in correlating damage features to strain. Thus, a knowledge-guided strain-damage image correlation (SDIC) framework is proposed to establish a robust mapping between localized damage morphologies and macroscopic mechanical responses. In this study, ultra-thin polystyrene (PS) films were utilized as a model system. The SDIC framework was developed to process image-based datasets, where damage evolution is represented through high-fidelity in-situ images. To assess the performance of the AI-driven correlation, the root mean square error (RMSE) and statistical inliers within a 30% error margin (ξ_{30}) were selected as key metrics, effectively accounting for the experimentally observed uncertainty and the practically accepted tolerance of fracture strain. Through extensive investigations into the required quantity of training data, a performance saturation was identified at approximately 10,000 data points, establishing a critical threshold for reliable prediction. Furthermore, a transfer learning-based ‘learning-to-learn’ strategy was introduced to facilitate the generalization of the SDIC framework to various polymer systems beyond the initial PS films. It was suggested that a model initially trained on a reference dataset could be effectively fine-tuned using a relatively small amount of target material data, thereby providing a versatile foundation for the accelerated reliability assessment of diverse soft material systems in next-generation electronics.

July 15, 2026 | 3:10 PM

Effect of substrate roughness on the formation of electroless nanotwinned copper and its thermal stability

Yu-Ting Yu, Zhao-Yu Yang, Ya-Chi Hsu, Yu-Hsun Chang, Cheng-En Ho
[1]Yuan Ze University, , Taiwan

Session 05 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 1:20 PM - 3:25 PM

Recently, (111)-oriented nanotwinned copper (nt-Cu) has attracted widespread attention in microelectronic packaging community because of its high surface diffusivity, improved oxidation resistance, superior mechanical strength, and high electrical conductivity. Therefore, (111) nt-Cu is now being regarded as a promising material for Cu-to-Cu bonding. Conventionally, electrodeposition with rotating disk electrode (RDE) was employed to deposit the (111) nt-Cu structure, whereas it exhibits non-uniform current distribution, resulting in variations of film thickness and crystallographic microstructure that might degrade the bonding characteristics. In this study, we attempted to deposit the (111) nt-Cu structure over various Ajinomoto Build-up Film (ABF) substrates through electroless plating process that enables uniform Cu metallization on complex geometries and insulating substrates without an external current. After electroless plating, the formation fraction of (111) nt-Cu and the thickness of transition layer were quantitatively characterized using focused ion beam (FIB), electron backscatter diffraction (EBSD), and X-ray diffraction (XRD). Additionally, the electroless Cu film was subjected to thermal annealing to examine the microstructure stability of the (111) nt-Cu structure. Details regarding the effect of substrate roughness on the formation of electroless (111) nt-Cu and its thermal stability will be presented in this talk.

July 15, 2026 | 3:30 PM

Active Control of Thin-Film Processing Plasma via a Tunable Metamaterial

Professor Sanghoo Park[1], Mr Hyunseung Lee[1], Mr Woojin Jeong[1], Prof. Hyoungsoo Kim[1]

[1]KAIST, 291 Daehak-ro, Yuseong-gu, Republic of Korea

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

As microelectronics manufacturing moves toward highly automated, data-driven dark-factory operation, the ability to monitor and control plasma uniformity on demand is becoming essential for stable and reproducible processing. However, real-time multidimensional diagnostic tools for plasma monitoring remain limited in industrial settings, and active control strategies for plasma uniformity are still underdeveloped. This challenge is becoming more significant as modern semiconductor processes grow more complex, with increasing numbers of control parameters and process variables that influence spatial uniformity. Here, we demonstrate a three-dimensionally tunable inductively coupled plasma (ICP) system enabled by an add-on reconfigurable metamaterial. The metamaterial consists of a dielectric disk patterned with an array of helical microchannels that can be selectively filled with liquid metal, allowing the electromagnetic field inside the ICP chamber to be reconfigured in situ. Using COMSOL Multiphysics simulations, we designed a metamaterial operating in the 60 MHz band and integrated it with a single-turn planar ICP source to identify configurations that improve plasma uniformity. Among the tested designs, a 10-turn helical structure arranged in a hexagonal array with a 34 mm pitch reduced plasma asymmetry and improved radial uniformity by up to 5%. These results suggest a new route toward adaptive plasma shaping and active uniformity control for next-generation semiconductor manufacturing.

Thermal atomic layer etching: Principles and applications for nanodevice fabrication

Taewook Nam[1]

[1]Sejong University, 209 Neungdong-ro, Gwangjin District, South Korea

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

As semiconductor devices scale down below 10 nm, conventional plasma-based etching techniques face severe limitations due to the surface damage caused by highly energetic radicals from plasma. In addition, for the fabrication of complex 3D architecture devices, such as gate-all-around FETs or 3D NAND, isotropic etching is required, which cannot be achieved by conventional plasma-based etching. Consequently, there is a high demand for an isotropic, damage-free etching method.

Thermal atomic layer etching (ALE), essentially the reverse process of atomic layer deposition (ALD), has emerged as a highly promising solution to resolve these issues. Like ALD, thermal ALE relies on sequential, self-limiting surface reactions. The process involves a surface modification using an initial precursor, followed by a volatile release where a second precursor reacts exclusively with the modified layer. This unique mechanism ensures 1) atomic-level thickness control, 2) exceptional large-area uniformity, and 3) conformal and isotropic etch characteristics. Unlike traditional reactive ion etching (RIE), which relies on directional ion bombardment resulting in anisotropic profiles, the isotropic nature of thermal ALE makes it highly suitable for uniform etching in complex 3D architectures.

In this presentation, the mechanism of thermal ALE will be introduced with examples of metal and metal oxide etching. A variety of in situ analyses, including quartz crystal microbalance (QCM) and quadrupole mass spectrometry (QMS), have been adopted to understand the etching mechanisms of the processes. Lastly, the current issues and research progress in thermal ALE will be presented.

July 15, 2026 | 4:10 PM

Detection of Pinholes in Thin-Film Solid Oxide Electrolytes via Selective Adsorption of Ag Nanoparticles Generated by Spark Discharge

Ph.D Student Doyoon Kim[1], Professor Ikwhang Chang[2], **Professor Jong Dae Baek**[1]
[1]Yeungnam University, , South Korea, [2]Wonkwang University, , South Korea

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

Pinhole-free ionic conductors are essential for the performance of thin-film solid oxide fuel cells (TF-SOFCs). Nanoscale defects, specifically pinholes, lead to parasitic current leakage and electrical short-circuits, resulting in cell failure. This study presents a methodology for detecting pinholes in yttria-stabilized zirconia (YSZ) thin-film electrolytes using the selective adsorption of silver (Ag) nanoparticles. The nanoparticles are synthesized via a spark discharge generator (SDG) and deposited onto the electrolyte surface. The interaction between Ag nanoparticles and nanoscale defects was characterized using focused ion beam (FIB), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). Experimental results confirm the effectiveness of this nanoparticle-based diagnostic method for high-resolution defect identification. This approach provides a reliable technique for quality assessment and defect characterization in thin-film solid oxide electrolytes.

AI-Driven Thermal Design Framework for Advanced Semiconductor Packaging

Prof. Haeun Lee[1]

[1]Yeungnam University, 340, Dongbuk-ro, Dong-gu, South Korea

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

As semiconductor packaging evolves toward 2.5D/3D high-density heterogeneous integration, thermal management has emerged as the most critical bottleneck threatening device performance and reliability. Escalating power densities and complex multi-layered interfaces significantly increase thermal impedance. Traditional thermal design relies heavily on physical experimentation and high-fidelity Computational Fluid Dynamics (CFD). However, direct experimental validation is highly inefficient during the early design phases. Furthermore, explicitly resolving intricate micro-scale geometries via traditional CFD incurs prohibitive computational costs and time.

To overcome these early-stage design limitations, we propose a comprehensive, multi-tiered AI-driven thermal design framework that integrates advanced CFD, physics-guided neural networks, and generative AI. This framework accelerates the design pipeline through three key phases. First, to overcome the computational bottleneck of baseline CFD, we implemented a porous media model as an advanced CFD approach, effectively replacing the need to explicitly resolve complex microchannel flows while drastically reducing computational overhead. Second, utilizing this accelerated data generation, we developed a surrogate model based on physics-guided neural networks. By embedding underlying physical laws, this model rapidly and accurately predicts heat spreading phenomena across packaging layers. Finally, building upon these instantaneous thermal predictions, we leveraged generative AI to autonomously explore and derive optimal cooling geometries and heat dissipation structures.

Ultimately, this methodology transcends mere simulation replacement; it serves as a powerful virtual prototyping tool that enables near real-time design space exploration. By bridging the gap between computational feasibility and early-stage design exploration, this framework establishes a robust foundation for future experimental validation and data-driven calibration in advanced packaging applications.

July 15, 2026 | 4:45 PM

Epitaxial growth of high-quality GaN on CVD MoS_2/c-sapphire by plasma-assisted molecular beam epitaxy

Dr Iwan Susanto[1], Hong-Shan Liu[2], Dr Ing-Song Yu[2], Dr Yen-Ten Ho[3]
[1]Politeknik Negeri Jakarta, Magister Program in Applied Manufacturing Technology Engineering, Politeknik Negeri Jakarta, Prof. Dr. G.A Siwabessy, Kampus Baru UI Depok, Depok 16425, Indonesia , Indonesia, [2]National Dong Hwa University, Department of Materials Science and Engineering, National Dong Hwa University, Hualien 974301, Taiwan , Taiwan, [3]National Yang Ming Chiao Tung University, International College of Semiconductor Technology, National Yang Ming Chiao Tung University, Hsinchu 300093, Taiwan, Taiwan

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

The epitaxial integration of gallium nitride (GaN) with two-dimensional (2D) materials offers a promising route for advanced electronic and optoelectronic applications. In this work, GaN films were grown on chemical vapor deposited (CVD) MoS_2/c-sapphire substrates using plasma-assisted molecular beam epitaxy (PA-MBE). The effects of growth temperature, thermal treatment, and pre-nitridation on the structural, morphological, and optical properties of the films were systematically investigated. Surface and interface characteristics were analyzed using RHEED, FE-SEM, AFM, Raman spectroscopy, XPS, HR-XRD, photoluminescence (PL), and TEM. The results indicate that pre-nitridation significantly improves interfacial quality, leading to smoother surface morphology and reduced defect density. Furthermore, increasing growth duration promotes enhanced crystalline and improved structural ordering of the GaN films. The optimized growth conditions yield high-quality GaN layers with enhanced optical performance. These findings provide insight into the controlled growth of GaN on 2D material templates and highlight the potential of MoS_2-assisted heteroepitaxy for high-performance coating and device applications.

Phase-Controlled Electronic Structure Engineering in Doped HfO2: A High-Throughput Graph Neural Network Study of Y, La, Al, Si, Ti, and Ce Dopants

Mr. Zunair Masroor[1], Mr. Bonwook Gu[1], Prof. Han-Bo-Ram Lee[1]

[1]Department of Materials Science and Engineering, Incheon National University, , South Korea

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

As the pioneering high-k dielectric successfully integrated into the silicon semiconductor industry, hafnium oxide (HfO2) serves as the foundational template for modern gate-stack engineering. To further scale CMOS technology, researchers continuously seek to improve its dielectric constant (k) and band gap (Eg) via elemental doping, a preferred method that avoids major process alterations. However, dopant selection remains a significant challenge due to the complex interplay between thermodynamic stability, electronic insulation, and dielectric response. Here, we establish a high-throughput computational framework integrating special quasi random structures (SQS), machine-learning interatomic potentials (SevenNet), and graph neural networks (ALIGNN) to systematically evaluate 240 doped HfO2 compositions across six dopants (Y, Ce, La, Si, Ti, Al) and four polymorphs (cubic, monoclinic, orthorhombic, tetragonal). Our analysis establishes that formation energy, band gap, and dielectric constant are fundamentally decoupled parameters requiring application-specific optimization. Specifically, silicon acts as the optimal dopant for mainstream gate dielectrics by preserving a pristine ~5.72 eV band gap to suppress leakage, despite thermodynamic penalties. Aluminum drives concentration-dependent band gap expansion (5.6-5.9 eV), securing the robust electronic insulation required for advanced voltage scaling, whereas yttrium minimizes formation energy (−3.763 eV/atom) to stabilize higher-symmetry phases critical for cap dielectrics and emerging ferroelectrics. Validation against experimental literature and first-principles DFT confirms quantitative accuracy (±0.02 eV band gap error for Si-doping, MAE ≤ 0.001 eV/atom for formation energy). Furthermore, cerium's catastrophic electronic failure, despite excellent thermodynamic stability, underscores the necessity of this multiparameter analysis. By resolving the fundamental trade-offs between stability and electronic performance, this framework transitions dopant selection from empirical trial-and-error to predictive, AI-driven design, accelerating the development of next-generation high-k gate stacks and advanced functional oxides.

Atomic-Scale Control of Stoichiometry and Oxygen Vacancies in Ferroelectric HfxYyOz Films via Atomic Layer Modulation

Mr Ngoc Le Trinh[1], Mr Minhyeok Lee[1], Mr Dong-In Han[2], Mr Wonjoong Kim[1], Mr Zunair Masroor[1], Ms Nayoung Lee[1], Mr Byungchan Lee[1], Prof. Youngho Kang[1], Prof. Min Hyuk Park[2], Prof. Han-Bo-Ram Lee[1]

[1]Department of Materials Science and Engineering, Incheon National University, , Republic of Korea, [2]Department of Materials Science and Engineering, Seoul National University, , Republic of Korea

Session 06 - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Boardroom - Level 3, July 15, 2026, 3:30 PM - 5:30 PM

Silicon-compatible ferroelectric materials are critical for next-generation memory and logic devices, driving extensive research on HfO2-based thin films due to their robust ferroelectric properties. However, achieving atomic-scale control in ultrathin films and fully elucidating the underlying mechanisms remain challenging despite extensive prior studies. In this study, we fabricate Y-doped HfO2 (HfxYyOz) thin films by engineering atomic-level stoichiometry using an atomic layer modulation (ALM) process, guided by a line graph neural network (LGNN) and first-principles calculations. First, the LGNN efficiently captures local atomic environments and defect–structure relationships, enabling rapid screening of representative stoichiometries and oxygen vacancy (Vo) configurations for subsequent density functional theory (DFT) calculations. The ALM process is then employed to precisely tune film composition through sequential precursor pulses, allowing systematic investigation of the effects of Y doping on crystallinity and ferroelectricity. In the ALM process, the surface was sequentially exposed to precursors with an intervening purging step between each exposure, followed by a reaction with a counter-reactant, resulting in the growth of the HfxYyOz film within a single atomic layer. The ratio of Y and Hf in ALM film was determined by steric hindrance and chemical reactivity of the precursors. The resulting HfxYyOz films with 5.8% Y exhibit significantly improved crystallinity and enhanced ferroelectric performance, achieving a remarkable remanent polarization (2Pr) of 71.6 μC/cm² at a thickness of only 7 nm. The DFT calculations provide mechanistic insights into the role of Y doping and Vo concentration, revealing that an optimized Vo level of ~8% stabilizes the ferroelectric phase and enhances polarization. These results establish a powerful framework for the rational design of HfO2-based ferroelectrics with tailored defect chemistry, enabling the development of next-generation devices with optimized performance.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Non-destructive and Non-contact Optical Measurement of Critical Dimension (CD) by Spectroscopic Ellipsometry (SE)

Ms Hong Xie[1], Mr Min Hao Goh[1]

[1]SIMTech, Singapore, Singapore

Poster Session - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

(TFS Abstract submission system trial)(TFS Abstract submission system trial)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

ALUMINIUM NITRIDE THIN FILM DEPOSITION GROWTH USING CERAMIC TARGET FOR DIELECTRIC AND PIEZOELECTRIC APPLICATIONS

Dr Muhammad Izzuddin Abd Samad[1]

[1]Universiti Teknologi Malaysia, , Malaysia

Poster Session - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Aluminium Nitride, Ceramic composite, Piezoelectric response

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

The Carbon-Free Trisilylamine as the Silicon Precursor for Si-doped HfO2 Gate Dielectrics by Atomic Layer Deposition

Mr. Pi-chun Juan[1], Mr. Tekalign Woldemariam Kukie[1]

[1]Ming Chi University Of Technology, 84 Gungjuan Rd., Taishan Dist., Taiwan

Poster Session - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Hf1-xSixO2 (HSO) dielectrics with varying doping ratios of Si and Hf were fabricated using thermal atomic layer deposition (ALD). The doping process was designed using sequential stacking cycles of SiO2 and HfO2. Atomic layers of SiO2 and HfO2 were deposited using trisilylamine (TSA) and tetrakis(ethylmethylamino)hafnium (TEMAH) as precursors, respectively. The crystalline phase exhibited a transformation from monoclinic to orthorhombic structure upon doping. The highest capacitance was achieved with a 2% SiO2/HfO2 doping ratio, while capacitance decreased as the doping amount increased. Compared to pure HfO2, HSOs demonstrated a smaller flat-band voltage shift (ΔVFB) and a lower interfacial trap density (Dit), indicating a significant reduction in oxide trap density and enhanced passivation on the silicon surface. Additionally, the leakage currents of HSOs were markedly lower than those of pure HfO2, which is attributed to the trap-assisted tunneling mechanism governing current transport. To further understand the atomic inter-diffusion under different doping conditions, depth profiling was performed using X-ray photoelectron spectroscopy (XPS). The results revealed that the incorporation of SiO2 effectively suppressed the inter-diffusion of Hf and O into the silicon substrate, improving the interface quality and reducing defect states. These findings demonstrate that Si doping in HfO2, particularly at low doping ratios, enhances the electrical performance and interface quality of high-k dielectrics for advanced semiconductor applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Fabrication of carbon-backed 191Ir thin film targets for the study of low-energy nuclear reaction dynamics

Dr. Amanjot Amanjot[1], Mr Amit Kumar[2], Dr Pushpendra P Singh[1]

[1]Indian Institute of Technology Ropar, , India, [2]Inter-University Accelerator Centre, , India

Poster Session - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

High-quality thin film targets of 191Ir are essential for precise cross-section measurements in heavy-ion induced nuclear reactions, where uncertainties in target thickness and uniformity directly influence the accuracy of extracted excitation functions and recoil observables. In the present work, 191Ir targets have been fabricated using ultra-high vacuum evaporation via electron-beam gun assembly technique with controlled thickness in the range of 150 μg/cm² on a suitable carbon backing.

The fabrication process was optimized to address challenges associated with iridium, including its high melting point, low vapor pressure, and adhesion characteristics. Thickness determination was carried out using the alpha-transmission method, and uniformity across the beam spot was ensured within acceptable limits. Surface morphology and structural integrity of the targets were evaluated to confirm their suitability for irradiation.

Special emphasis was placed on the stability of the prepared targets under heavy-ion beam exposure, where thermal effects and sputtering can significantly affect target performance. The fabricated targets exhibited good adhesion and mechanical robustness, making them suitable for use in nuclear reaction experiments involving compound nucleus formation and evaporation residue measurements.

The present study demonstrates that careful optimization of thin film fabrication parameters leads to reliable target performance, thereby reducing systematic uncertainties in nuclear reaction measurements. Detailed experimental data and analysis will be presented at the conference.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Correlation between Plasma Uniformity and Surface Wettability Distribution

Hyeseong PARK[1], Hyunseong Lee[1], Jiwon Choi[1], Prof. Sanghoo Park[1]
[1]Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology (KAIST), 291 Daehak-ro, Yuseong-gu, South Korea
Poster Session - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Plasma is indispensable in semiconductor manufacturing for etching, deposition, and surface modification. As process complexity increases and technology approaches atomic-scale limits, tighter control of plasma uniformity is increasingly required. This need is especially important for emerging plasma pretreatment processes for heterogeneous material integration, including HBM-related applications. Yet in most plasma processes, uniformity optimization still depends on ex-situ trial-and-error because in-situ diagnostic and control capabilities remain limited. In this work, we present optical emission tomography (OET) as a process-relevant diagnostic tool for wafer-scale plasma uniformity monitoring. Line-integrated optical emission signals acquired from multiple viewing angles were reconstructed into two-dimensional emission distributions using Phillips–Tikhonov regularization with prior system information. To validate the method, Si/SiO2 wafers were treated in an argon capacitively coupled plasma system and analyzed by water contact angle (WCA) and atomic force microscopy (AFM). Across a 200 mm wafer, the reconstructed emission distribution closely matched spatial variations in surface properties: regions with higher emission intensity showed lower WCA and higher root-mean-square roughness. These results demonstrate that OET can directly capture plasma nonuniformity relevant to process outcomes, highlighting its potential as a wafer-scale diagnostic platform for predictive, data-driven plasma process control.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A Comprehensive Study on the Mechanical Stabilization for Large-Area Thin-Film SOFCs

Dr. Suhan Lee[1], Prof. Yong-Jin Yoon[1,2,3]

[1]Department of Mechanical Engineering, Korea Advanced Institute Of Science and Technology (KAIST), 34141, South Korea, [2]School of Mechanical and Aerospace Engineering, Nanyang Technological University (NTU), 639798, Singapore, [3]Department of AX, Korea Advanced Institute Of Science and Technology (KAIST), 34141, South Korea

Poster Session - S12: Thin Film for Semiconductor Fabrication and Packaging (TSP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Thin-film solid oxide fuel cells (TF-SOFCs) offer exceptional power density at reduced operating temperatures, making them ideal for next-generation portable power sources. However, as the active area scales up, the "size effect" significantly increases the susceptibility of ultra-thin (100 nm) membranes to mechanical failure, such as buckling and thermal-stress-induced fracture.

This presentation introduces an advanced structural design strategy for the mechanical stabilization and scale-up of TF-SOFCs. We focus on upgrading the conventional tapered Si-edge structure to more effectively redistribute internal stresses within the membrane-electrode assembly. This optimized configuration enables the successful transition from micro-scale laboratory prototypes to a practical 6 mm large-area architecture. Furthermore, a robust Pt-YSZ-Pt free-standing fuel cell structure was implemented to ensure thermal-mechanical durability under harsh operating conditions.

The results demonstrate that the upgraded structural design effectively suppresses mechanical degradation, achieving stable electrochemical performance in a 6 mm free-standing configuration. By providing a scalable structural framework, this work successfully bridges the gap between fundamental thin-film research and real-world energy applications, such as long-endurance drones and portable electronics.

SYMPOSIUM S13 | ABSTRACT #616

July 14, 2026 | Keynote | 10:50 AM - 11:15 AM | Kallang - Level 3

Microenergy harvesting technology enabled fully self-powered real-time wireless sensing

Jikui Luo 1

1 College of Info. Sci. & Electron. Eng., Zhejiang University, No.38 Zheda Road, Hangzhou, Zhejiang, China

Keynote - S13: Smart Materials and Microsystems (SMM), Kallang - Level 3

With the rapid advancement of technology, self-powered wireless sensing has become an urgent need for applications in the IoT, smart cities, intelligent manufacturing, healthcare, and beyond. Micro-energy harvesting technologies-especially piezoelectric and triboelectric nanogenerators (PENGs and TENGs)-are expected to address this demand, as they can provide sustained power without requiring periodic maintenance. Although significant progress has been made in energy harvesting, translating these scientific and technological advances into widespread practical applications remains a key challenge.

In this talk, I will present our recent advances in this field. First, I will introduce the development of various high-performance PENGs and TENGs using diverse technologies and material combinations. Next, I will highlight the role of microswitches in achieving pulsed outputs that can drive systems for self-powered wireless sensing. Then, by integrating energy harvesters with resonators and sensors, we have realized multiple fully self-powered, instantaneous wireless sensing systems capable of long-range, real-time monitoring of various environmental and physiological parameters. Finally, I will discuss several application cases that demonstrate the potential of these systems in environmental and industrial monitoring, healthcare, and other areas.

SYMPOSIUM S13 | ABSTRACT #597

July 14, 2026 | Keynote | 11:15 AM - 11:40 AM | Kallang - Level 3

Bio-inspired Structural Materials and Devices Based on 2D Materials

Pingan Hu 1

1 Harbin Institute Of Technology, 92 West Street Nangang District, Harbin, China

Keynote - S13: Smart Materials and Microsystems (SMM), Kallang - Level 3

Flexible functional structural materials and devices hold significant application potential in fields such as artificial intelligence and smart healthcare. My research group fully leverages the exceptional mechanical and electrical properties of graphene and two-dimensional (2D) semiconductors. Using graphene and 2D semiconductors as fundamental building blocks, we have constructed various high-performance bio-inspired material structures (e.g.) and health monitoring devices, electronic skins (e-skins) and human-eye-inspired devices. Representative achievements include: 1. Nacre-mimetic fibers with helical microstructures achieving >400% stretchability and 640 J g^-1 toughness, while CdTe nanowire integration enables mechanically tunable luminescence. 2. Design and fabrication of functional sensitive structures with a large linear response range for highly sensitive e-skin devices integrating proximity sensing and force/tactile perception functions. These devices were successfully implemented in robotic safety control systems.3. Janus membranes enabling auto-filtration of impurities in undiluted sweat for real-time health monitoring. Sweat-based FET biosensors incorporating molecularly imprinted graphene detect disease biomarkers (e.g., TNF-· for inflammation/cancer) at ultralow concentrations (0.31 pM). 4. Structures inspired by biological models (e.g., jellyfish mesoglea and human skin), specifically hybrid hydrogel-flexible frameworks and gradient pore microstructure (GPS) films, enabling simultaneous pressure/temperature sensing with ultrahigh pressure resolution (0.06%). Neural network signal decoupling enhances stability without requiring complex additional structures. These advances highlight the critical role of 2D materials in merging biomimetic design with scalable manufacturing. Challenges remain in optimizing interfacial interactions and expanding multimodal sensing capabilities. Future work will focus on the clinical integration of wearable systems and the development of adaptive robotics

July 14, 2026 | 11:40 AM

Acoustic wave enhancement of free space optical communication system via piezoelectric thin-film based SAW

Mr Alex Cameron[1], Dr Xicong Li[2], Prof. Zabih Ghassemlooy[1], Prof. Yong-Qing Fu[1]
[1]Northumbria University, School of Engineering, Physics, and Mathematics, United Kingdom, [2]University of Glasgow, James Watt School of Engineering, United Kingdom
Session 01 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 10:50 AM - 12:25 PM

Free space optics (FSO) is seen as a complementary wireless technology to radio frequency (RF), for applications including high-speed and long-distance communications. Optical communication surpasses traditional communication technologies with higher data rates, electromagnetic interference immunity, a license free spectrum, and increased security at the physical layer. Unfortunately, FSO communication performance is heavily affected by natural and manmade atmospheric conditions. While there have been many attempts to solve this issue, no existing methods target the root cause of the signal degradation, they are often costly and bring additional health and safety risks and there is an urgent need for monitoring or sensing platform for FSO systems. In this work, we present the results using a piezoelectric thin film-based surface acoustic wave (SAW) platform to create a monitoring device, which can be combined with acoustic enhancement system on a laboratory controlled atmospheric chamber and FSO link. In the monitoring or sensing system, sputtered ZnO coated SAW sensors on both glass and silicon with different resonant frequencies were used to pre-empt and sense atmospheric discontinuities. Once the threshold reaches for these SAW sensing signals, the targeted airborne acoustics or acoustic orbital angular momentum (OAM) optical guiding system will be activated to remove the fogging or particles.

Acousto-Optogenetics Bandpass Stabilizer: A Programmable Platform for Mapping Single-Cell Phenotypic Life Trajectories

Mr. Yuxin Wang[1], Professor Yinning Zhou[1]

[1]University of Macau, ,

Session 01 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 10:50 AM - 12:25 PM

Photobleaching-induced signal decay undermines the accuracy of fluorescence-based drug screening across multiple disease models (e.g., HER2/EGFR-targeted therapies). Traditional phototoxicity mitigation strategies, primarily through reduced illumination, inevitably compromise imaging resolution and further providing false positive/false negative. Here, we introduce an innovative active photobleaching intervention strategy to solve these problems with the potential for broad applicability across a wide range of cell species. We employ the ultra-low-frequency (500–2000 Hz) acoustic modulation to control 3D cellular rotation (precisely in x-y/y-z planes) with a linearly tunable rotational speed, establishing the first quantitative framework linking acoustic parameters to photobleaching kinetics. Our results indicate that acoustic frequency scanning exerts a bandpass-filter effect on photobleaching half-life, peaking at 1500 Hz and achieving approximately 30-fold fluorescence preservation compared to static conditions. By harnessing our newly developed Acousto-Optogenetics Bandpass Stabilizer, we transform phototoxicity into a tunable parameter, thereby enabling artifact-free drug response analysis. While maintaining maximal photostability, frequency-division multiplexing further permits real-time calcium flux monitoring during optogenetic activation. Complementing this, we engineer FlowMind, an AI-powered software, to automate single-cell dynamic library processing. As proof of concept, screening calcium channel blockers under optimal photostability conditions reveals significant variations in drug screening sensitivity. By integrating acoustic modulation with optogenetics, this paradigm not only pioneers the programmable control of photostability via acoustics, but also catalyzes a transformative shift in precision oncology, heralding a new era of patient-tailored therapeutic regimens with enhanced clinical predictability.

Dielectric Breakdown Fabrication of TMD Nanopore Sensors

Jinyan Cheng, 维 郭, 志山 袁, 其娇 孙

[1]Guangdong University of Technology, Guangdong University of Technology, Xiaoguwei Street, Panyu District, Guangzhou City, Guangdong Province,China, China

Session 01 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 10:50 AM - 12:25 PM

Transition metal dichalcogenide (TMD) nanopores, owing to their unique physicochemical properties and atomically ultra-thin structures, exhibit significant application potential in the field of single-molecule detection. However, the controllable fabrication of sub-5 nm TMD nanopores remains a critical technical bottleneck. In this work, taking monolayer molybdenum disulfide (MoS_2) as the research object, we successfully fabricated sub-1–3 nm monolayer MoS_2 nanopores in electrolyte solutions with different pH values using a self-built dielectric breakdown processing platform, combined with high-low voltage collaborative fabrication and real-time pore diameter monitoring technology. An ionic current detection platform was constructed based on the prepared monolayer MoS_2 nanopores, and the detection of Oligo DNA molecules was realized, verifying the sensing performance of TMD nanopores. This study achieves the controllable fabrication of TMD nanopores at the sub-nanometer scale, addresses the issues such as poor pore diameter controllability in traditional preparation methods, provides technical support for the application of TMD nanopores in high-resolution single-molecule detection and biomedical fields, and opens up a new path for the development of nanopore fabrication technology.

SYMPOSIUM S13 | ABSTRACT #139

July 14, 2026 | Keynote | 1:20 PM - 1:45 PM | Kallang - Level 3

Harnessing the giant and switchable surface energy of liquid metals for robotics

Shiyang Tang 1,2, Tim Cole3, Xiangpeng Li4

University of New South Wales, Sydney, Australia
University of Southampton, Southampton, UK
University of Birmingham, Birmingham, UK
Soochow University, Suzhou, China

Keynote - S13: Smart Materials and Microsystems (SMM), Kallang - Level 3

Gallium-based liquid metal alloys are a unique class of materials that remain in the liquid state at (or near) room temperature. They are particularly attractive due to their unusual combination of fluidic behaviour and metallic properties, together with an exceptionally large surface tension (>600 mN/m, ~9 times that of water). As a fluid conductor, liquid metals offer an unparalleled combination of stretchability, deformability, and high electrical conductivity among soft materials. This distinctive coupling enables electrical modulation of interfacial tension, providing a powerful actuation mechanism.

This talk will highlight our recent advances in liquid metal electromechanical systems (LMEMS), with a particular focus on soft robotics and adaptive manipulation. I will first introduce capillary liquid metal muscles (CLMM), which exploit large, reversible changes in interfacial tension to generate force and motion. We present the theoretical framework governing their operation, including scaling laws linking capillary dimensions to force output, and demonstrate optimisation strategies for maximising stroke and actuation efficiency. With closed-loop feedback, both force output and displacement can be precisely regulated. Beyond actuation, we draw inspiration from biological systems to develop a liquid metal universal gripper. This system enables adaptive grasping and active release of objects spanning a wide range of shapes, sizes, and mechanical properties in both liquid and air environments. We reveal a surface-tension-induced active release mechanism that allows programmable and tunable release dynamics, including for microscale objects. The gripper operates across an extraordinary dynamic range of approximately 14 orders of magnitude in weight (from 10^-12 g to 200 g), while maintaining an ultralow contact pressure of ~10 Pa, enabling safe handling of delicate and soft materials.

Overall, these advances establish liquid metal systems as a versatile platform for next-generation soft robotic actuators and adaptive manipulators, bridging fundamental interfacial physics with practical applications in biomedical engineering, microsystems, and intelligent robotics.

SYMPOSIUM S13 | ABSTRACT #703

July 14, 2026 | Keynote | 1:45 PM - 2:10 PM | Kallang - Level 3

Ferroelectric Photovoltaic Effect and Device

Jie Wei, 1 Shigeng Song 2

1 Electronic Materials Research Laboratory, Key Laboratory of Ministry of Education & Shaanxi Engineering Research Center of Advanced Energy Materials and Devices, School of Electronic Science and Engineering, Xi'an Jiaotong University, Xi'an 710049, P. R. China
2 Institute of Thin Films, Sensors and Imaging, University of the West of Scotland, SUPA Paisley PA1 2BE, Scotland, UK

Keynote - S13: Smart Materials and Microsystems (SMM), Kallang - Level 3

More recently, the photovoltaic effect in the BiFeO3-based ferroelectric materials has attracted increasing attention. In contrast to conventional p-n junction solar cells, a built-in electric field induced by ferroelectric polarization in the ferroelectric material that extends throughout the entire ferroelectric body, effectively separates photo-generated carriers, thereby yielding a giant open-circuit voltage Voc that far exceeds the ferroelectric bandgap width (Eg). Moreover, theoretical calculations indicate that BiFeO3-based ferroelectric photovoltaic device can achieve high power conversion efficiency exceeding the Shockley-Queisser limit, thereby significantly reducing the unit cost of power generation in photovoltaic technology. Consequently, BiFeO3-based ferroelectric semiconductor materials are regarded as the most promising candidates for breakthrough applications in next-generation photovoltaic cells or optoelectronic devices.

This paper provides a brief introduction to the fundamental principles of the ferroelectric photovoltaic effect, reviews its historical development, discusses the current state of research and existing challenges, and outlines its future directions or prospects.

July 14, 2026 | 2:10 PM

Controllable Preparation of Se-Vacancy Bi_2O_2Se Thin Films and Their Integrated Photosensing-Memory Devices

Prof. Jia Zhang[1]

[1]Harbin Institute of Technology, No.92 West Dazhi Street, China

Session 02 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 1:20 PM - 3:15 PM

This report focuses on the controllable preparation of Se-Vacancy Bi_2O_2Se thin films and their integrated photosensing-memory devices. At first, a low-temperature chemical vapor deposition (CVD) technique is developed to achieve rational control of Se-Vacancy concentration and spatial distribution by precisely controlling the growth temperature, precursor ratio, and annealing atmosphere, yielding high-quality, defect-tunable Bi_2O_2Se single-crystal thin films with dimensions scalable to the submillimeter scale. Second, a simple device architecture for integrated photosensing-memory is designed, utilizing selenium vacancies as trapping and storage centers for photogenerated charge carriers. By combining gate voltage modulation with optoelectronic excitation, multifunctional devices capable of simultaneous photodetection, signal storage, and synaptic plasticity are constructed. Finally, the device performance is systematically evaluated in terms of photoelectric response, synaptic plasticity (including short-term/long-term potentiation and depression, paired-pulse facilitation, etc.), and multispectral imaging, while exploring their potential applications in filtering and image preprocessing. Through the above research, this study aims to establish a methodology for the precise control of selenium vacancies and the optimization of device functionalities, providing a material and device foundation for the development of low-power, high-density novel neuromorphic visual perception systems.

July 14, 2026 | 2:30 PM

A Flexible Thin-Film Multimodal Intracranial Sensing System for Real-Time Brain Injury Monitoring

Doctor Tiezhu Liu[1]

[1]Harbin Institute of Technology, No. 92, Xidazhi Street, Nangang District, China

Session 02 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 1:20 PM - 3:15 PM

Severe brain injuries require precise, real-time multimodal monitoring, yet traditional rigid probes often cause secondary tissue damage. Flexible thin-film bioelectronics offer an ideal platform for conformal, minimally invasive neural interfaces. Here, we present a novel flexible multimodal intracranial sensing system (FMISS) based on high-density thin-film integration. Fabricated on an ultrathin, biocompatible polyimide (PI) substrate (merely 4 × 8 mm^2), the FMISS heterogeneously integrates functional micro-layers to simultaneously monitor five critical parameters: electrocorticography (ECoG), intracranial pressure (ICP), intracranial temperature (ICT), and potassium (K^+) and sodium (Na^+) ion concentrations.

The device leverages advanced thin-film engineering. The ion sensors utilize PEDOT:PSS solid-contact films coupled with polymeric ion-selective membranes to achieve highly sensitive, Nernstian-driven concentration monitoring. Meanwhile, the physical sensors incorporate optimized piezoresistive microstructured films for ICP and platinum thin-film thermistors for precise ICT tracking. The mechanical flexibility of the PI thin film ensures highly conformal contact with the dynamic curvilinear surface of the brain, minimizing interfacial impedance and tissue trauma.

In vivo validations were conducted in rat models representing typical neurological pathologies: epilepsy, subarachnoid hemorrhage, and cerebral infarction. The thin-film sensor array successfully captured real-time, multimodal anomalous signal fluctuations during pathological progression. Furthermore, by coupling the multiplexed sensor data with classification algorithms, we achieved robust disease state identification.

In conclusion, the FMISS demonstrates the tremendous potential of functionalized thin-film materials and microfabrication in sophisticated biomedical applications. This highly integrated thin-film platform advances in situ neural monitoring, paving the way for data-driven diagnostics and targeted interventions in neurocritical care.

July 14, 2026 | 2:45 PM

Plasma-Driven Surface Functionalization of Common Polymers for Smart Material and Microsystem Applications

Miss Ayesha Armani[1], Doctor Muhammad Shahid Rafique, Miss Tehreem Arshad, Miss Aneesa Naveed, Mr. Muhammad Muddasar, Mr Muhammad Qasim

[1]University of Engineering and Technology, Lahore, Grand Trunk Road (G.T. Road), near Shalimar Gardens, Lahore, Punjab, 54890, Pakistan, Pakistan

Session 02 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 1:20 PM - 3:15 PM

Atmospheric plasma treatment is widely used for surface activation of polymers; however, the influence of ionic wind–driven dielectric barrier discharge (DBD) plasma on the combined electrical, mechanical, and chemical characteristics of polymer surfaces has not been systematically examined. Understanding these coupled property modifications is important for developing functional polymer materials suitable for smart material and microsystem technologies.

This research investigates the application of ionic wind generated through dielectric barrier discharge (DBD) plasma to enhance nitrogen ion (N^+) implantation in common polymer substrates, including polyethylene (PE), polypropylene (PP), and CR-39. Plasma treatments were conducted at 18 kV for exposure times up to 50 minutes. SRIM/TRIM simulations predicted penetration depths of approximately 0.17 μm for PE and PP and 0.2 μm for CR-39 for 45 keV N^+ ions. Surface morphology analysis revealed ion-track alignment and trench formation following plasma exposure, while FTIR spectroscopy confirmed significant chemical modifications associated with nitrogen incorporation and surface activation.

Electrical and mechanical characterization showed notable improvements in surface conductivity and hardness, particularly for CR-39 at treatment durations of 20–40 minutes and for PE and PP at approximately 40 minutes of exposure. These surface-confined modifications indicate strong ionic wind–polymer interactions that can effectively tailor polymer functionality without altering bulk material properties.

The results demonstrate that DBD-assisted ion implantation offers a scalable approach for engineering functional polymer surfaces for smart materials and microsystem applications, including flexible electronic substrates, sensor interfaces, optical polymer components, and photovoltaic encapsulation layers where PE and PP are commonly used.

July 14, 2026 | 3:00 PM

Stiffness-Programmed 3D Microelectrodes for Near-Linear and Tunable Iontronic Pressure Sensing

Ms Fengling Zhuo[1], Prof. Xiaozhi Wang[1], Prof. Jikui Luo[1]
[1]Zhejiang University, 38 Zheda Road, China

Session 02 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 1:20 PM - 3:15 PM

Flexible pressure sensors that rely on deformation-controlled contact evolution require progressive contact expansion to achieve linear transduction, typically through compliant microstructures. However, such microstructures are often constrained by viscoelastic dissipation and geometry-induced instabilities, resulting in hysteretic and nonlinear mechanical responses that compromise quantitative pressure readout. Here, we introduce a mechanics-based strategy that programs deformation through stiffness-encoded 2D-to-3D assembly to guide controlled contact evolution for iontronic pressure sensing. Spatial stiffness gradients embedded in planar precursors drive deterministic buckling into dome-like microelectrodes with tunable effective stiffness, enabling sequential apex-to-periphery flattening under compression. Unlike conventional soft microstructures that primarily depend on material compliance and empirical geometric optimization, this architecture prescribes how the sensing interface engages during loading and enables pressure transduction through structural programming. Integrated into an electric-double-layer capacitive configuration, the resulting deformation establishes a robust pressure-displacement-capacitance relationship, enabling highly sensitive, near-linear, and tunable pressure sensing. The 2D-to-3D assembly strategy further supports scalable fabrication of addressable arrays for reconstructing object contours and contact-pressure distributions from capacitance maps. More broadly, stiffness-encoded deformation provides a general design principle for interface-dominated sensors and a versatile route toward smart tactile microsystems, structurally programmed flexible electronics, and next-generation human-machine interfaces.

SYMPOSIUM S13 | ABSTRACT #388

July 14, 2026 | Keynote | 3:30 PM - 3:55 PM | Kallang - Level 3

A 3D-Printed Miniaturized Electromagnetically Actuated Compliant Parallel Delta Robot for Precision Micromanipulation

Hejun Du 1,2, Van Thai Tran 1

School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore
Singapore Centre for 3D Printing, Nanyang Technological University, 50 Nanyang Avenue, Singapore

Keynote - S13: Smart Materials and Microsystems (SMM), Kallang - Level 3

Miniaturized manipulators are crucial in precision manufacturing, micro-assembly and biomedical applications, where compact size, rapid response and accurate motion are required. Among these systems, parallel delta robots are particularly attractive at small scales due to their low inertia, high stiffness and precise positioning performance. However, the fabrication of small-scale delta robots often involves mechanically complex designs and labor-intensive assembly. Furthermore, most current devices utilize piezoelectric actuator as the main driving mechanism, which requires high driving voltage and is relatively brittle. Meanwhile, electromagnetic actuation in miniature compliant parallel manipulators remains relatively unexplored. Here, we present an additively manufactured miniaturized electromagnetically actuated compliant parallel delta robot for three-dimensional (3D) translational micromanipulation. The system integrates three electromagnetic actuators, each composed of a pair of permanent magnets, a copper coil and a 3D-printed linear compliant structure. Each actuator can convert input electrical signals into linear motion. In addition, the delta mechanism, fabricated by a single-equipment multi-material 3D printing process, enables the integration of rigid and elastomeric elements within a compact architecture. An inverse kinematic model controls and synchronizes motion of all actuators, allowing precise positioning of the end-effector. Experimental results demonstrate repeatable actuator behavior, precise three-dimensional translational motion and reliable point-to-point positioning. These findings establish the proposed system as a compact and effective smart actuation platform for precision micromanipulation, with strong potential for applications in micro-assembly, tissue engineering and biomedical manipulation. More broadly, the study highlights the potential of integrating compliant mechanisms, electromagnetic actuation and multi-material 3D printing in next-generation smart microsystems.

SYMPOSIUM S13 | ABSTRACT #299

July 14, 2026 | Keynote | 3:55 PM - 4:20 PM | Kallang - Level 3

A MEMS Self-Calibrating Tactile Sensor Based on Precision Force Source Drive Technology

Chenxi Yue 1, Yuxin Zhong 1, Yuze Yang 2, Chaoran Liu 1, Yu Gao 1, Weihuang Yang 1, Liang Lou 2, Linxi Dong 1,

Hangzhou Dianzi University, Hangzhou, Zhejiang Province, China
Shanghai Industrial μ Technology Research Institute, Chengbei Road, Jiading District, Shanghai, China

Keynote - S13: Smart Materials and Microsystems (SMM), Kallang - Level 3

The rapidly expanding robotics industry has given rise to an imperative for high-performance tactile sensors that exhibit both high precision and long-term stability. However, existing tactile sensors are plagued by inherent limitations including performance degradation, hysteresis, and creep. Moreover, integrated self-calibration designs frequently entail trade-offs between functionality, miniaturization, and manufacturability. This paper puts forth a novel MEMS self-calibrating tactile sensor based on precision force source drive technology, which integrates high-performance force sensing and on-chip self-calibration capability. The study investigated the driving mechanism of PZT-driven double-clamped silicon piezoresistive beam. Utilizing the inverse piezoelectric effect of PZT, the integrated piezoelectric structure generates precise and controllable driving forces through the bending deformation of the double-clamped silicon piezoresistive beam. This effectively compensates for sensor performance drift without the need for additional off-chip calibration equipment.The tactile sensor is equipped with array comprising self-decoupled piezoresistive beams, facilitating the detection of forces along the X, Y, and Z axes. The driving mechanisms for the X and Y axes employ differential excitation, while the Z axis utilizes a single-electrode configuration. The findings reveal that the tactile sensor exhibits exceptional comprehensive performance, characterized by 0.496% FS accuracy, 0.43% FS hysteresis, 0.23% FS linearity error, 0.08% FS creep and a self-calibration error of just 0.92% within the 0-50% FS range. This work provides essential theoretical and technical support for intelligent robotic tactile sensing applications.

July 14, 2026 | 4:20 PM

Flexible Superoxide Anion Electrochemical Sensor Based on Piezoelectric Substrate for Synergistic Enhancement via Electric Double Layer Reconstruction and Oxygen Vacancy Enrichment

Dr. Yubo Li[1]

[1]Zhejiang University, ,

Session 03 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 3:30 PM - 5:10 PM

In situ monitoring of transient reactive molecules, such as superoxide anions (O2·-), at complex bio-environmental micro-interfaces faces severe physicochemical bottlenecks. Traditional rigid electrochemical sensors are constrained by the diffusion resistance of the solid-liquid electric double layer (EDL) and the high steric hindrance of local microenvironments. Consequently, ultrashort-half-life target molecules undergo massive disproportionation and quenching before reaching the electrode, resulting in severe signal lag and distortion. To overcome the interfacial mass transfer limit, this study proposes a multimodal sensing architecture based on flexible film engineering and the synergistic regulation of piezoelectricity and oxygen vacancies. A polyvinylidene fluoride (PVDF) composite film is employed as a highly compliant substrate, integrated with a defect-rich transition metal oxide sensing layer to establish non-destructive contact with dynamic micro-interfaces. Mechanistically, the system utilizes a microstrain-induced piezoelectric polarization field to exert an EDL gating effect, which actively compresses the Debye length and transforms the inefficient Brownian diffusion of O2·- into high-speed electrophoretic drift across viscous matrices. Concurrently, the piezopotential-induced band tilting profoundly couples with localized vacancy potential wells, significantly lowering the Schottky barrier and constructing high-speed electron tunneling channels across the interface. This flexible sensing system is anticipated to achieve a nanomolar (nM)-level Faradaic response to O2·- in complex viscous media. Simultaneously, by leveraging acoustic frequency shifts and interfacial impedance, it quantifies mass loading and mechanical evolution induced by interfacial attachments. This "electro-chemo-mechanical multimodal cross-validation paradigm" breaks the conventional passive diffusion rules of mass transfer, providing an innovative engineering solution for non-destructively deciphering the dynamic evolution of complex micro-ecosystems.

July 14, 2026 | 4:40 PM

A High-Performance Bi-directional Flexible Strain Senor Based on Liquid Metal for Versatile Application

Dr Yuanbin Mu[1,2], Mr Zhihui Liu[1], **Associate Professor Weihuang Yang**[1], Mr Yujian Shen[1], Mr Fengting Sun[1], Mr Huan Huang[3], Ms Lan Luo[3], Mr Jiagen Cheng[1], Mr Zhiquan Qiu[1], Mr Xingwei Lu[1], Dr Yu Gao[1], Prof Chaoran Liu[1], Prof Gaofeng Wang[1], Prof Linxi Dong[1]

[1]Engineering Research Center of Smart Microsensors and Microsystems, Ministry of Education, School of Electronics and Information Engineering, Hangzhou Dianzi University, , China, [2]Internet of Things Technology Research Institute, Hangzhou Polytechnic, , China, [3]Zhejiang Key Laboratory of Ecological and Environmental Big Data, Ecological and Environmental Monitoring Center of Zhejiang Province, , China

Session 03 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 3:30 PM - 5:10 PM

Flexible strain sensors are crucial for accurately determining the complex strain states involved in emerging sensing applications. Although significant efforts have been made to improve the detection range and selectivity of strain sensors, existing research still suffer from challenges as only uniaxial direction detection, complicated fabrication process, and low sensitivity, which limits the sensors to be used only in specific application scenarios. In this study, inspired by the structure of a bionic fishing net, an ultra-flexible strain sensor based on liquid metal (LM) is innovatively proposed, which can achieve highly sensitive, bi-directional, and micro-strain detection for versatile application. The device can be prepared by simple laser ablation of LM without complicated semiconductor manufacturing process. In addition, owing to the concise and ingenious structural design and the high conductivity, excellent flexibility, and self-repairing properties of LM, the designed sensor has low hysteresis, temperature stability, and high repeatability, etc. Simulation and experimental results show that the sensor achieves excellent bi-directional strain discrimination over a wide range, enabling precise multi-dimensional robotic grasping and real-time human motion recognition (e.g., finger bending and nine-gesture identification). Furthermore, its robust reliability and fabrication simplicity facilitate seamless integration into critical real-world scenarios, including high-accuracy pulse monitoring, structural health assessment (e.g., bridge crack detection), and intuitive human-computer interaction via Morse code messaging. This research provides an innovative solution for flexible sensors in complex and versatile strain environments, which is expected to promote their practical applications in the fields of healthcare, industrial monitoring and human-computer interaction.

July 14, 2026 | 4:55 PM

Simultaneous Characterization of Full Elastic Constants and Thickness of Freestanding Membranes Using Ultrafast Optoacoustics

Mr. Shuchang Zhang[1], Dr. Yi He[1], Mr. Guojie Luo[1], Mr. Jie Huang[1], Mr. Haoyu Cui[1], Professor Lin Ye[2], Professor Yehai Li[3], Professor Zhongqing Su[1]

[1]The Hong Kong Polytechnic University, , Hong Kong, [2]Southern University of Science and Technology, , China, [3]Sun Yat-sen University, , China

Session 03 - S13: Smart Materials and Microsystems (SMM), Kallang - Level 4, July 14, 2026, 3:30 PM - 5:10 PM

Nanocrystalline membranes are emerging as essential components to underpin the burgeoning development of post-Moore electronics, flexible devices, and nano-electromechanical systems, owing to their supreme mechanical compliance, tunable electronic response, and ultrathin thickness. Unleashing their full potential requires precise characterization of multiphysical features, of which the mechanical properties are of particular interest. However, current characterization approaches suffer from fundamental limitations: (i) atomic force microscopy risks damaging fragile membranes under out-of-plane loading; (ii) ex-situ micromechanical fixtures offer low-throughput, modulus-only readouts with imposed isotropy assumptions; and (iii) photonic methods lack sensitivity to mechanical behavior. Targeting freestanding ultrathin membranes, we introduce an ultrafast optoacoustics-based approach for characterizing their elastic constants and geometric features. Gigahertz (GHz) guided Lamb waves are photo-thermoelastically generated to propagate in nanocrystalline copper membranes. Both dispersive non-propagating zero-group-velocity (ZGV) resonances and propagating modes of GHz Lamb waves are captured, encoding the elastic symmetry and wave dispersion characteristics of the membrane. Dispersion of GHz Lamb waves is interrogated and exploited for simultaneously determining the thickness and fill anisotropic elastic constants of the membrane via a multi-parameter inversion algorithm. The reconstructed elastic constants and geometric parameters quantitatively match those obtained using X-ray diffraction (XRD) and the step-height profilometry. Furthermore, results reveal that the deposition substrate substantially affects the shear stiffness (C44) of nanocrystalline membranes. The developed ultrafast optoacoustic approach provides a new, fully non-contact, non-destructive, in-situ metrology tool for the simultaneous characterization of anisotropy and thickness in ultrathin freestanding membranes—a nontrivial multi-parameter inverse problem—facilitating reliability and stability improvement in the design and fabrication of next-generation micro- and nano-devices.

SYMPOSIUM S13 | ABSTRACT #233

July 15, 2026 | Keynote | 10:50 AM - 11:15 AM | Atrium Ballroom - Level 4

Ultrafast Optoacoustic Metrology: A Non-Destructive Approach for 3D Nanoscopic Characterization of Semiconductor Devices

Shuchong Zhang 1, Yi He 1, Guojie Luo 1, Jie Huang 1, Haoyu Cui 1, Lin Ye 2, Yehai Li 3, Zhongqing Su 1

The Hong Kong Polytechnic University, Hong Kong, China
Southern University of Science and Technology, Shenzhen, China
Sun Yat-sen University, Shenzhen, China

Keynote - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4

The rapid advancement of micromanufacturing is fueling the development of next-generation semiconductor devices that are smaller, faster, and more complex than ever before, facilitating deployment of high-performance computing chips and flexible electronics to nano-electromechanical systems (NEMS) and quantum sensors. This progress has intensified the demand for fast, non-destructive metrology capable of revealing hidden interior nanostructures in opaque microchips and precisely evaluating the mechanical reliability of ultrathin freestanding membranes-two intertwined factors influencing device yield, long-term stability, and overall performance. Traditional metrology methods fall short: they are destructive, restricted to surfaces, or too slow for real-time production environments, leaving manufacturers unable to detect process variations or material inconsistencies early enough to prevent costly failures downstream. In this study, a unified ultrafast optoacoustic metrology platform is developed to address these critical needs, offering a fully non-contact, in-situ solution that delivers three-dimensional nanoscopic insights across both opaque chip interiors and freestanding membranes within a single workflow. This capability enables real-time process monitoring and quality assurance, dramatically reducing scrap rates, accelerating yield ramp-up, and shortening time-to-market for advanced devices. It also provides insight into the fundamental links between hidden microstructures and mechanical behavior, empowering engineers to optimize fabrication recipes, prevent issues such as membrane buckling or resonance drift, and design more robust components for flexible electronics, high-frequency acoustic devices, and next-generation quantum technologies. By seamlessly bridging characterization challenges across the entire semiconductor value chain, this approach not only safeguards today's high-volume production lines but also unlocks the reliable, high-performance micro- and nano-devices essential for tomorrow's electronics revolution.

SYMPOSIUM S13 | ABSTRACT #260

July 15, 2026 | Keynote | 11:15 AM - 11:40 AM | Atrium Ballroom - Level 4

Interaction Between Surface Acoustic Waves and Electrons

Wei Luo 1

1 Huazhong University Of Science And Technology, 1037 Luoyu Road, Hongshan District, Wuhan, Hubei, China

Keynote - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4

The acoustoelectric effect refers to the electron-phonon interactions between the electronic charge carriers in the semiconductor and the SAW phonons, which results in acoustic velocity change and attenuation. This effect plays a crucial role in various applications within SAW devices, including gas sensing, optoelectronic detection, and integrated devices for surface acoustic wave filtering and amplification. This lecture provides a detailed overview of the research conducted by our team in the realm of acoustoelectric effects, encompassing precise modeling techniques, the design and fabrication of high-performance SAW gas and UV sensors, and the development of a novel, highly sensitive PT gas sensor based on engineering acoustic wave losses. Finally, we offer insights into potential future directions and trends in this research field.

July 15, 2026 | 11:40 AM

Self-powered wearable piezoelectric nanogenerators enabled by functional thin films for HMIs, IoTs, and biomedical systems

Dr Sasikumar Ragu[1], Dr Byungki Kim[1]

[1]Korea University of Technology And Education, 1600, Chungjeol-ro, Byeongcheon-myeon, Dongnam-gu,, South Korea

Session 04 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

Self-powered wearable piezoelectric nanogenerators (PENGs) based on functional thin films and engineered surface coatings have emerged as a promising energy solution for next-generation electronic systems. By exploiting the piezoelectric properties of advanced thin-film materials, PENGs efficiently harvest mechanical energy from human motion, ambient vibrations, and biomechanical activities, enabling compact and autonomous power sources. The mechanical flexibility, lightweight design, and process compatibility of piezoelectric thin films make them particularly suitable for wearable and portable applications. In human–machine interfaces (HMIs), thin-film PENGs enable self-powered sensing and actuation, facilitating real-time and precise interaction without external power supplies. For the Internet of Things (IoT), they address the challenge of energy autonomy, supporting continuous operation of distributed sensors and smart devices in dynamic or remote environments. In biomedical applications, thin-film PENGs offer new opportunities for self-powered health monitoring, implantable electronics, and therapeutic systems, significantly reducing reliance on conventional batteries. This invited talk will present recent advances in piezoelectric thin-film materials, surface modification strategies, device architectures, and integration techniques that enhance energy conversion efficiency, mechanical durability, and multifunctionality. Key challenges related to thin-film reliability, output power optimization, interfacial stability, and scalable fabrication for commercialization will also be discussed. Overall, this presentation highlights the critical role of thin films and surface coatings in advancing PENG technologies toward sustainable, intelligent, and self-sufficient electronic systems.

Minimalist Design Strategies for Stretchable and Flexible Triboelectric Sensors: From Scalable Fabrication to Intelligent Wearable Systems

Shuting Liu[1]

[1]Hangzhou City University, School of Information and Electrical Engineering, China

Session 04 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 15, 2026, 10:50 AM - 12:20 PM

The pursuit of flexible, self-powered triboelectric sensors for wearable health monitoring and human–machine interaction has intensified in recent years. Yet, despite significant progress, the field remains constrained by a fundamental tension: fabrication strategies that enable high performance often sacrifice scalability, while those prioritizing simplicity fail to deliver the structural complexity required for multifunctional, intelligent systems. To bridge this gap, a coherent design philosophy is demonstrated wherein structural design—rather than fabrication complexity—plays a dominant role in determining electromechanical performance.

In this report, a systematic framework linking material structure, device performance, and system-level functionality is established based on minimalist fabrication principles. Rather than relying on multi-step, instrument-intensive methods, a streamlined, one-step casting strategy utilizing commercially accessible elastomeric matrices and porous conductive networks is introduced. This approach eliminates process complexity while enabling the scalable construction of stretchable triboelectric sensor arrays. The result is a versatile platform that supports diverse functions, including self-powered input devices and continuous biomechanical tracking, with seamless integration into machine learning pipelines.

Building on this scalable platform, the critical trade-off between sensitivity and mechanical robustness is addressed. By leveraging structurally engineered conductive interfaces, high-sensitivity dual-functional devices serving as both energy harvesters and self-powered sensors are developed, demonstrating that simplicity in fabrication does not compromise functional performance. Extending these principles toward more intuitive human-machine interfaces, flexible wearable systems—such as microstructured smart gloves—are further designed to translate natural kinematics into real-time robotic control and advanced gesture recognition.

Finally, an ongoing exploration of sacrificial templating strategies is highlighted to engineer highly porous elastomeric films with tunable microstructures. This approach provides a simple and adaptable pathway for enhancing triboelectric performance through structural design. Taken together, this body of work outlines a practical technical framework that bridges s nnovation and next-generation AI-assisted wearable applications.

SYMPOSIUM S13 | ABSTRACT #428

July 15, 2026 | Keynote | 1:20 PM - 1:45 PM | Atrium Ballroom - Level 4

Piezoelectric Thin-Film-Enabled Acoustofluidic Microsystem for Deterministic Single-Cell Dispensing and Native-State Proteomics

Xin Yang 1

Cardiff University, UK

Keynote - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4

Advances in smart materials and microsystems are enabling transformative capabilities in bioanalytical technologies, particularly where precise, non-contact manipulation of biological entities is required. Here, we present an image-guided acoustofluidic microsystem based on a piezoelectric thin-film actuator for deterministic, picolitre-scale single-cell dispensing, designed to preserve the native molecular state of clinical samples for downstream proteomic analysis.

The system integrates a multilayer piezoelectric acoustic actuator within a disposable microfluidic cartridge to generate transient, highly localized acoustic pressure impulses. This enables "cold" droplet generation without thermal or mechanical damage, overcoming limitations associated with conventional fluorescence-activated sorting and inkjet-based systems. By coupling high-speed imaging with AI-driven morphological analysis, the platform achieves real-time identification and selection of viable single cells based on size and roundness, enabling deterministic "on-demand" encapsulation into ~235 pL droplets.

The acoustofluidic mechanism is governed by the interplay between acoustic radiation forces, capillary instability, and viscous flow, allowing precise control over droplet formation while maintaining low shear and minimal perturbation. Automated closed-loop calibration ensures stable monodisperse droplet generation across a wide operational window, supporting robust and scalable operation.

Applied to heterogeneous clinical samples, including head and neck squamous cell carcinoma, the system achieves high single-cell isolation efficiency (>94%) and enables deep single-cell proteomic profiling (>2,700 protein groups per cell), revealing intra-tumour heterogeneity with high reproducibility.

This work demonstrates how piezoelectric thin-film-enabled smart microsystems can bridge materials science and precision medicine, offering a versatile platform for next-generation single-cell analysis. The approach highlights the broader potential of acoustically driven smart materials for applications in biofabrication, diagnostics, and microscale fluid manipulation.

July 15, 2026 | 1:45 PM

Droplet acoustofluidics technology facilitate the precise analysis of miRNA

Professor Jingui Qian

[1]Hefei University of Technology, Tunxi Road, No.193, China

Session 05 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

MicroRNAs (miRNAs) are critical biomarkers for early cancer detection, but their trace-level analysis faces challenges such as low sensitivity, slow response, and operational inflexibility. Conventional methods are hindered by high sample consumption, cost, and complex workflows. This work introduces a novel acoustofluidic platform leveraging tunable acoustic tweezers to overcome these limitations. Three key innovations are presented: (1) Orthogonal-tunable acoustic tweezers integrate on-chip microdroplet manipulation and centrifugation with isothermal amplification, achieving a miRNA detection limit of 100 fM, a 10-fold improvement over existing POCT systems. (2) Spiral-array acoustic tweezers construct a multichannel acoustic centrifuge, combining DNA probe-modified microsphere fluorescence detection to enrich trace miRNAs down to 10 fM, balancing sensitivity and throughput. (3) Reconfigurable acoustic tweezers employ multidimensional parameter modulation for adaptive acoustic field control, integrating CRISPR/Cas sensing with tumor cell lineage tracing to reduce the detection limit to 1 fM. The acoustofluidic system minimizes sample volume (nL-scale), enables on-chip reaction concentration, and enhances detection precision, addressing critical bottlenecks in miRNA analysis. This platform offers a high-sensitivity, high-throughput solution for cancer liquid biopsies, with future integration into a compact chip system poised to accelerate clinical translation. Our results demonstrate the potential of acoustofluidic technology to revolutionize point-of-care diagnostics for precision oncology.

July 15, 2026 | 2:05 PM

A Programmable SAW-Activated Microneedle Microfluidic Chip for Integrated Cell Lysis, RNA Purification, and Quantitative PCR Detection

Zijia Sun, Yupeng Yang, Prof Jun Wei, Professor Xiaoyan Liu, **Prof Zenan Wang**[1]

[1]Shenzhen Institutes Of Advanced Technology,Chinese Academy of Sciences, 1068 xueyuan rd, China

Session 05 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Rapid, accurate point-of-care detection of RNA viruses is hindered by multistep sample preparation, reliance on highly trained personnel, and dependence on bulky laboratory equipment—barriers that limit timely diagnosis in decentralized settings. Here we present a single-chip platform that integrates surface acoustic wave (SAW) technology with microneedle arrays to perform a fully integrated workflow from cell lysis through RNA purification to PCR thermal cycling. Microneedle arrays are fabricated on a lithium niobate substrate and chemically modified for affinity capture of RNA. During lysis, SAW-induced high-speed microvortices drive vigorous collisions between suspended cells and the immobilized microneedles; by tuning the SAW driving frequency to the mechanical resonance of the microneedles, vibrational energy transfer is maximized, producing rapid and efficient cell disruption and intracellular RNA release. A programmable microfluidic channel sequence then delivers capture, wash, and elution buffers to selectively bind, purify, and recover the released RNA from the surface-modified microneedles. Finally, the interdigital transducer provides precise thermal cycling via Joule heating to enable reverse transcription and PCR amplification for quantitative detection of target RNA. Experiments show the device requires only one-quarter of the reagent volume used in manual extraction. After 10 minutes of thermal cycling, RNA concentrations reached 258 ng/μL—within the effective detection window—and amplification results were comparable to those from a commercial qPCR instrument. By integrating lysis, RNA purification, and amplification on a single programmable chip, this approach eliminates external sample-preparation equipment and complex thermal cyclers, enabling a rapid, automated “sample-in–answer-out” solution for point-of-care RNA virus testing.

July 15, 2026 | 2:25 PM

Single-beam acoustical tweezers for the trapping and assembly of a single cell for lab-on-a-chip applications

Prof. Zhixiong Gong[1], Mr. Shiyu Li[1], Mr. Yicheng Feng[1], Mr. Zhe Zhang[1]
[1]Shanghai Jiao Tong University, Dongchuan Rd. 800, China

Session 05 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Single-beam acoustical tweezers show promising prospects in various fields such as biomedical engineering, bubble-based controlled drug delivery, and acoustic material printing for microparticle manipulation and assembly with high spatial resolution. Focused beam and focused vortex have the advantage of highly-localized energy with large potential gradient, which are good candidates for the noncontact trapping of single cell or particle. We will show our recent MEMS device fabricated in the clean room at AEMD, Shanghai Jiao Tong University with validated watertank experiment measurement and numerical simulations. Both selective trapping and realistic assembly configurations are proposed and demonstrated based on numerical simulations and/or experiments. This work will facilitate the development of a versatile tool for the acoustic manipulation of a single cell, droplet, microparticle etc. without physical contact and provide a potential probe for biological forces/torques with larger radiation force compared with optical tweezers. At last, we will talk about the perspectives and ongoing challenges of single-beam acoustical tweezers for the future applications.

July 15, 2026 | 2:45 PM

Autonomous underwater acoustic propulsion system via lithium niobate ultrasonic transducer

Prof. Dr. Deqing Kong[1]

[1]Toyota Technological Institute, Hisakata 2-12-1, Tenpaku-ku, Japan

Session 05 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

In the area of acoustofluidic actuation with high frequency and micro-nano vibration, the manipulation, micropump, and atomization have been studied and applied for a long time. Underwater acoustic propulsion system utilizes acoustic waves to achieve autonomous movement in the novel area of acoustofluidic actuation. It presents a novel underwater propulsion approach in small scale swimmer. This study introduces an autonomous underwater acoustic propulsion system via lithium niobate ($LiNbO_3$) ultrasonic transducer. $LiNbO_3$ is a ferroelectric single crystal with an ilmenite structure. It is characterized by extremely low vibration loss, low heat rising, and low dielectric loss. Because of the excellent high-power characteristics, it is expected to be used as a vibration source for acoustic propulsion. Based on the $LiNbO_3$ substrate, acoustic propulsion systems with surface acoustic wave transducer and thickness-vibration-mode transducer are presented and investigated in the simulation and measurement. Advancing the miniaturization of acoustic propulsion system at the microscales and powerful propulsion thus holds considerable promise for pipeline inspection robot and intravascular robot.

SYMPOSIUM S13 | ABSTRACT #490

July 15, 2026 | Keynote | 4:00 PM - 4:25 PM | Sembawang - Level 3

Acoustic Microfluidics for Precision Medicine

Ye Ai 1

1 Singapore University of Technology and Design, Singapore

Keynote - S13: Smart Materials and Microsystems (SMM), Sembawang - Level 3

Biological cells in human bodies, as the fundamental unit of life, are heterogeneous in nature. It is essential to identify and sort specific cell populations from highly heterogeneous biological samples for a variety of applications in biology, diagnostics, and medicine. Microfluidic technologies capable of accurate cell analysis and precise cell manipulation can provide unprecedented capabilities to automate conventional biological assays. As acoustic waves can easily propagate through solids and fluids, acoustic technique readily enables non-contact cell manipulation in relatively long operating distances. The merging of acoustics into microfluidics has led to a new research direction, acoustofluidics, which generally exploits the use of ultrasonic waves to manipulate biological cells and other types of biological particles. In this talk, I will present our acoustic microfluidic platforms for precise microscale manipulation. We have further integrated single cell fluorescence detection with our acoustic microfluidic platforms to implement flow-based high-throughput fluorescence activated sorting of single cells. We have demonstrated the integrated acoustic microfluidic platform for different biomedical applications, for example sorting of live cells from cryopreserved cell samples in single cell sequencing, sorting of iPSC-derived cardiomyocytes for personalized drug testing and sorting of transfected cells for gene editing and cell therapy. This new type of acoustic manipulation platform has enabled high-precision and on-demand single cell sorting in diverse precision medicine applications.

July 15, 2026 | 4:25 PM

Flexible and multimodal acoustofluidics enabled by piezoelectric thin films and bulk piezoelectric materials

Dr. Yong Wang[1]

[1]Hangzhou City University, No. 51, Huzhou Road, China

Session 06 - S13: Smart Materials and Microsystems (SMM), Sembawang - Level 3, July 15, 2026, 4:00 PM - 6:05 PM

Surface acoustic wave (SAW)-based microfluidic technologies have garnered significant attention for applications in fluid manipulation, particle and cell manipulation, and lab-on-a-chip systems. Piezoelectric materials, encompassing both bulk and thin-film forms, can be utilized to fabricate microfluidic actuators. Among these, bulk piezoelectric substrates such as LiNbO3 are widely adopted due to their large piezoelectric coefficients and high electromechanical coupling efficiency. Nevertheless, their intrinsic rigidity restricts their suitability for flexible and wearable applications. Moreover, conventional LiNbO3 substrates exhibit fixed thickness and anisotropic piezoelectric properties; once the orientation of IDTs is defined, only a limited number of acoustic modes can be excited, thereby constraining the versatility and tunability of acoustofluidic functionalities. In contrast, piezoelectric thin-film materials offer distinct advantages, including low fabrication cost and facile integration onto diverse substrates such as silicon, glass, and metals. These features enable tunable acoustic wave propagation characteristics. Furthermore, by tailoring the substrate thickness, devices can attain enhanced mechanical flexibility while promoting the evolution of acoustic vibration modes, thereby enabling a broader spectrum of acoustofluidic phenomena. In this report, we will report the strategies for the excitation of multiple acoustic modes on both piezoelectric thin films and LiNbO3 substrates by modulating the ratio of acoustic wavelength to substrate thickness. This approach enables diverse fluidic and particulate manipulation behaviors. Additionally, we demonstrate the integration of piezoelectric thin films onto flexible metallic substrates, achieving device flexibility while preserving low-power actuation performance. This work not only expands the application scope of flexible acoustofluidic devices, but also provides new design principles and technical pathways for controllable multimodal acoustic excitation and the realization of complex microfluidic functionalities.

July 15, 2026 | 4:45 PM

Surface Acoustic Wave-Assisted Swing-Angle Spray: From Mechanism Investigation to Deposition Characteristics and In Vivo Wound Healing

Chenhui Gai[1], Yu Gu[1], Hong Hu[1]

[1]Harbin Institute of Technology, Shenzhen, Shenzhen University Town, China

Session 06 - S13: Smart Materials and Microsystems (SMM), Sembawang - Level 3, July 15, 2026, 4:00 PM - 6:05 PM

Wound care remains a significant global challenge, where delayed healing can lead to severe complications. While aerosol-based drug delivery offers a promising alternative to conventional treatments, its efficacy is often compromised by inconsistent atomization and poor distribution. Surface acoustic wave (SAW)-driven atomization can generate uniform micro-droplets but is fundamentally limited by the low propagation velocity of conventional surface mists and a fixed, unalterable spray direction. Here, we introduce a SAW-assisted swing-angle spray (SAW-SAS) strategy that overcomes these limitations. This method achieves effective, directionally adjustable spraying using only traveling SAWs, achieving targeted deposition while eliminating the need for external accelerating fields, and thereby transcending the conventional restriction of SAW atomization to the 22° Rayleigh angle. SAW-SAS produces a highly focused spray, enabling precise control over deposition area and droplet size. We demonstrate that the swing-angle mechanism is governed by modulating the input frequency relative to the device's resonant frequency. This modulation alters the multi-modal acoustic waves in the device's edge region, which shown by 2D simulations, shifts the internal acoustic streaming within the parent droplet and repositions the unstable oscillation point of the air-liquid interface. Deposition experiments confirmed that SAW-SAS provides excellent surface coverage with consistent droplet sizes across a range of spray angles. Furthermore, in a murine model, SAW-SAS-based drug delivery significantly accelerated skin wound healing. By using a narrow spray angle for deep drug penetration and a wider angle for broad surface coverage, our approach enables tailored drug delivery that matches the dosage to the wound's topography, thereby minimizing the risk of adverse effects from excessive drug application.

July 15, 2026 | 5:05 PM

Acoustic Separation and Sensing Based on Flexible ZnO Piezoelectric Thin Films

Tengfei Zheng[1]

[1]Xi'an Jiaotong University, ,

Session 06 - S13: Smart Materials and Microsystems (SMM), Sembawang - Level 3, July 15, 2026, 4:00 PM - 6:05 PM

Flexible acoustic thin films, featuring excellent mechanical compliance, strong acousto-electric coupling capability, and broad adaptability to diverse scenarios, hold great promise in wearable biosensing, intelligent healthcare, and cell engineering. However, under complex deformation conditions such as stretching, bending, and twisting, the stability of acoustic-wave propagation, sensing reliability, and acoustic manipulation capability remain major challenges. To address the demands of applications under complex deformation, this work developed a flexible acoustic device platform based on ZnO piezoelectric thin films. A flexible surface acoustic wave (SAW) biosensor integrated with a Nafion–aptamer sensitive layer was constructed, overcoming the challenge of frequency drift induced by mechanical deformation. Highly sensitive detection of TNF-α was achieved over a concentration range of 0.0026–1 μg/mL, while maintaining stable responses under stretching, bending, and simulated wearable conditions. Furthermore, for biofabrication on complex curved surfaces, stable standing wave fields were established under bending and twisting states using the flexible acoustic thin films, enabling linear and ordered cell patterning. The mechanism by which deformation-induced acoustic field evolution regulates cell alignment behavior was further revealed, expanding the application scenarios of flexible acoustic thin-film microfluidics. This study overcomes the critical challenge of functional stability of flexible acoustic thin films under complex deformation conditions, providing a new technological pathway for wearable intelligent healthcare and flexible biofabrication.

Ice nucleation and detachment on acousto-dynamic surfaces

Dr. Deyu Yang[1], Prof. Ran Tao[2], Prof. Xianghui Hou[1], Prof. Hejun Li[1]
[1]Northwestern Polytechnical University, Shaanxi Laboratory of Advanced Materials, Shaanxi Key Laboratory of Fibre Reinforced Light Composite Materials, China, [2]Shenzhen University, Shenzhen Key Laboratory of Advanced Thin Films and Applications, College of Physics and Optoelectronic Engineering, China
Session 06 - S13: Smart Materials and Microsystems (SMM), Sembawang - Level 3, July 15, 2026, 4:00 PM - 6:05 PM

Thin-film acoustic waves and related technologies have emerged as promising strategies in the anti/de-icing field, owing to their high interfacial energy efficiency and ease of structural integration. However, current studies have primarily focused on macroscopic performance evaluation, whereas in-depth investigations into phase change behaviour and synergistic effects at water/ice/structure interfaces under acoustic excitation remain lacking. To address these challenges, systematic in-situ icing experiments and finite element analysis are conducted to investigate the fundamental mechanisms governing ice nucleation and detachment on various acousto-dynamic surfaces. By tailoring the interdigital transducer structure on piezoelectric $LiNbO_3$ substrates, acousto-dynamic surfaces capable of generating diverse acoustic wave modes are fabricated, thereby covering all wave types commonly employed in anti/de-icing applications. For the ice nucleation study, a theoretical framework integrating classical nucleation thermodynamics with acoustic kinetics is established to elucidate the role of acoustic effects in regulating nucleation behaviour. In-depth analysis of droplet dynamic density and supercooling temperatures demonstrates that acoustic vibration and streaming promote nucleation, whereas the acoustic thermal effect suppresses it. The distinct influences of different acoustic wave modes are also identified, where the damped interfacial energy propagation characteristic of surface waves minimises the suppressive acoustic thermal effect, while cavitation induced by plate waves accelerates both nucleation and growth rates. Regarding the de-icing mechanisms, a new concept termed the interfacial tunnel effect is proposed and verified. This phenomenon involves the formation of a concentrated acoustic energy pathway along the ice/solid interface, which facilitates interface separation through localised mechanical vibrations, shear stress, and acoustic thermal phase changes. This work addresses critical knowledge gaps concerning the influence of acoustic waves on heterogeneous ice nucleation and detachment mechanisms. It thereby contributes to the fundamental understanding of water, solidification, and surface science, while offering practical guidance for ice mitigation and refrigeration engineering.

SYMPOSIUM S13 | ABSTRACT #447

July 15, 2026 | Keynote | 5:40 PM - 6:05 PM | Sembawang - Level 3

Effect of boron concentration on the corrosion resistance of boron doped diamond films

Chenglong Meng 1, Zhaofeng Zhai 2, Jinlong Li 3, Xinyu Li 4, Haitao Ye 1

College of Future Information Technology, Fudan University, Shanghai, China
Institute of Metal Research, Chinese Academy of Sciences, Shenyang, China
Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, China
School of Engineering, University of Leicester, Leicester, UK

Keynote - S13: Smart Materials and Microsystems (SMM), Sembawang - Level 3

Silicon-based materials are foundational to modern photovoltaic technologies; however, their susceptibility to corrosion in aqueous electrolytes significantly limits long-term performance and stability. Boron-doped diamond (BDD) films have emerged as a promising protective coating due to their exceptional chemical inertness, tunable electrical conductivity, and high charge-carrier mobility.

In this work, a series of BDD films with varying boron concentrations were synthesized via hot filament chemical vapor deposition (HFCVD). We systematically investigate the influence of boron incorporation on film microstructure and its corresponding corrosion resistance. Electrochemical measurements conducted in a NaCl solution reveal that films with higher doping concentration delivers the most effective corrosion protection. This enhanced performance is attributed to its refined grain structure and superior crystalline quality.

Notably, the boron doped diamond film achieves a 64% improvement in protective performance compared to the undoped film. These findings provide valuable insights into the design and optimization of BDD films, offering practical guidance for their implementation in corrosion-resistant protection of silicon-based devices.

SYMPOSIUM S13 | ABSTRACT #140

July 16, 2026 | Keynote | 8:35 AM - 9:00 AM | Atrium Ballroom - Level 4

Aluminum Nitride Piezoelectric Thin Films and FBAR Filters

Bin Yang1

1 Hunan University, Lushan South Road, Changsha, Hunan, China

Keynote - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4

Aluminum nitride (AlN) has been extensively applied in high-frequency mobile communications, particularly in the area of high-frequency film bulk acoustic resonators (FBARs). Nevertheless, the performance of FBARs is limited by the poor piezoelectric coefficient and mechanical-coupling coefficient of AlN films. Here, we present recent progresses in my group in understanding the growth mechanism of oriented wurtzite-structure AlN films and summarize existing strategies for manipulating crystalline orientations during the sputtering process. Additionally, we will introduce chemical doping mechanisms and feasible approaches to enhance the piezoresponse of AlN films. Finally, the design and fabrication of ultra-wideband FBAR acoustic wave filters will be presented.

Structural Designs of Flexible Strain Sensors for High Performance Sensing Based on Strain Synergetic Strategy

Ms Weijuan WANG[1], Prof. Fangxin Zou[2,1]

[1]The Hong Kong Polytechnic University, Department of Aeronautical and Aviation Engineering, Hung Hom, Kowloon, , , [2]Beijing Institute of Technology, Zhuhai, Energy and Transportation Domain, , China

Session 07 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 8:35 AM - 10:10 AM

Heterogeneous strain engineering has emerged as a powerful strategy for developing high-performance stretchable strain sensors, yet the rational design of strain distributions to achieve optimal sensitivity remains underexplored. In the first phase, we establish a theoretical framework for deriving the optimal heterogeneous strain topology and identify universal sensitivity-regulating parameters. Sensitivity is governed by a strain synergistic effect: reducing the low-strain value or increasing its proportion enhances local strain accumulation, maximizing the contribution of strained regions to resistance increase. As proof of concept, patterned graphene strain sensors with parameterized grooves are designed following the optimal topology, achieving up to 10.7- and 3.3-fold sensitivity enhancements through precise structural modulation and reaching a gauge factor of 25,600 at 100% strain. Building on this design principle, we next draw inspiration from the nano-fibril architecture of spider silk to develop a programmable microcrack array-based strain sensor. Through spatially confined microcracks and controlled multiplication of crack density, global strain partitioning is achieved, effectively mitigating stress concentration at crack tips. This design yields an ultrahigh gauge factor of 4106 with exceptional linearity over a 200% strain range, successfully overcoming the sensitivity-linearity trade-off while preserving the high-sensitivity characteristics identified in the optimal topology. Focusing further on the microcrack confinement strategy, we elucidate the mechanisms governing sensitivity enhancement under parallel cracks. Guided by these insights, we extend the design to incorporate cross cracks and introduce an auxetic framework to amplify sensitivity in the low-strain regime. The auxetic structure induces localized strain concentration, while the cross-crack geometry promotes multiaxial strain redistribution, collectively enabling further sensitivity enhancement. Together, this three-stage study establishes a coherent strain-synergistic design pathway from theoretical topology optimization and crack-density engineering to auxetic-enhanced crack architectures, offering a comprehensive strategy for achieving high-performance stretchable strain sensors with tunable sensitivity, broad linear range, and multifunctional applicability.

Dynamic Control Method and Mechanism of Surface Acoustic Waves Mediated by Optical Virtual Interdigital Transducers

Prof. Dengmu Cheng1

1Southwest Petroleum University, No. 8, Xindu Avenue, China

Session 07 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 8:35 AM - 10:10 AM

Conventional surface acoustic wave (SAW) devices are constrained by a fundamental limitation: once fabricated, the key characteristics of their core component, the interdigital transducer (IDT)-such as center frequency and wavelength-become fixed and cannot be adjusted in real time. This significantly restricts the flexibility of such devices in adaptive radio frequency signal processing and other application scenarios. To overcome this fundamental constraint, this paper proposes an optical virtual IDT for the dynamic generation and precise control of SAWs based on the optoacoustic effect. The paper systematically clarifies the physical mechanisms underlying this control method, establishes a coupled theoretical model that links the optical field, carrier distribution, and acoustic excitation, and validates through simulation the feasibility of core functions such as tunable bandpass filtering and dynamic delay lines based on the optical virtual IDT. This research provides a contactless, highly flexible, and low cost technical pathway for the development of software defined SAW devices and adaptive RF signal processing systems, with important theoretical and practical engineering value.

July 16, 2026 | 9:40 AM

Surface acoustic wave ice protection via piezoelectric film integrated aircraft wing leading edges

Mr Danny Blackburn[1], Mr Glen Bowen[1], Mr Luke Haworth[1], Mr Yihao Guo[2], Mr Andreas Winkler[3], Mr Jian Zhou[2], Ms Maryam Parsa[1], Mr Yong-Qing Fu[1]
[1]Northumbria University, NE1 8ST, United Kingdom, [2]College of Mechanical and Vehicle Engingeering, Hunan University, Changsha, China, [3]Leibniz Institute for Solid State and Material Research, SAWLab Saxony, Helmholtzstr, Germany
Session 07 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 8:35 AM - 10:10 AM

Ice protection of aircraft wing leading edges remains a critical challenge due to the high power consumption, added mass, integration complexity, and limited scalability of conventional thermal systems. This work reports the first experimentally validated, structurally integrated solid-state ice protection system based on surface acoustic wave (SAW) actuation using piezoelectric film coated aluminium stripes embedded within a representative wing leading-edge structure. The acoustically actuated aluminium plate exhibits robust acoustofluidic performance at both inclined and vertical orientations, with associated surface thermal effects systematically characterised. Finite element modelling combined with laser Doppler vibrometer measurements confirms effective wave mode excitation and propagation over a long range and large structural area. Using such the piezoelectric films, actuation energy can be efficiently dissipated along the leading edge without external moving components, fluid systems, or aerodynamic surface modification. Icing wind tunnel experiments under controlled conditions demonstrate significant suppression of ice accretion and reliable, repeatable ice shedding at low power input, confirming the energy efficiency of the approach. These results establish acoustically active wing leading edges as a previously unrealised, scalable, and energy-efficient ice protection technology with strong potential for next-generation aircraft applications.

July 16, 2026 | 9:55 AM

High-Transconductance and Biocompatible OECTs for Direct, High-Precision Electrophysiological Signal Acquisition

Mingxuan Huang[1], Professor Yubo Li, Professor JIkui Luo

[1]Zhejiang University, China, Zhejiang, Hangzhou, Zhejiang University (Yuquan Campus), China

Session 07 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 8:35 AM - 10:10 AM

Accurate acquisition of electrophysiological signals is critical for biomedical diagnostics and wearable health monitoring; however, conventional systems rely on multi-stage amplification circuits that increase complexity, power consumption, and noise. This study aims to develop a simplified yet high-performance bioelectronic device capable of direct, high-precision signal amplification.

To address this challenge, we propose a high-transconductance (gm) organic electrochemical transistor (OECT) with excellent biocompatibility for electrophysiological signal recording. The device is fabricated using a streamlined photolithography process, enabling high reproducibility, scalability, and compatibility with standard microfabrication techniques. By optimizing device geometry, the edge effect is effectively enhanced, leading to improved ion–electron coupling and superior electrical performance. This simple and integrable fabrication strategy supports batch production and facilitates seamless integration into flexible bioelectronic platforms.

The resulting OECT exhibits a high transconductance of up to 9.32 mS and a rapid response time of 0.1 ms, enabling efficient amplification of weak bioelectrical signals at low operating voltages. When applied to skin potential measurements, the device achieves a high signal-to-noise ratio, demonstrating its capability for reliable detection of subtle electrophysiological variations. Notably, the proposed device replaces conventional complex amplification circuits with a single transistor, significantly simplifying system architecture while maintaining excellent performance.

In conclusion, this work presents a high-performance OECT platform that combines fabrication simplicity, strong amplification capability, and biocompatibility. The ability to achieve high-quality electrophysiological signal acquisition using a single device highlights its potential for next-generation wearable and implantable bioelectronic systems, offering a promising pathway toward compact, low-power, and high-precision biomedical sensing technologies.

SYMPOSIUM S13 | ABSTRACT #157

July 16, 2026 | Keynote | 10:45 AM - 11:10 AM | Atrium Ballroom - Level 4

Nitrogen Doping Induced Synergistic Tuning of SP3/SP2 Bonds in Diamond-Like Carbon Films

Hongyuan Cui 1, Tao Chen 2, Lunlin Shang 3, Yufei Liu 2

School of Electronic Science and Engineering, Chongqing University of Posts and Telecommunications, Chongqing 400065, China
Key Laboratory of Optoelectronic Technology & Systems (Chongqing University), Ministry of Education, Chongqing 400044, China
Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou 730000, China

Keynote - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4

Diamond-like Carbon (DLC) film has demonstrated its outstanding properties of high hardness, low coefficient of friction, and excellent corrosion resistance, which has been widely applied in many fields such as anti-wear protection for mechanical components, electronic components packaging, and thermal dissipation enhancement, etc.. This paper focuses on the preparation of nitrogen-doped DLC films, and investigates the variations in the content of sp3 and sp2 bonds induced by nitrogen doping with different concentrations. Furthermore, the effects of nitrogen doping on the hardness, surface roughness and electrical resistivity of DLC films are analyzed. The experimental results shown that the hardness of DLC films decreases, while the surface roughness and electrical resistivity increase with the rising flow rate of nitrogen gas during the DLC deposition process.

July 16, 2026 | 11:10 AM

Spontaneous droplet transport on shape-evolving microfiber rails

Dr Pingan Zhu[1]

[1]City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, China

Session 08 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 10:45 AM - 12:10 PM

Directional droplet motion on solid surfaces, governed by Gibbs' theory of minimizing surface free energy, traditionally relies on static surface gradients. However, such approaches face intrinsic constraints, including fixed transport directions and interdependence between transport distance and speed. Here, we introduce shape-evolving microfiber rails (SEMRs) that enable spontaneous droplet transport on initially non-gradient surfaces. Inspired by a domino-like mechanism, the SEMRs dynamically generate cascading gradients through shape deformations in response to droplet-surface interactions, diverging from conventional static-gradient designs. This adaptive strategy allows for steerable droplet motion, independent control over transport distance and velocity, and design flexibility for on-demand performance optimization. The SEMR's versatility heralds advanced applications across analytical chemistry, cargo transport, electronics, and diagnostics, paving the way for advanced intelligent fluidic systems.

Ultrasound-Enabled Physical Catalysis for Electrochemical Energy and Biosensing Systems

Dr. Pengzhan Liu[1], Dr. Huiyu Huang[2]
[1]Nanjing University, , China, [2]Huai'an University, , China
Session 08 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 10:45 AM - 12:10 PM

Ultrasound has recently emerged as a promising physical-field approach for regulating interfacial electrochemical processes. Compared with conventional strategies based on material modification or complex catalyst design, ultrasonic excitation can directly manipulate mass transport and reaction kinetics through acoustic pressure and acoustofluidic effects, offering a versatile pathway for enhancing electrochemical systems.

In this talk, we present a series of studies on ultrasound-enabled electrochemical catalysis, covering both energy devices and biosensing systems. First, we demonstrate that the ultrasonic capillary effect can drive electrolyte circulation in metal-air flow batteries, enabling a compact acoustofluidic battery architecture and significantly enhancing discharge performance. We further show that the airborne focused ultrasound can catalyze oxygen reduction reactions (ORR) at the cathode interface of metal-air batteries, where acoustic pressure and acoustic streaming promote oxygen transport and interfacial reaction kinetics.

Building upon these findings, we develop an ultrasonic liquid-phase catalysis strategy for bioelectrolyte batteries powered by biological fluids such as sweat. The synergistic effects of acoustic pressure, acoustic streaming, and ultrasonic stirring dramatically accelerate interfacial mass transport and electrochemical reactions, leading to substantial improvements in output power and system stability.

Beyond energy systems, we further extend this concept to biosensing applications. An acoustics-catalyzed electronic tongue (ACET) is proposed for high-performance detection and identification of sweat metabolites, where ultrasonic excitation significantly enhances sensing response and reduces the limit of detection (LOD). Furthermore, we develop a miniaturized wearable ultrasonic sensing platform integrating a compact piezoelectric actuator with an electrochemical sensing interface, enabling real-time physiological monitoring with improved sensitivity and robustness.

These results demonstrate that the ultrasound-induced physical catalysis provides a universal strategy for upgrading electrochemical processes, bridging energy devices and wearable biosensing technologies. The presented framework opens new opportunities for the development of compact, efficient, and multifunctional acoustofluidic electrochemical systems.

An ultrasensitive multimodal intracranial pressure biotelemetric system enabled by exceptional point and iontronics

Jie Li[1]

[1]Hangzhou Dianzi University, , China

Session 08 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 10:45 AM - 12:10 PM

The accurate monitoring of vital physiological parameters exemplified by heart rate, respiratory rate, and intracranial pressure (ICP), is of paramount importance, particularly for managing severe cranial injuries. Despite the rapid development of implantable ICP sensing systems over the past decades, they still suffer from, for example, wire connection, low sensitivity, poor resolution, and the inability to monitor multiple variables simultaneously. Here, we propose an ultrasensitive multimodal biotelemetric system that amalgamates an iontronic pressure transducer with exceptional point (EP) operation for the monitoring of ICP signals. The proposed system can exhibit extraordinary performance regarding the detection of minuscule ICP fluctuation, demonstrated by the sensitivity of 115.95 kHz/mmHg and the sensing resolution down to 0.003 mmHg. Our system excels not only in the accurate quantification of ICP levels but also in distinguishing respiration and cardiac activities from ICP signals, thereby achieving the multimodal monitoring of ICP, respiratory, and heart rates within a single system. Our work may provide a pragmatic avenue for the real-time wireless monitoring of ICP and thus hold great potential to be extended to the monitoring of other vital physiological indicators.

July 16, 2026 | 1:30 PM

Decoding Lipid Membrane Interactions via Electrical Signals for Intelligent Screening of Nanoscale Analytes

Ms. Qiannan Xue[1], Miss Yu Fu[1], Miss Jiaxu Wang[1], Prof. Xuexin Duan[1]
[1]Tianjin University, , China

Session 09 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 1:30 PM - 2:20 PM

Intelligent screening of nanoscale analytes in environmental and food systems is of great importance for safety assessment and risk control. Lipid bilayer membranes, as biomimetic interfaces with intrinsic sensitivity to interfacial interactions, provide a promising platform for such applications. Here, a lipid bilayer-based microsystem is developed to decode membrane–analyte interactions into measurable electrical signals, enabling label-free detection and discrimination. Using size-identical nanoplastics with different surface properties as model targets, distinct membrane interaction pathways —including adsorption, embedding, and translocation—are decoded via real-time ionic current responses. A supported lipid bilayer constructed on a microporous substrate provides a sub-membrane space that enables differentiation between embedding and translocation processes. These interaction modes induce characteristic variations in membrane resistance and ion transport behavior, leading to distinguishable current signatures and spike events. As a result, nanoplastics can be screened according to their interaction mechanisms with the lipid bilayer, rather than solely relying on size or charge differences. By further integrating a conductive polymer nanowire array beneath the membrane as electrodes, interfacial electrical signals are effectively transduced and amplified, enhancing the coupling between membrane dynamics and electrode response and enabling more sensitive decoding of subtle interfacial perturbations. This platform is subsequently extended to biological molecules, where antibiotics generate distinct electrochemical impedance responses through specific interactions with the lipid membrane, reflected in impedance–frequency and phase characteristics. Taken together, the lipid bilayer functions as an active recognition interface, while electrical signals serve as direct, quantifiable readouts for decoding interaction pathways, enabling mechanism-based discrimination of diverse analytes. This approach supports label-free, miniaturized screening and offers broad potential for intelligent detection in complex environmental and food matrices.

July 16, 2026 | 1:50 PM

Silicon-based piezoelectric MEMS ultra-thin active cooling device

Jiafeng Ni[1], Mr. Ziyang Wu[2], Jiajun Leng[3], Professor Weipeng Xuan[2], Professor Jikui Luo[1]

[1]Zhejiang University, , China, [2]Hangzhou Dianzi University, , China, [3]Chinese Academy of Sciences, , China

Session 09 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 1:30 PM - 2:20 PM

With the continuous increase in power density of mobile and highly integrated electronic systems, conventional passive cooling technologies are approaching their performance limits under stringent constraints on size and power consumption. In this work, a silicon-based piezoelectric MEMS ultra-thin active cooling device is proposed, in which high-frequency vibration of a piezoelectric thin film under an alternating electric field induces microscale airflow and enhances convective heat transfer. A comprehensive multiphysics framework, incorporating electro-mechanical coupling, fluid–structure interaction, and heat transfer, is established to elucidate the intrinsic mechanisms governing airflow generation and thermal enhancement. Based on this framework, the piezoelectric diaphragm, cavity geometry, and flow channel are systematically optimized to achieve efficient energy conversion and airflow output under low driving voltage conditions (≤15 Vpp). The optimized device, with a compact size of ≤3 × 3 × 1 mm^3, is capable of generating an airflow velocity exceeding 6 m/s while maintaining an ultralow power consumption below 10 mW. Furthermore, thermal experiments conducted using a simulated heat source demonstrate that the device can reduce the temperature from 85 °C to 56 °C, thereby validating its effectiveness for microscale active cooling applications. Owing to its compact form factor, low power consumption, and high cooling efficiency, the proposed device exhibits significant potential for thermal management in a wide range of applications, including mobile electronics, wearable devices, high-performance chips, and other compact systems with high heat flux.

July 16, 2026 | 2:05 PM

Ultraviolet Light-Activated Ultrahigh-Frequency Surface Acoustic Wave Sensor for DMMP Gas Detection with a 10 ppb Limit of Detection at Room Temperature

Shengyu Wen[1], Mr Renxin Wu[1], Mr Daizhu Xie[1], Prof. Jian Zhou[1], Prof. Lin Shi[1]
[1]Hunan university, changsha city, China

Session 09 - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 16, 2026, 1:30 PM - 2:20 PM

Dimethyl methylphosphonate (DMMP) is widely employed as a sarin simulant for calibrating organophosphorus detectors, and among various DMMP sensing platforms, surface acoustic wave (SAW) sensors have attracted considerable attention due to their advantages of wireless monitoring, digital signal output, and cost-effectiveness, yet a critical challenge remains: it is difficult to simultaneously enhance sensitivity and lower the limit of detection (LOD) for room-temperature DMMP detection. In this work, we developed an integrated strategy by utilizing Cu ion-doped ZrO_2 (Cu–ZrO_2) nanocomposite as a high-performance sensing layer coated on an ultrahigh-frequency (4.98 GHz) SAW device for trace-level DMMP detection at room temperature under ultraviolet (UV) light activation; the as-fabricated sensor demonstrates an exceptional sensitivity of 1198.2 kHz/ppm (~1198-fold higher than a conventional 162.4 MHz SAW sensor), an ultralow LOD of 10 ppb, rapid response/recovery times of 39 s/25 s, and excellent long-term stability over 30 days, whose superior performance is primarily ascribed to the Cu–ZrO_2 sensitive layer—doped Cu ions generate abundant unsaturated Zr^{4+} sites to increase Lewis acid sites and strengthen their specific interactions with DMMP molecules—alongside a pronounced elastic loading effect derived from the ultrahigh resonant frequency of the SAW device, which further boosts the sensing performance, thus offering a promising and versatile strategy for realizing ultrasensitive DMMP detection based on high-frequency SAW technology.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

3D Smart Oxide Nanomaterials for Future Advanced Technologies

Yuanyuan Sun[1]

[1]Tianjin University, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Nanostructures of oxide materials with complex shapes, tetrapods, multipods, flowers, seaurchins, etc. hold the potentials to bridge this gap by their unique self-assembling ability. Irrespective of how they placed together, these complex shaped oxide nanostructures building blocks construct three-dimensional (3D) porous interconnected network. Such a highly porous 3D architecture offers easy accessibility of nanoscopic surface while being structurally intact, and at the same time simple to utilize. If needed, additional nanostructures from any external material can be easily integrated for any desired function. The 3D architectured oxide materials in hybrid form open new scopes toward understanding new fundamental structure-property relationships and at the same open the door to many advanced technologies, such as, mechanics, photonics, plasmonics, nanoelectronics, sensing, and other technologies.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Grasping Force Control Strategy for Underwater Soft Robotic Grippers Based on Ultrasonic Sensing

Yanzong Li[1], Kaifu Sun[1], Zhihan Zhang[1], Hongjia Zhang[1], Prof. Xianhao Le[2], Prof. Qian Zhang[1]

[1]Harbin Engineering University, 150001, China, [2]Yongjiang Laboratory, 315201, China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In unstructured scenes such as underwater exploration and marine organism sampling, soft robotic grippers present an optimal solution for grasping and manipulation tasks owing to their deformable and adaptive characteristics. Nevertheless, their adaptive capacities encounter constraints when dealing with underwater targets that exhibit substantial variations in stiffness and density. In such cases, inappropriate grasping forces may result in grasping failure or damage to the target object. Existing solutions that incorporate tactile and curvature sensors typically implement feedback compensation after slippage occurs. This approach demands extremely fast response times and may cause damage to the target object. This paper proposes a grasping force control strategy for underwater soft robotic grippers based on ultrasonic sensing. Leveraging the excellent acoustic transmission properties of water, the ultrasonic transducers integrated into the soft robotic grippers can capture the ultrasonic echo characteristics of the target object without causing damage. Through the analysis of echo information, the system identifies material properties (related to density) and conducts contour scanning to estimate the mass of the target object. In combination with pre-trained data, the system can pre-determine an optimal grasping force range, thus enabling effective grasping within a tolerance range. Experimental results indicate that the proposed method can effectively distinguish multiple materials and estimate the density of unknown objects. In grasping tests, the average success rate achieved by the pre-perception approach reached 81%, which represents a significant improvement compared to the 46% success rate of visual methods. In turbid underwater environments, this method maintains robust performance compared to visual solutions. This paper offers a novel solution for intelligent grasping by underwater soft robotic grippers.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Wide-temperature flexible barometric sensor for aircraft surface pressure measurement

Mr. Kun Wei[1], Ms. Xiaoke Lu[1], **Prof. Xueyong Wei**[1]
[1]Xi'an Jiaotong University, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Surface pressure measurement is essential for aircraft flight safety and efficiency. Flexible sensors that can conform to surfaces are tailored for aircraft surface pressure measurement, but there are two major challenges. First, such aviation applications accept only sensors to detect both positive and negative wind pressure over a wide range. Second, flexible sensors often exhibit low fatigue life at both low and high temperatures. Here, we report a flexible barometric pressure sensor with a wide temperature range: by designing the encapsulation method, it achieves wide-range barometric measurement from -100 to +100 kPa and with no signal drift; by adjusting molecular chain spacing, thereby enhancing the cold resistance of the sensor's sealing and dielectric materials, it has high fatigue life at low temperature (-70 °C), ambient temperature (20 °C), and high temperature (140 °C). The sensor can be attached to curved surfaces of a wing for barometric measurement and lift calculation. This study provides a practical approach for flexible pressure measurement technology in aviation.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Bandgap engineering of NdZnO film for solar-blind UV photovoltaic detectors with low dark current and high rejection

Dr. Zhe Chen[1], Dr. Qichang Hu[1]

[1]Fujian Agricature and Forestry University, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Rare-earth oxide Nd2O3, known for its high dielectric constant and ultrawide bandgap, is increasingly being applied in solar-blind UV detection research. However, the ultrawide bandgap (5.75 eV) results in an absorption cutoff edge (215 nm), which is much shorter than the ideal cutoff of 280 nm, and its excessively high internal resistance significantly limits its application in solar-blind detectors. Therefore, this study utilized band engineering to regulate the bandgap width of Nd2O3 by Zn doping, resulting in an amorphous NdZnO film with a 280 nm absorption cutoff edge. Building on this, graphene was integrated to construct a p-Gr/i-NdZnO/n-Si heterojunction solar-blind ultraviolet photodetector. The dual built-in electric field facilitated by the P-I-N heterojunction promotes the generation and separation of photogenerated carriers within the device , effectively increasing the photocurrent. Meanwhile, the device retains the inherent advantage of low background noise characteristic of the rare-earth oxide NdZnO. The results demonstrate that the device exhibits a dark current of only 1.44×10^{-11} A at 0 V, with a maximum responsivity of 4.34 mA/W and a detectivity of 6.07×10^{11} Jones under 255 nm illumination. Additionally, it achieves an ultrafast response time of 89 ms, along with a high UV-Visible rejection ratio of up to 7.1×10^{3} (R_{255} nm/R_{532} nm). This work successfully achieves Nd2O3 band engineering for the first time, along with its application in heterojunction solar-blind UV photodetector. This study not only offers a high-performance solar-blind detection device but also provides a novel approach for the device applications of other ultrawide bandgap semiconductor materials.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Surface Acoustic Wave-Driven Continuous-Flow Exfoliation of Ultrathin Metal-Organic Framework Nanosheets for High-Performance Composite Membranes

Dr. Haiwei Lu[1], Dr. Xia Liu[2], Dr. Chaohui Wang[2], Dr. Tengfei Zheng[2]

[1]Hebei Normal University, No.20, 2nd Ring South Road, China, [2]Xi'an Jiaotong University, No.28 Xianning West Road, China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

We present a continuous-flow surface acoustic wave (SAW) microfluidic system for efficient exfoliation of two-dimensional (2D) $Zn_2(bim)_4$ nanosheets with controlled thickness and their subsequent application in high-performance composite separation membranes. The exfoliation process is achieved within a closed polydimethylsiloxane (PDMS) microchannel, exploiting SAW-induced acoustic streaming and electric field effects to achieve high-throughput production of ultrathin nanosheets. The obtained nanosheets are incorporated into ultrafiltration membrane supports to fabricate composite membranes, which demonstrate significantly enhanced rejection rates for organic dyes compared to commercial polypropylene membranes. The composite membranes also exhibit excellent selectivity, permeability, and long-term stability, showing the potential of SAW-exfoliated 2D metal-organic framework (MOF) nanosheets in advanced separation technologies.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

AChE-Activatable Smart Bioluminescent Probe for In Vivo Microsystem Monitoring of Drug-Induced Apoptosis

Xifeng Sun[1], Prof. Chunyu Zhang[1], Prof. Xueyong Wei[1]

[1]Xi'an Jiaotong University, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Integrating smart materials with microsystem technology is crucial for advancing real-time biosensing in vivo. Acetylcholinesterase (AChE) serves as a key biomarker for tissue apoptosis, yet a bioluminescent (BL) probe capable of responding to endogenous AChE within a micro-environment has remained elusive. Herein, we report the development of three AChE-activatable smart probes—AhBL-1, AhBL-2, and AhBL-3—constructed by conjugating N,N-dimethyl ester derivatives with D-luciferin. These probes function as intelligent moleculars that enable highly selective and sensitive interfacial recognition of AChE. Among them, AhBL-3 demonstrates superior specificity toward AChE, achieving an ultralow detection limit for exogenous AChE (0.384 mU·mL-1) and a remarkably low cellular detection threshold (152 cells). In the context of smart microsystems for drug screening, AhBL-3 was further evaluated in cisplatin-treated apoptotic tumor tissues, where it enabled real-time monitoring of intracellular AChE fluctuations. The system exhibits high selectivity, an ultrahigh signal-to-noise ratio, and excellent biocompatibility, allowing for dynamic visualization of drug-induced apoptosis in vivo. This work highlights the potential of integrating smart materials based probes into microsystems and sensor platforms for advanced pharmaceutical and clinical diagnostics.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Low-dimensional heterostructures for new generation of POCT

Dr Ran Tao[1]

[1]Shenzhen University, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study presents a novel class of biomedical sensors that capitalizes on the synergistic enhancement between low-dimensional composite heterojunctions and surface plasmon resonance (SPR). We have integrated advanced materials, including TiO_2-nano MXene, Pt-doped SnO_2, and Pt-doped ZnO, onto a flexible, fiber-optic SPR platform to achieve the high sensitivity and real-time response essential for non-invasive diagnostics. The versatility of this technology is demonstrated through several key applications, such as ultra-sensitive humidity detection for non-invasive breath analysis, ammonia and isopropanol sensing for health monitoring. This work establishes a highly reliable and responsive sensing platform that overcomes fundamental limitations of conventional sensor designs. Our innovative approach paves the way for the development of compact, multi-channel, and low-cost biomedical devices. Ultimately, these enhanced SPR sensors are poised to advance point-of-care diagnostics, personalized medicine, and at-home health monitoring systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Wearable Surface Acoustic Wave Activated Microneedle Metamaterials for Transdermal Drug Delivery

Dr Jikai Zhang[1], Miss Tuling Cai[2], Prof Zhishan Yuan[2], Prof Yunhong Jiang[3], Prof Meng Zhang[3], Prof Peter Arnold[1], Prof Qiang Wu[1], Prof Xin Yang[4], Prof Jian Zhou[5], Prof Yongqing Fu[1]

[1]School of Engineering, Physics and Mathematics, Northumbria University at Newcastle, Newcastle upon Tyne, NE1 8ST, UK, , , [2]School of Electro-Mechanical Engineering, Guangdong University of Technology, Guangzhou 510006, China, , , [3]Living Construction Group, School of Geography and Natural Sciences, Northumbria University at Newcastle, Newcastle upon Tyne, NE1 8ST, UK, , , [4]Department of Electrical and Electronic Engineering, School of Engineering, Cardiff University, Cardiff CF24 3AA, UK, , , [5]College of Mechanical and Vehicle Engineering, Hunan University, Changsha 410082, China, ,

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Microneedle (MN) based transdermal drug delivery (TDD) offers a minimally invasive route for therapeutic administration; however, its dependence on diffusion dominated transport inherently constrains delivery rate, penetration depth, and spatiotemporal control. Here, we report a wearable surface acoustic wave (SAW) activated microneedle platform that enables active, spatially localised transport by coupling acoustic fields into skin penetrating microstructures. In this system, MHz frequency SAWs generated on a flexible piezoelectric thin film substrate are efficiently coupled into periodic MN arrays, which act as subwavelength acoustic scatterers and waveguides, forming an acoustically responsive metamaterial interface. This coupling produces localized pressure gradients and steady acoustic streaming vortices at the MN tissue interface, enabling convective transport that complements and surpasses diffusion limited delivery. Finite element analysis reveals that acoustic coupling is maximized when the SAW wavelength approaches geometric commensurability with MN dimensions, enabling enhanced momentum transfer and localized energy confinement. Stable micro vortices are generated near MN tips, reducing diffusion boundary layers and accelerating intradermal transport. Experimentally, in agarose gel and porcine skin models, the SAW-MN system significantly enhances molecular delivery across multiple length scales. For a 5 kDa model molecule, rhodamine B, under an acoustic power of 3.20 W, the SAW activated metal MN group achieved an average transport depth of 480 μm after 10 minutes of treatment, corresponding to 2.1-fold and 1.9-fold increases compared to MN only and SAW only groups, respectively. In dissolvable hydrogel SAW-MN systems, 30-minute delivery matches over 18 hours of passive diffusion, achieving an approximately 30-fold acceler :m was further validated for the

simultaneous delivery of therapeutics spanning a range of physicochemical properties, including both hydrophobic and hydrophilic agents. This work demonstrates microneedles as acoustic metamaterials and establishes a wearable, controllable, and highly efficient strategy for transdermal delivery, with particular relevance for macromolecular therapeutics and combination drug therapies.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

High-Quality WS2 Gas Sensors by Polymer-assisted Decomposition for NO2 Detection with high Mechanical Stability

Mr Zhicong Chen[1], Dr Yuanbin Mu[1,2], **Associate Professor Weihuang Yang**[1], Mr Huan Huang[3], Ms Lan Luo[3], Mr Jiahao Song[1], Associate Professor Changjie Zhou[4], Prof Chaoran Liu[1], Dr Yu Gao[1], Prof Gaofeng Wang[1], Prof Linxi Dong[1]

[1]Engineering Research Center of Smart Microsensors and Microsystems, Ministry of Education, School of Electronics and Information Engineering, Hangzhou Dianzi University, , China, [2]Internet of Things Technology Research Institute, Hangzhou Polytechnic, , China, [3]Zhejiang Key Laboratory of Ecological and Environmental Big Data, Ecological and Environmental Monitoring Center of Zhejiang Province, , China, [4]Department of Physics, School of Science, Jimei University, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

As one of the representative members of two-dimensional transition metal chalcogenides, tungsten disulfide (WS2) possesses a high surface-to-volume ratio, a tunable band gap, and excellent electrochemical and mechanical properties. Therefore, it holds broad prospects for application in the field of flexible gas sensing. However, achieving large-scale, continuous, and uniform preparation of WS2 films with high quality remains fundamental and crucial for their industrial application. In this study, a polymer-assisted decomposition method is presented by us using ammonium tetrathionate (ATT), which enables the large-scale preparation of uniform and continuous WS2 films with high quality. Subsequently, we propose a method for transferring WS2 films suitable for thermolysis methods to achieve high-quality transfer. The fabricated flexible WS2 gas sensor exhibits excellent response and repeatability towards NO2 gas detection. Additionally, this paper have investigated the gas-sensitive response of the flexible WS2 sensor under bending conditions while evaluating its mechanical stability and long-term performance.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Parallel Self-Biased Converse Magnetoelectric Transducer Based on Piezoelectric and Magnetostrictive Thin Films

Master Student Ziheng Yuan[1]

[1] 重庆大学, 重庆大学虎溪校区, China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

To meet the multiple demands of low frequency, high bandwidth and miniaturization in modern communication, this study proposes a low-frequency converse magnetoelectric transducer based on a parallel structure. The device is fabricated by bonding two FeSiB layers of different dimensions (60 mm × 5 mm × 0.1 mm and 60 mm × 6 mm × 0.1 mm) onto the surface of a PZT-5H sheet (60 mm × 20 mm × 0.2 mm), with a thin Ni layer coated on the FeSiB surface.Experimental results show that the 3 dB bandwidth of this structure reaches 1 kHz, which is four times higher than that of the conventional PZT-5H/FeSiB structure. Its resonant frequency is 20 kHz, representing a 23% reduction compared with the traditional structure. By implementing the parallel structure on a single piezoelectric sheet and coating the FeSiB with a Ni layer, this design eliminates the need for a DC bias magnetic field, thereby achieving device miniaturization.The proposed transducer is expected to promote the development of modern low-frequency communication.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

An omnidirectional piezoelectric wave energy harvester with frequency self-tuning characteristics

Dr. Chao Xiong[1], **Professor Jing Qiu**[2], Mr. Aocheng Nong[3], Ms. Zhounan Han[4], Dr. Huanbin Liu[5]

[1]Chongqing University ; Jialingjiang Laboratory, Chongqing 401331, China ; Jialingjiang Laboratory, Chongqing University, Chongqing, 401331, China, , China, [2]Chongqing University ; Jialingjiang Laboratory, Chongqing 401331, China ; Jialingjiang Laboratory, Chongqing University, Chongqing, 401331, China, , China, [3]Chongqing University ; Jialingjiang Laboratory, Chongqing 401331, China ; Jialingjiang Laboratory, Chongqing University, Chongqing, 401331, China, , China, [4]Chongqing University ; Jialingjiang Laboratory, Chongqing 401331, China ; Jialingjiang Laboratory, Chongqing University, Chongqing, 401331, China, , China, [5]Chongqing University ; Jialingjiang Laboratory, Chongqing 401331, China ; Jialingjiang Laboratory, Chongqing University, Chongqing, 401331, China, , China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Wave energy is difficult to harvest effectively due to its multi-direction and ultra-low frequency. Meanwhile, the cantilever beam harvester is difficult to work effectively away from the resonant frequency. Therefore, this paper proposes an omnidirectional piezoelectric wave energy harvester with frequency self-tuning characteristics (OPWEH-FS), which can efficiently collect multi-directional and ultra-low-frequency wave energy. By introducing a spring, the fixed end of the cantilever is transformed into a movable end to achieve broadband wave energy harvesting. The nonlinear driving force and system governing equations are analyzed theoretically, and the theoretical motion model of rotating pendulum under simplified wave motion is established. The effects of key parameters such as wave inclination angle, magnet spacing, and external load resistance were studied. Under the optimal operating conditions, the maximum RMS voltage and output power of the proposed energy harvester are 1.82 V and 15.62 μW respectively. The OPWEH-FS can effectively collect multi-directional and ultra-low-frequency wave energy.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A bistable piezoelectric–triboelectric hybrid energy harvester for broadband ocean wave energy harvesting

Zhounan Han[1]

[1]Key Laboratory of Optoelectronic Technology and Systems of the Education Ministry of China, College of Optoelectronic Engineering, Chongqing University, Chongqing, 400044, China, , [2]Jialingjiang Laboratory, Chongqing 401331, China, , [3]Jialingjiang Laboratory, Chongqing University, Chongqing, 401331, China,

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Traditional linear wave energy harvesters usually have a narrow operating bandwidth and are difficult to adapt to complex ocean wave environments. Meanwhile, energy harvesters based on a single conversion mechanism often suffer from limited power output. Therefore, this paper proposes a bistable piezoelectric–triboelectric hybrid energy harvester (BPTEH), which is capable of efficiently harvesting broadband wave energy. By introducing a ring-shaped connection structure, the movable range at the connection end between the piezoelectric beams and the proof mass is enlarged, ensuring sufficient motion freedom of the beams. In addition, friction surfaces with a certain inclination angle are designed to enhance the efficiency of charge generation during contact. The mathematical model of the proposed harvester is established, and the governing equations of the system motion are derived in detail. Finally, experimental tests are conducted to evaluate the energy conversion performance of the device and to investigate the effects of key parameters, such as the bistable structure and the inclination angle of the friction surfaces, on the output characteristics. The proposed energy harvester features easy start-up and a wide operating bandwidth, and the hybrid structure enables more effective collection of wave energy.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Continuous-Operating High-Gain Acoustoelectric Amplifier Based on InSb Multilayer Films

Yang Yuan[1]

[1]Jiangxi Normal University, 99 Ziyang Avenue,, China

Poster Session - S13: Smart Materials and Microsystems (SMM), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Piezoelectric acoustic devices integrated with semiconductors can exploit the acoustoelectric effect to achieve gain in the acoustic domain, offering potential improvements in performance and miniaturization of radio-frequency (RF) systems. However, the development of high-gain acoustoelectric amplifiers is limited by the electrical properties of semiconductor thin films. In this study, a high-performance acoustoelectric amplifier capable of continuous operation is demonstrated by integrating SiOx/InSb/In0.6Al0.4Sb multilayer films on a 128° YX LiNbO3 substrate via magnetron sputtering. To meet the demands of the acoustoelectric effect, the sputtering parameters for the In0.6Al0.4Sb buffer and InSb active layers were optimized, followed by annealing in argon, yielding multilayer films with a mobility of 1700 cm2/(V·s) and a sheet carrier density of 7×1011 cm−2. The optimized films were subsequently integrated with surface acoustic wave (SAW) devices using microelectromechanical systems (MEMS) processes, achieving stable continuous operation with a gain of 5.35 dB/mm at 433 MHz. This work establishes a viable material platform and integration strategy for next-generation multifunctional, single-chip RF signal processing systems.

July 14, 2026 | 10:50 AM

Plasma-Engineered Amorphous TiZrNbTaFe High Entropy Alloy Coatings for Integrated Mechanical and Biological Surface Protection

Distinguished Professor Bih-Show Lou[1], Medical Doctor Shih-Jie Lin[2], Postdoctor Pei-Shan Wu[1], Student Sen-You Hou[3], Chair Professor Jyh-Wei Lee[3]
[1]Chang Gung University, No.259, Wenhua 1st Rd., Guishan Dist.,, Taiwan, [2]Chang Gung Memorial Hospital, New Taipei Municipal TuCheng Hospital, Taiwan, [3]Ming Chi University of Technology, 84 Gungjuan Rd., Taishan Dist.,, Taiwan

Session 01 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Surface reliability remains the primary limitation of metallic orthopedic implants operating under simultaneous mechanical loading and corrosive physiological environments. Conventional cp-Ti surfaces are susceptible to corrosion-assisted degradation and insufficient bone fixation, necessitating advanced surface engineering solutions.

This work presents the process-driven development of amorphous TiZrNbTaFe high-entropy alloy (HEA) coatings fabricated using a hybrid High Power Impulse Magnetron Sputtering (HiPIMS)–RF co-sputtering platform. By modulating RF power applied to the Ti target, Ti content was systematically tuned while preserving a fully amorphous structure. The high ionization density of HiPIMS combined with RF-assisted compositional control enabled dense, defect-minimized coatings with strong interfacial adhesion.

The engineered TiZrNbTaFe coatings exhibit hardness ~10 GPa and robust adhesion, providing mechanical stability suitable for load-bearing applications. Electrochemical testing in simulated body fluid demonstrated markedly enhanced corrosion resistance compared to bare cp-Ti, attributed to the chemically homogeneous amorphous matrix and stable multicomponent passive film formation.

Beyond mechanical and electrochemical protection, in vitro osteoblast assays confirmed enhanced cell adhesion and proliferation. In vivo rat femur implantation further revealed significantly improved collagen deposition, mineralization, and interfacial fixation strength, particularly for Ti-enriched compositions.

This work establishes a plasma-enabled compositional engineering strategy that integrates mechanical durability, corrosion resistance, and osseointegration within a single amorphous HEA surface—offering a new paradigm for multifunctional surface treatment of next-generation biomedical implants.

Surface finish and hardness improvements of selective laser melted aluminium alloy by surface mechanical attrition treatment

Professor Yong Sun[1], Dr. Congcong Zhao, Dr. Huaping Tang, Professor Yunjie Bi
[1]Jihua Laboratory, , China

Session 01 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Selective laser melting (SLM) has been used to manufacture aluminium alloy components for aerospace and aeronautical engineering applications. However, components fabricated by SLM mostly have a relatively poor surface finish, with roughness values (Ra) typically ranging between 5 μm and 20 μm, which are not suitable for many engineering applications. Post processing is thus necessary to improve the surface finish and surface integrity of SLM components. In this work, surface mechanical attrition treatment (SMAT) has been used to treat the surfaces of an aluminium alloy manufactured by SLM. SMAT involved impacting the SLM sample surface with spherical balls at a frequency of 30 Hz for 10 min to 30 min, which induced severe plastic deformation of the sample surface, leading to the change in surface finish and surface hardness. The surface finish, morphology, hardness, and structural features have been investigated. The results show that SMAT is very effective in improving the surface finish of SLM aluminium alloy surface. After 30 min treatment, the roughness value (Ra) was reduced from 19.4 μm to 2.6 μm, an improvement of 87%. SMAT also has the benefit of increasing the surface hardness of SLM aluminium alloy from 125 HV0.1 to 160 HV0.1, and thus has the potential of improving wear resistance. In addition, SMAT induced compressive residual stress of around 100 MPa on the treated surface, which would be beneficial in improving the fatigue properties of SLM aluminium alloy. The mechanisms of surface smoothing, hardness increase and compressive residual stress evolution by SMAT are discussed in terms of severe surface plastic deformation, strain hardening and grain refinement.

Laser Polishing Strengthening Mechanism and Mechanical Performance of Nickel-Based Alloys

Zongsheng Ye

[1]Nanjing University of Aeronautics and Astronautics, , China

Session 01 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

This study systematically investigates the laser polishing strengthening technology for nickel-based alloy surfaces, covering nanoscale mechanisms, process optimization, and performance regulation. A thermal-fluid-solid coupled finite element model was established to reveal the dynamic evolution of the micro-melt pool and the nanoscale thermal/mechanical coupling mechanism during laser polishing. The surface planarization principle driven by the Marangoni effect, which enables “peak clipping and valley filling” of the molten metal, was elucidated. Subsequently, optimal process parameters were determined through orthogonal and single-factor experiments, and the surface roughness was significantly reduced from 6.485 μm to 77.6 nm. Investigation of the surface protection performance of the polished components shows that, due to the synergistic effects of surface grain refinement, strengthened texture, dislocation/recrystallization composite structure, and residual compressive stress, the wear resistance (wear volume reduced by 53%), thermal resistance (oxidation weight gain rate reduced by 77.32%), and corrosion resistance of the laser-polished components are all markedly improved. This research provides a solid theoretical basis and a feasible process solution for surface strengthening and performance enhancement of key nickel-based alloy components in aero-engines.

July 14, 2026 | 11:45 AM

Influence of Substrate Bias and Plasma Density on the Peeling Behavior of FCVA-Deposited DLC Films

Yuheng Deng[1], Yi Xuan Yeo[1], Yutong Chen[1], Feng Tian[1], Awadesh Kumar Mallik[1], Yik Kai Tan[1], Chong Wei Tan[1], Kun Liang[1], Jacob Kiat Song Lim[2], Beng Kang Tay[1]
[1]NTI-NTU Corp Lab, Nanyang Technological University, 73 Nanyang Avenue, Singapore, [2]Nanofilm Technologies International Limited, 11 Tai Seng Drive, Singapore

Session 01 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Diamond-like carbon (DLC) films deposited by filtered cathodic vacuum arc (FCVA) have been widely investigated for protective coatings and electronic applications due to their extraordinary mechanical performance and chemical stability. Previous studies have shown that ion energy and ion flux during deposition strongly influence the bonding structure, residual stress, and adhesion of carbon films. However, the combined effect of substrate bias and local plasma density on film adhesion and peeling behavior has not been systematically investigated. This study aims to address this gap by examining the deposition of carbon films on silicon wafers under different substrate bias conditions and varying plasma density environments within the FCVA system. Film thickness was measured to evaluate deposition characteristics, while Raman spectroscopy was used to analyze bonding structures and gain insight into the film formation process. Scanning electron microscopy (SEM) was further employed to investigate the surface morphology and peeling features of the deposited films. Attention was given to the peeling behavior observed at low substrate bias and high plasma density conditions. To further understand the underlying mechanisms, simulations based on Multiphysics framework were conducted to analyze the local energy flux and the associated thermo-mechanical responses during film growth. The combined experimental and simulation approach provides a framework for interpreting the peeling phenomenon and exploring possible mechanisms related to the interaction between ion energy and plasma density. The insights obtained from this study contribute to a better understanding of adhesion reliability in FCVA-deposited carbon films and provide guidance for optimizing deposition parameters in industrial coating processes.

July 14, 2026 | 12:00 PM

Stoichiometry and mechanical properties of (TiZrTa)Bx thin films.

Yung-I Chen[1], **Guan-ting Lu**[1], Hao-Yu Wang[1]
[1]National Taiwan Ocean University, , Taiwan

Session 01 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Quaternary boride thin films, (TiZrTa)Bx, were deposited using a direct current magnetron cosputtering system. The Taguchi experimental design (L9 orthogonal array), with four deposition factors: sputtering power, substrate temperature, bias voltage, and working pressure, was employed to investigate the relationship between chemical stoichiometry (x) and mechanical properties. The films in both Batch A and Batch B formed simple solid solutions with an AlB2-type structure. For Batch A films prepared with a total sputter power of 300 W, the hardness and elastic modulus were in the range of 25.3–28.0 and 223–243 GPa, respectively, and the x values ranged from 2.5 to 3.0. Moreover, the Batch B films, prepared with a total sputter power of 250 W, exhibited higher hardness and elastics modulus values of 35.7–42.4 and 371–395 GPa, respectively, accompanied with lower x values of 1.8–2.6. An appropriate stoichiometry value significantly enhances the mechanical properties of boride films. The Taguchi method was utilized to analyze the signal-to-noise (S/N) ratio of each factor, thereby determining the optimal deposition parameters for superior mechanical properties.

Construction of tough and corrosion-resistant (CrMoNbTi)Six high-entropy alloy coatings and coupled damage mechanisms in deep-seaenvironment

Dr. Jianguo Qian[1], Prof. Aiying Wang[1], Prof. Zhenyu Wang[1]

[1]Ningbo Institute of Materials Technology & Engineering, CAS, , China

Session 01 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 10:50 AM - 12:30 PM

Key components of deep-sea equipment are subjected to multiple coupled factors, including high hydrostatic pressure, highly corrosive media, and alternating loads, which can easily lead to mechano–electrochemical synergistic wear and structural degradation. However, conventional ceramic and organic coatings generally suffer from insufficient toughness and stability under such extreme conditions, making it difficult to satisfy the long-term service requirements of deep-sea equipment. In this project, a (CrMoNbTi)1−xSix high-entropy alloy coating system will be fabricated by high power impulse magnetron sputtering (HiPIMS) based on a design strategy that combines negative mixing enthalpy–driven structural regulation with corrosion-resistant cation synergistic passivation. The influence of negative mixing enthalpy on the formation mechanisms of locally ordered structures and amorphous/nanocrystalline phases in the coatings will be investigated, and a composition–structure–property correlation model will be established to elucidate the synergistic strengthening mechanism of toughness and corrosion resistance. Furthermore, erosion service behaviors of the coatings will be studied using a deep-sea environmental simulation device. The formation–rupture–repassivation process of passive films, as well as crack initiation and propagation and interfacial instability mechanisms, will be revealed. The damage evolution behavior of the coatings under multi-factor coupling conditions in deep-sea environments will be further clarified, and structural design strategies for optimizing erosion–wear resistance will be proposed. The outcomes of this study will deepen the understanding of the synergistic strengthening mechanisms of toughness and corrosion resistance in high-entropy alloy coatings and their multi-field coupled damage behaviors, thereby providing a theoretical basis for the design of protective materials for deep-sea environments.

July 14, 2026 | 1:20 PM

Dynamic Anti/Deicing Performances of the Hierarchical Structure Surfaces Based on Flow Environments with Microdroplets

Yizhou Shen[1]

[1]Nanjing University Of Aeronautics And Astronautics, 29# Yudao St., Qinhuai District, Nanjing 210016, China, China

Session 02 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Nowadays, the microstructural morphologies of superhydrophobic surfaces play a crucial role in determining their aerodynamic performance under high-speed flow conditions. Undesigned microstructures even have adverse effects on energy consumption during flight. In this work, a hierarchical structure with both aerodynamic drag reduction and superhydrophobic properties was designed and fabricated. Simulation results indicate that a higher reverse velocity grade and larger micro-vortexes together contribute to a 3.79% drag reduction rate in the microstructure. Moreover, an optimal microstructure angle of 30° not only inhibits ice nucleation on the superhydrophobic surface under static conditions, but also isolates the supercooled droplets from the surface by inducing microvortices in dynamic flow environments, demonstrating a remarkable ice mass reduction of 28.1%. Notably, the hierarchical structure surface exhibits an exceptionally low ice adhesion force (<6 kPa), which is primarily attributed to the concentrated stress induced by its structural morphology. The excessively concentrated stress promotes the phase transformation of ice crystals without the requirement of melting and the formation of a “sliding layer,” significantly lowering the critical force required to initiate ice movement. The exploration of this hierarchical structure surface offers a novel perspective and theoretical framework for advancing the practical deployment of superhydrophobic materials in anti-icing applications.

July 14, 2026 | 1:40 PM

A photothermal superhydrophobic coating for passive anti-icing and active de-icing

Assistant Professor Cong Li[1,2], Miss Kimberly Atmadja[2], Mr. Xinye Wang[2], Professor Zhong Chen[2]

[1]School of Materials Science and Engineering, Xi'an Jiaotong University, No.28 Xianning West Road, China, [2]School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, 639798, Singapore

Session 02 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Ice accretion can cause damage and mechanical failure in components such as high-voltage power lines, aircraft, and wind turbines under low-temperature conditions, leading to significant economic losses and increased energy consumption. Superhydrophobic surfaces effectively reduce ice adhesion due to their low surface energy and slippery microstructure. By incorporating photothermal particles, active de-icing performance is further enhanced, facilitating ice melting under sunlight irradiation. In this work, an icephobic coating with superior anti-icing and de-icing properties was fabricated. The influence of surface characteristics on ice prevention and removal mechanisms in superhydrophobic coatings was investigated. Furthermore, the coating exhibited excellent anti-corrosion performance and superior mechanical properties. This robust photothermal polymer coating paves the way for advanced materials used in industrial and commercial applications involving icing and corrosion.

Environmentally Friendly Underwater Superhydrophobic Surface for Anti-Biofouling Applications

A/Prof Xinghua Wu[1]

[1]Guangdong University of Technology, , China

Session 02 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Ice, pollution and organisms in marine ecosystems create significant threats to human activities like shipping (intercontinental ocean cargo) occurs on diverse time scales. To address the ice obstruction and contaminant transport problems, a facile and cost-effective underwater superhydrophobic surface was developed, aiming to reduce bio-fouling and ice attachment for cross-time zone shipping activities. The surface was designed by the oxidation of reduced iron powders to constructure nano-barrier decorated mammillaria structures which enabling underwater superhydrophobicity at hydrostatic pressure of 13.72 kPa and improving resistance to biofouling. The surface could inhibit liquid infiltration, bio-adhesion, and corrosion for more than 12days. Additionally, the oxidized iron powders presented electrothermal effect. When the power density was 2.5 $W \cdot cm^{-2}$, the temperature of the coating could rapidly rise to 149.9°C within 150 s.The uniformly dispersed powders play a crucial role in effective deicing properties, suppressing contamination transportation within ice. Furthermore, the surface presented superhydrophobicity after a scratching distance of 140 cm on a 400 grit sandpaper. The developed durable and anti-biofouling surfaces provide a new strategy for marine industries.

July 14, 2026 | 2:20 PM

Patterned hybrid surfaces for efficient dew water harvesting

Professor Zhong Chen[1], Dr. Lan Wei[1]

[1]Nanyang Technological University, 50 Nanyang Avenue, Singapore

Session 02 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Dew harvesting is an ideal method for addressing the world water shortage problems because it is minimally influenced by climates and geographical locations. Hydrophilic or superhydrophobic surfaces, characterized by their high affinity for water, are effective for dew condensation on to a solid surface. However, a significant challenge arises from the high surface capillary force that impedes water from sliding down and being effectively collected. The resulting water film on the hydrophilic or superhydrophobic surface tends to stay around the edge of the water collection surface, leading to evaporation loss and reduced collection efficacy. To overcome this challenge, hydrophobic or superhydrophobic surface has to be integrated to facilitate water transport, leading to efficient water collection. In this work, patterned surfaces have been designed through fluid dynamics simulation to enable quick water flow to the collector once the dew is condensed on the surface. In this presentation, 2D triangular patterns and 3D triangularly converging chevron channels with low surface adhesion with water were introduced. These modifications on the water collection surfaces have significantly improved the efficiency of water collection. Results indicate that the hybrid surface has significantly reduced the time for the first water droplet to slide down and increased water collection efficiency when compared to uniform superhydrophilic surface. The mechanism can be explained by the interplay between the Laplace pressure and gravitational force.

July 14, 2026 | 2:35 PM

Construction of Multifunctional Superhydrophobic Wood Coatings via the Sand-In Method and Their Interfacial Regulation Mechanisms

Jie Tao[1], **Xingzhou Yao**[1]

[1]Nanjing University Of Aeronautics And Astronautics, Jiangjun Road Campus, 29 Jiangjun Avenue, Jiangning District, Nanjing, China

Session 02 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

This study addresses the inherent drawbacks of wood, such as moisture-induced deformation and poor durability, by proposing a simple and efficient surface functionalization strategy, namely the sand-in method. This approach follows a three-step process of “primer coating–sand embedding–top coating”. First, an epoxy resin (EP) layer is applied to form an anchoring layer and fill the wood pores. Subsequently, functional particles are embedded into the substrate surface using rotating sandpaper, generating a stable micro/nano-scale rough structure through synergistic mechanical and chemical effects. Finally, an EP/PDMS composite system is spray-coated and thermally cured to achieve low surface energy modification and structural stabilization, thereby constructing a robust superhydrophobic interface. Based on this method, SiO_2-based self-cleaning superhydrophobic coatings and Fe_2O_3-based colored superhydrophobic coatings were successfully fabricated, enabling the synergistic optimization of performance and functionality. The results show that the SiO_2 coating exhibits a water contact angle of up to 163.2° and a sliding angle of 2°, demonstrating excellent self-cleaning ability and resistance to acid and alkali environments. After introducing surface-modified iron oxide particles, the coating maintains its superhydrophobicity (contact angle up to 159°) while achieving tunable coloration, enhanced interfacial adhesion, and a certain degree of self-healing capability. The results indicate that the sand-in method realizes the integration of micro/nano-structure construction and interfacial stability through a synergistic mechanism of “particle embedding–interfacial crosslinking”. This method features a simple process, low cost, and scalability for large-area fabrication. It provides a novel strategy for developing multifunctional wood surface coatings and shows promising potential for integrated decorative and protective applications.

July 14, 2026 | 2:50 PM

Steam oxidation behavior of Cr coatings without and with a Mo diffusion barrier: Kinetics and oxidation mechanisms

Qining Zheng[1], chengyu Zhang[1]

[1]northwestern polytechnology university, No. 127 Youyi West Road, Zhangjiacun Subdistrict, China

Session 02 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 1:20 PM - 3:05 PM

Zr–Cr interdiffusion is a primary factor limiting the durability of Cr coated zirconium alloy cladding under accident conditions. To address this, Cr coatings with and without a Mo diffusion barrier were deposited by multi-arc ion plating and their oxidation behavior was studied in 1200 °C steam. The Cr/Mo coating exhibited superior performance: it prolonged the parabolic oxidation stage, halved the parabolic rate constant, and extended the effective protection time from 50 min to 120 min compared to the Cr coating. Microstructural analysis revealed that the Mo barrier and the resulting fine-grained Zr (Cr, Mo)2 interlayer effectively suppressed Zr–Cr interdiffusion and oxygen ingress, thereby inhibiting Kirkendall voids and blister—the dominant early failure mechanisms in the Cr coating. The eventual failure of the Cr/Mo coating still results from micropore coalescence in the oxide layer combined with the consumption of the Cr2O3 layer via reduction by outwardly diffusing Zr. This work reveals the critical role of the Mo interlayer in enhancing the oxidation resistance, thereby offering a guideline for the design of more reliable accident-tolerant fuel claddings.

July 14, 2026 | 3:30 PM

Constructing Superhydrophobic Dental Resin-Based Material to Inhibit Bacterial Adhesion

Dr. Shunli Zheng[1]

[1]Anhui Medical University, No. 81 Meishan Road Hefei China, China

Session 03 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

It is the key scientific problem to inhibit the formation of dental plaque biofilm on the tooth surfaces in stomatology. The study aimed to construct a biocompatible micro-nano structured superhydrophobic dental resin-based coating on tooth surfaces based on the bionic lotus leaf surface to inhibit bacterial adhesion. The superhydrophobic dental resin-based coating, which is similar to fissure sealants or flowable resins, with the lotus leaf-like structure was prepared by mixing and optimizing the inorganic nanofillers, silane coupling agent, and the hydrophobic modifier into a mixture containing bisphenol A diglycidyl methacrylate. Then the prepared resin coating was cured under light irradiation with a wavelength of 420-480nm. The wettability, degree of polymerization, and surface morphology were investigated by the water contact angle equipment, Fourier transform infrared spectrometer, and scanning electron microscope. Biocompatibility was assessed against mouse embryonic osteoblast precursor cells (MC3T3-E1) for 1, 3, and 5 days. The inhibition of bacterial adhesion was evaluated by co-culturing with Streptococcus mutans in vitro. The optimal dental resin-based coating with ~ 9 wt.% SiO2 loading showed a contact angle higher than 150°, exhibiting superhydrophobicity. The degree of polymerization can reach up to ~ 80%. By introducing the inorganic filler, the micro-roughness of the coating was improved to construct a lotus-leaf-like micro-nano hierarchical structure, which could retain air to form an air layer on the coating surface, thus reducing the contact area between the bacteria and the coating surface. In such a case, the adhesion of Streptococcus mutans is inhibited. In addition, the as-prepared superhydrophobic dental resin-based coating showed good biocompatibility to MC3T3-E1. The prepared superhydrophobic dental resin-based coating was proven to have good biocompatibility and inhibition of bacterial adhesion, which can provide a new strategy in the prevention of dental plaque-related diseases and the development of novel oral materials.

July 14, 2026 | 3:50 PM

Multiscale surface engineering on the interfacial adhesion of steel-CFRTP hybrid structures for pipe coupler applications

Dr Qi Wang[1], Kaidong Ye[1], Albert Wei Ming Yek[1], Dr. Xincai Wang[1], Yixuan Wu[1], Zi An Wu[1], Dr. Chen Wang[1]

[1]Singapore Institute of Manufacturing Technology (SIMTech), Agency for Science, Technology and Research (A*STAR), 5 Clean Tech Loop, Singapore

Session 03 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

The reliable joining of metals to carbon-fibre reinforced thermoplastic (CFRTP) composites is increasingly critical for the development of high-performance, lightweight hybrid structures in the automotive, aerospace and new energy sectors. One of the typical applications is to apply steel-CFRTP hybrids in pipe couplers. However, achieving a robust interfacial bond between dissimilar materials remains a significant challenge. This study investigates the influence of multi-scale surface engineering strategies on the bonding strength between carbon steel and polycarbonate/carbon fibre (PC/CF) composites.

A two-stage surface modification strategy was adopted. First, steel substrates were sandblasted using different grit sizes to produce three roughness levels, ranging from Ra 2 to 6 μm. The treated steel coupons were then joined to PC/CF composites by hot pressing to fabricate single-lap shear (SLS) test specimens. The influence of surface roughness on the bonding strength of the hybrids was evaluated through mechanical testing. In the second stage, laser treatment was applied to the sandblasted steel surfaces to further tailor the interface morphologies. The as treated and debonded surfaces were characterized using scanning electron microscopy (SEM) and optical microscopy.

The SLS test results showed a non-monotonic dependence of joint strength on surface roughness: the shear strength increased initially and then decreased with increasing roughness. Following laser treatment, the surface roughness remained unchanged, while the joint performance was further improved. Microscopic observations indicated that laser treatment generated finer micro-scale structures on the sandblasted surface without significantly changing the overall roughness.

These results of steel–thermoplastic bonding were discussed with a hierarchical interfacial mechanism. The findings at the coupon-level offer a practical guidance for optimizing multiscale surface treatments to improve the structural reliability of metal-thermoplastic hybrid pipe couplers.

July 14, 2026 | 4:10 PM

Plasma electrolytic polishing for surface finishing of metal alloys

Principal Scientist Hongfei Liu[1]

[1]Institute Of Materials Research And Engineering, 2 Fusionopolis Way, Singapore

Session 03 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Plasma electrolytic polishing (PEP) has emerged as a transformative surface finishing technology bridging electrochemistry, plasma physics, heat transfer, and fluid dynamics. Unlike conventional electropolishing governed by viscous diffusion layers, PEP operates in a high-voltage regime characterized by VGE formation, microarc discharge plasma events, intrinsic acoustic emissions, and thermally assisted electrochemical dissolution. This review critically consolidates the historical development, mechanistic models, electrolyte engineering, waveform design, immersion and cyclic strategies, acoustic coupling, and jet-assisted configurations of PEP. Emphasis is placed on its application to additively manufactured alloys, including Ti-, Al-, Ni-, and steel-based systems, where surface topology, residual stress states, and microstructural anisotropy strongly influence polishing response. Competing theoretical interpretations of plasma-assisted dissolution are evaluated, and unresolved mechanistic debates are highlighted. The review concludes with an outlook on digital process control, multi-physics modeling, sustainability, and integration with advanced manufacturing workflows.

July 14, 2026 | 4:30 PM

Degradation of Antenna Performance Induced by Substrate Warpage in 76–81 GHz Radar Systems

Yu-Hsun Chang[1], Chi Lee[1], Chih-Ling Chang[1], Ying-Chih Chiang[1], Cheng-En Ho[1]
[1]Yuan Ze University, 135, Yuandong Road, Taiwan

Session 03 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Millimeter-wave (mmWave) solutions have proven highly effective in meeting the stringent requirements of next-generation advanced driver-assistance systems (ADAS) applications. To ensure seamless integration behind vehicle bumpers while maintaining high angular resolution, ADAS radars leverage the 76–81 GHz spectrum. During high-frequency transmission in the 76–81 GHz range, however, not all input power can be effectively radiated from the mmWave antenna of ADAS. A significant portion is dissipated as electromagnetic (EM) loss, which undergoes thermal conversion and subsequently elevates the antenna's operating temperature. Elevated operating temperatures induce thermomechanical stress due to the coefficient of thermal expansion (CTE) mismatch between the organic substrates and copper traces, ultimately resulting in structural deformation and substrate (antenna) warpage. In this study, we systematically investigated the effect of substrate warpage on the microstrip comb-line antenna characteristics, including gain (G), directivity, radiation patterns, and reflection coefficient (S11) through 3D electromagnetic simulation software (ANSYS-HFSS), anechoic chamber, and vector network analyzer (VNA). Our research findings indicate that while S11 and G exhibit minimal sensitivity to the substrate warpage, the main lobe direction of the radiation pattern may deviate in correlation with the degree of warpage. This effect inevitably degraded the angular resolution and detection accuracy of automotive radar systems. Details regarding the effect of substrate warpage on the antenna performance will be presented in this talk.

July 14, 2026 | 4:45 PM

A general strategy towards improving the strength and thermal shock resistance of glass-ceramics through microstructure regulation

Dr. Min Feng[1], Chengyang Jiang[1], Minghui Chen[2], Shenglong Zhu[3], Fuhui Wang[2]
[1]Hangzhou International Innovation Institute, Beihang University, 166 Shuanghongqiao Street, Pingyao Town, Yuhang District, China, [2]Shenyang National Laboratory for Materials Science, Northeastern University, No. 3-11, Wenhua Road, Heping District, China, [3]Institute of Metal Research, Chinese Academy of Sciences, No. 72, Wenhua Road, Shenhe District, China

Session 03 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 14, 2026, 3:30 PM - 5:00 PM

Glass-ceramics are usually obtained through controlled crystallization. In this work, we propose a new strategy to add an appropriate amount of oxide particles to the parent glass to improve the performance of glass-ceramics. Different amounts of Al_2O_3 or/and CeO_2 particles were added into a SiO_2-Al_2O_3-ZnO-CaO-ZrO_2-TiO_2 based glass, and crystallization behavior, fracture strength, and thermal shock behavior were systematically evaluated. The results indicate that with the addition of Al_2O_3 or/and CeO_2 particles of moderate amount, the unfavorable needle-like $ZrSiO_4$, Zn_2SiO_4, and $CaTiSiO_5$ crystals were largely inhibited when annealed at 900 °C. Accordingly, fracture strength is maintained high after heating at high temperatures. The thermal shock resistance is also enhanced drastically. The additive Al_2O_3 is thermodynamically favorable to react with the glass, forming particulate $ZnAl_2O_4$ instead of precipitating the needle-like crystals of Zn_2SiO_4 and $CaTiSiO_5$; while CeO_2 will combine with ZrO_2 to form a solid solution and promote the precipitation of primary crystal $CaZrTi_2O_7$ that will not transform to $ZrSiO_4$ with prolonging thermal exposure.

Interfacial Free Energy Governs Nucleation Transition in Cu Interconnects for Advanced Packaging

Assistant Professor Chia Hua Lin[1]

[1]Tunghai University, No. 1727,Sec. 4,Taiwan Blvd.,Xitun Dist., Taiwan

Session 04 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

As interconnect dimensions decrease, microstructure evolution becomes increasingly sensitive to interfacial free energy and bonding stability. Although nanotwinned Cu exhibits superior mechanical strength and electromigration resistance, the mechanism linking interfacial condition to nucleation behavior and twin formation remains unclear. In this study, both the Si substrate surface condition and the crystalline phase of TaN barrier layers were systematically varied. Ar/N_2 plasma pre-treatment was applied to modify the surface bonding state and free energy of the Si substrate prior to TaN deposition. In addition, different TaN phases were prepared to alter the interfacial energy landscape at the barrier/seed interface.

Electrochemical nucleation analysis revealed that the combined modification of substrate surface energy and TaN phase stability significantly changed the nucleation energy barrier. A transition from three-dimensional instantaneous nucleation to two-dimensional layer-confined growth was observed under reduced interfacial free energy conditions. EBSD characterization showed enhanced {111} texture intensity and increased nanotwin density in samples with lower effective interfacial energy.

These results indicate that the effective interfacial free energy, determined jointly by substrate surface state and barrier phase structure, defines the critical nucleation barrier governing twin formation. The coupling between interfacial thermodynamics and electrochemical kinetics provides a mechanistic basis for microstructure evolution in electrodeposited Cu.

July 15, 2026 | 11:10 AM

Interfacial Adhesion Improvement and Pool Boiling Heat Transfer Augmentation of GNPs/Epoxy Coatings via Plasma Treatment

Dr. Jhao-Yu Guo[1], CHI-CHANG CHEN[1], YI-JIE LIAO[1]

[1]Department of Mechanical and Mechatronic Engineering, National Taiwan Ocean University, No.2, Beining Rd., Zhongzheng Dist., Taiwan

Session 04 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Boiling heat transfer has attracted significant attention for cooling high-power electronic devices owing to its ability to achieve high heat dissipation with small temperature differences. This study investigates the effects of graphene nanoplatelets (GNPs)/epoxy (EP) composite coatings on the pool boiling performance of pure copper substrates. To enhance the adhesion strength between the polymer coating and the metallic substrate, the copper surface was first functionalized using a plasma system. The results demonstrate that plasma treatment markedly increased surface polarity, reducing the water contact angle from 65.4° to 7.9°. Subsequently, composite coatings with different GNPs loadings were fabricated on the treated copper substrates via spin coating, including 0% GNPs/EP, 10% GNPs/EP, and 20% GNPs/EP. Adhesion tests confirmed that all coatings exhibited excellent adhesion performance, achieving a 4B rating in the cross-cut test. Further material characterizations were conducted using Raman spectroscopy, X-ray diffraction (XRD), and scanning electron microscopy (SEM) to examine the layer characteristics of GNPs, the crystalline structure, and the surface morphology of the coatings. Pool boiling experiments revealed that the 20 wt% GNPs/EP coating exhibited the optimal performance, attaining a critical heat flux (CHF) of 162 kW/cm², corresponding to an enhancement of approximately 27% compared to the bare copper surface. The results indicate that the incorporation of GNPs effectively increases the density of active nucleation sites and facilitates bubble departure, thereby suppressing dry spot formation and significantly improving boiling heat transfer efficiency and system stability.

July 15, 2026 | 11:30 AM

Enhanced corrosion resistance and mechanical stability of superhydrophobic micro-nano particles/epoxy coatings for the protection of cements

Dr. Zongjing He[1], Prof. Zhong Chen[2]

[1]Harbin Institute of Technology, 92 West Dazhi Street, Nan Gang District, Harbin, China, [2]Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore

Session 04 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

As an advanced protective material, superhydrophobic coatings utilize their distinctive surface properties to
effectively prevent moisture and other corrosive substances from directly contacting the substrate, thereby significantly enhancing its service life. This study introduces a robust superhydrophobic coating specifically designed for cement-based substrates. The coating system, developed through a two-step fabrication process, primarily comprises quartz sand and nanomaterials with hierarchical structures. Comprehensive evaluations were conducted focusing on abrasion resistance, corrosion resistance, UV aging resistance, and freeze-thaw cycle durability. Notably, the 12 wt.% nano-Al2O3 coating prepared via two dip-coating cycles (12Al-2D coating) demonstrated superior hydrophobicity and stability. The 12Al-2D coating achieved remarkable surface properties with a contact angle of 153° and an ultra-low sliding angle of 1.8°. Under sandpaper abrasion, the coating retained a contact angle >150° after 50 friction cycles, demonstrating exceptional wear resistance. Additionally, the 10 wt.% nano-SiO2 coating fabricated through three dip-coating cycles (10Si-3D coating) attained a hardness level of 6H Both coatings displayed strong adhesion. After 50 freeze-thaw cycles, the 12Al-2D coating retained a contact angle of 140°, demonstrating robust environmental adaptability. In simulated corrosive environments, the coatings exhibited excellent durability without significant corrosion damage. The 12Al-2D coating maintained its hydrophobic characteristics, providing effective protection for the substrate. This research provides valuable insights and innovative strategies for the corrosion protection of cements.

CO2 Laser-Fabricated Heterowetting PTFE/Al2O3 Platform for Geometry-Controlled Droplet Enrichment and Raman Enhancement

Mr. Cheng Han Yu[1], Prof. Jiann Shieh[1]

[1]National United University, No. 2, Lienda Rd., Taiwan

Session 04 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Precise control of droplet localization and evaporation-driven solute enrichment is crucial for improving the sensitivity and reproducibility of Raman-based detection. In this study, a CO2 laser-fabricated heterowetting PTFE/Al2O3 platform was developed by integrating a laser-textured superhydrophobic PTFE top film with designed openings and a laser-processed superhydrophilic Al2O3 bottom substrate. This architecture enables droplets to be pinned at predefined sites while suppressing undesired spreading on the surrounding surface.

The incorporating of the superhydrophilic Al2O3 substrate significantly enhanced droplet retention compared with samples without laser treatment, confirming the effectiveness of the heterowetting design in stabilizing droplets. The effects of opening size and geometry on analyte enrichment and Raman response were further investigated using rhodamine 6G as a model probe. Circular openings with different diameters exhibited distinct droplet confinement behaviors, indicating that geometric confinement influences evaporation-driven concentration.

Furthermore, polygonal openings revealed clear geometry-dependent Raman enhancement. Triangular openings produced more pronounced signal amplification at sharp corner regions, whereas square openings showed weaker corner-to-edge contrast. These observations suggest that sharper geometric features promote localized accumulation of analytes during drying, thereby enhance Raman intensity.

The proposed platform provides a simple and effective laser-based route for droplet pinning, controlled enrichment, and geometry-assisted Raman enhancement, offering promising potential for functional surface engineering and trace chemical sensing applications.

July 15, 2026 | 12:00 PM

Hybrid Post-Processing for Surface Smoothening of Additively Manufactured Ti-6Al-4V

Joseph Kee Seng Wong[1], Dr Zhaohong Huang[1], Dr Wenjin Yan[1]

[1]Singapore Institute Of Manufacturing Technology (SIMTech), 2 Fusionopolis Way, #08-04 Innovis, Republic of Singapore

Session 04 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Additively manufactured (AM) Ti6Al4V is experiencing increasing demand for medium-sized spare parts with complex geometry for maintenance, repair, and overhaul (MRO) services, particularly in the oil & gas, aerospace, and commercial sectors. However, as-printed AM surfaces typically exhibit high roughness (Ra > 40 μm, Rz > 250 μm) due to adhered semi-melted (dross) particles and micro-defects, especially on low-printing-angle surfaces (< 40°) formed during the printing process. This study presents a two-stage hybrid process: 1) Ultrasonic-assisted chemical pre-treatment using a less-toxic acid mixture of phosphoric, sulfuric, and lactic acids to efficiently remove dross particles, followed by 2) electropolishing in a green deep eutectic solvent (DES) electrolyte composed of choline chloride and ethylene glycol. This hybrid process overcomes the dross-shielding effect and improves process safety and efficiency for post-processing low-printing-angle Ti6Al4V surfaces. The results show that significant surface smoothening of 3D printed Ti6Al4V was achieved after 60 minutes of the hybrid process treatment, with reductions of 81% in Ra and 88% in Rz. The process was effective across all surface angles and printing orientations, irrespective of the initial roughness, which reached up to 44 μm (Ra) and 330 μm (Rz). In addition, this study demonstrates that electropolished Ti alloy surfaces are suitable for subsequent coating applications, such as color anodizing, highlighting their potential for further coating development.

Development of electroless copper plating and PVDF coating methods for improving the corrosion resistance of La–Co–Fe–Si magnetocaloric alloy

M.S. student Dong-Hyeon Lee[1], Dr. Da Seul Shin[2], Dr. Dong-Gyu Ahn[1], Dr. Jeong-Won Lee[1]

[1]Department of Mechanical Engineering, Chosun University, College of Engineering Building No. 1, Dong-gu joseondae1gil 10, South Korea, [2]Korea institute of Materials Science, 797 Changwon-daero, Seongsan-gu, South Korea

Session 04 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Magnetic refrigeration, which exploits the magnetocaloric effect to provide cooling without the use of refrigerants, has been recognized as an environmentally friendly and energy-efficient cooling technology. However, the limited corrosion resistance of magnetocaloric materials in aqueous environments remains a significant obstacle to their commercialization. Among these materials, La–Co–Fe–Si-based magnetocaloric alloys demonstrate excellent magnetocaloric performance, but they are prone to rapid degradation when exposed to water or saline environments, thereby restricting their long-term use. In this study, electroless copper displacement plating and PVDF (poly(vinylidene fluoride)) dip-coating were applied to a La–Co–Fe–Si alloy, and the effectiveness of these two surface protection approaches was comparatively assessed. Copper displacement plating was carried out under alkaline conditions (pH 12.5–13.0) with immersion times ranging from 10 s to 5 min, whereas PVDF coatings were fabricated by dip-coating using a PVDF/DMF (N,N-dimethylformamide) solution. Surface wettability and coating characteristics were investigated, and immersion tests in deionized water over time were conducted to evaluate surface degradation behavior. Furthermore, corrosion performance was examined in a 3.5 wt% NaCl solution by first stabilizing the open-circuit potential (OCP), followed by linear polarization resistance (LPR) and polarization measurements. The findings show that both coatings enhance corrosion resistance relative to the bare alloy, while exhibiting different surface features as well as distinct advantages and limitations depending on the application. This study demonstrates the potential for improving the corrosion resistance of La–Co–Fe–Si magnetocaloric alloy in aqueous and saline environments through the application of copper displacement plating and PVDF coating and is expected to contribute to the development of surface protection strategies for the long-term operation of magnetic refrigeration systems.

July 16, 2026 | 1:30 PM

Fibers surface treatment to enhance fiber-polymer interfacial bonding and strengthen the composite properties

Dr. Junhua Kong[1], Dr. Suxi Wang, Dr. Songlin Liu, Dr. Warintorn THITSARTARN, Dr. Siok Wei Tay

[1]A*STAR, 2 Fusionopolis Way, Innovis, #08-03, 38634, Singapore

Session 09 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 1:30 PM - 3:20 PM

In the world of polymer composite materials, different types of additives are introduced into polymer matrices for properties enhancement and functionalization. As one of the strongest composites, fiber reinforced polymer composites (FRP) have found wide applications in various domains such as aerospace, automobile, oil and gas, and new energy sector. The poor interfacial bonding between fibers and polymers, especially thermoplastic resins, however, negatively affects the structural integrity of the composites thus their mechanical properties and robustness. Therefore, surface modification of the fibers is highly necessary to enhance the bonding. In this talk, taking carbon fibers, glass fibers and several thermoplastic polymers as examples, we present some in-house developed strategies for the enhancement of interfacial bonding, and elaborate how they affect the properties as well as how they benefit some emerging applications like hydrogen storage and transport.

Plasma-Polymerized Organosilane Films as a Versatile Platform for Biofunctional Surface Engineering of Metallic and Ceramic Implants

Dr Shu-chuan Liao[1]

[1]Tamkang University, No.151, Yingzhuan Rd., Tamsui Dist., Taiwan

Session 09 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 1:30 PM - 3:20 PM

Plasma surface modification has emerged as a versatile strategy for tailoring the interfacial properties of biomedical implants. However, achieving simultaneous biointegration and antibacterial functionality across different implant materials remains a critical challenge. In this study, plasma-polymerized organosilane films were employed as a universal interfacial platform for surface functionalization of both metallic (titanium) and ceramic (zirconia) implants. Using low-temperature plasma polymerization, hexamethyldisilazane (HMDSZ)-derived films were deposited to form conformal organosilane coatings with tunable surface chemistry. On titanium substrates, the plasma-deposited layer was further combined with UV-grafted thermoresponsive functional hydrogels for immobilization of bioactive molecules, enabling dual-functional performance in promoting osseointegration and antibacterial activity. On zirconia substrates, plasma-polymerized organosiloxane films derived from different precursors were utilized to modulate surface wettability, chemical composition, and cellular response. Comprehensive characterization, including wettability, surface chemistry, and biological evaluations, demonstrated that plasma-polymerized organosilane films provide a stable and adaptable interface for subsequent functionalization. The modified surfaces exhibited enhanced hydrophilicity, improved cytocompatibility, and effective antibacterial performance, while also supporting bone-related cellular activity and in vivo integration.

This work highlights the role of plasma-polymerized organosilane films as a material-independent surface engineering platform, bridging metallic and ceramic implant systems. The proposed strategy provides new insights into the design of multifunctional implant surfaces through controllable plasma-assisted thin film processes.

July 16, 2026 | 2:10 PM

Modulating Surface States for Photoelectrocatalytic Selective Oxidation of Biomass-Derived Sugars

Xin ZHAO[1], Yilin Zuo[1]

[1]China Agricultural University, Beijing, China

Session 09 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 1:30 PM - 3:20 PM

The photoelectrocatalytic (PEC) oxidation of biomass-derived sugars into high-value chemicals, such as glucaric acid, formic acid, or 5-hydroxymethylfurfural, represents a promising route for sustainable chemical manufacturing. However, the selective conversion of these complex polyhydroxy compounds is often hindered by competing oxygen evolution reactions (OER) and unselective overoxidation at the semiconductor/liquid junction. This abstract explores the critical role of modulating surface states—intrinsic or extrinsic electronic defects at the photoelectrode interface—as a decisive strategy to steer reaction pathways for enhanced selectivity and activity. Surface states on typical photoanodes α-Fe_2O_3 act as recombination centers or active sites that dictate charge transfer kinetics. In their native form, these states often favor water oxidation or promote non-selective radical attacks, degrading sugar substrates to CO_2. Atomic-scale passivation such as single-atom catalysts can directly tunes the density and energy distribution of surface states, suppressing the generation of radicals and increasing the target products' selectivity. This surface-state engineering not only improves Faradaic efficiency toward target products but also increases the photocurrent performances. Consequently, modulating surface states is emerging as a powerful paradigm to valorize biomass streams under mild conditions, offering mechanistic insights into photogenerated hole transfer to organic molecules and guiding the rational design of next-generation PEC platforms for lignocellulosic biorefineries.

July 16, 2026 | 2:30 PM

Regulation Mechanism of Oxygen Plasma Etching on the Initial Frictional Interface and Long-Term Wetting Stability of Tetrahedral Amorphous Carbon (ta-C) Films

Aisheng Jiang[1], Ding Chen[2], Chuandong Zhang[2], Yinchao Xu[1], **Zhenhuai Yang**[2]
[1]Zhuzhou Cemented Carbide Cutting Tools Co, Ltd., , China, [2]Jihua Laboratory, , China
Session 09 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 1:30 PM - 3:20 PM

Tetrahedral amorphous carbon (ta-C) films serve as a high-potential protective coating for semiconductor components, wherein clarifying their structural and performance evolution under oxygen plasma environments is critical to enhancing component stability under extreme operating conditions and extending their functional service lifespan. In this study, customized oxygen plasma etching modification was implemented on pre-deposited ta-C films via two distinctive plasma excitation configurations, namely the anode layer ion source (ALS) and remote plasma source (RPS). Multi-scale correlative characterizations, encompassing surface topography evolution, etching kinetic behavior, microstructural rearrangement, bulk mechanical integrity, surface wetting characteristics and tribological performance responses, were systematically performed to elucidate the underlying structure-performance correlation and reveal the intrinsic modification mechanisms induced by differentiated plasma field effects.The results reveal that both oxygen plasma etching processes can introduce oxygen-containing functional groups onto the ta-C film surface, while preserving the bulk mechanical properties essentially intact. Concomitantly, the initial friction coefficient is diminished, the running-in duration is abbreviated, and the wear rates are reduced to 2.00×10-7 mm3/N·m and 2.61×10-7 mm3/N·m , respectively. In stark contrast, pronounced disparities are evident in the wettability aging behavior of the modified specimens: ALS-treated samples exhibit a notable recovery in contact angle following 2 weeks of aging, progressively transitioning from hydrophilicity to hydrophobicity, whereas RPS-etched samples maintain a robustly stable hydrophilic state throughout the entire testing duration. Collectively, these findings establish that oxygen plasma modification can effectively tailor the initial frictional interface state and modulate the long-term surface wetting stability of ta-C films, with the RPS process demonstrating superior potential for the fabrication of a structurally robust, long-lasting hydrophilic oxidized surface layer.

July 16, 2026 | 2:50 PM

Stability of titanium deuteride films irradiated with pulsed ion beams

Doctor Tao Wang[1], Pan Dong, Jie Li, Longjian Ye

[1]Institute Of Fluid Physics, Caep, 64th Mianshan Road , China

Session 09 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 1:30 PM - 3:20 PM

Titanium deuteride films used as target materials for neutron generators. Intense pulsed ion beams irradiated titanium deuteride films, and structure stability was investigated by combination with scanning electron microscopy, transmission electron microscopy, grazing incidence angle X-ray diffraction, slow mono-energetic positron beam, scratch test and finite element analysis. Five different irradiation fluences of 3E14, 1E15, 3E15, 1E16, 3E16 cm-2 were performed. The main conclusions can be drawn from the present experimental results: First, Lattice structures of the titanium deuteride film kept stable after ion irradiation. Phase transformation was not observed. Second, The threshold normal stress for the titanium deuteride film spallation is over 100N in the as-deposited sample, while it decreased to 31N after 3E16 cm-2 irradiation. Surface morphology of scratch tracks shows the transition of ductile fracture to brittle fracture when the irradiation fluence is ≥3E15 cm-2. Third, Surface cracks, grain melting and grain growth occurred when the irradiation fluence is 1E16 cm-2. Next, XTEM images present lots of bubbles and columnar grains formed in the as-deposited film. After ion irradiation to a fluence of 1E16 cm-2, the number of bubbles decreased and grain growth occurred in the damaged layer. Moreover, cracks along interface between the film and Mo substrate were formed. Then, Shear stress and normal stress induced by ion irradiation increased with increasing temperature, which is related to the beam energy density and fluence. Residual stress within the film can account for the occurrence of surface cracks and interface cracks. Finally, Irradiation-induced lattice defects and grain growth result in inhibition of column sliding, and therefore the film become brittle. The research result is critical for evaluate lifetime of titanium deuteride films based on failures in structures and decrease in concentration of inner deuterium.

July 16, 2026 | 3:05 PM

Ultrathin Carbon-Based Overcoats for Superior Tribological Performance and Oxidation Control

Mr Rajesh Kumar[1,2], Dr Neeraj Dwivedi[1,2]

[1]CSIR-Advanced Materials and Processes Research Institute, Bhopal,, India, [2]Academy of Scientific and Innovative Research, Ghaziabad,, India

Session 09 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 1:30 PM - 3:20 PM

Every mechanical component in sliding contact experiences resistance to motion due to tribological problems, leading to excessive energy loss and premature failure in the system. Corrosion is another critical challenge that limits the functionality of the systems. To overcome these problems, overcoats are widely used to engineer the surface of several moving mechanical systems for tailoring friction, wear and metal-oxidation. However, evaluation of the effectiveness at the ultrathin regime, especially sub 3 nm thicknesses overcoat with protective properties, is a challenge. Therefore, in order to develop low friction, wear and metal-oxidation in the mechanical system, we applied an ultrathin monolithic carbon overcoat with carbon thicknesses ranging from 0.7-10 nm. Furthermore, we investigated the efficiency of bilayer overcoats with an atomically thin (~ 0.4 nm) silicon nitride (SiNx) interlayer introduced between the substrate and carbon overlayer, which enhanced the sp3 carbon bonding content and promoted interatomic mixing and the formation of strong hybrid bonds that significantly improved the interfacial strength. As a result, the adhesion between the substrate and the overcoat is improved, exhibiting exceptional tribological and metal-oxidation resistance properties. The functional properties of carbon-based monolithic and bilayer overcoats are well-explained based on carbon microstructure, surface chemistry, interfacial-bonding, and other fundamental reasons, to explain the tribological and metal-oxidation mechanisms. The present work has enormous potential for a wide range of applications, including next-generation high-areal-density hard disk drives, NEMS, MEMS, sensors, and other industrial machinery components.

Keywords: hard disk drives, ultrathin carbon overcoats, SiN interlayer, friction, wear and corrosion.

July 16, 2026 | 3:45 PM

Multiscale Fabrication Pathways and Their Effects on Phase Stability, Microstructure, and Corrosion Resistance in CoCrFeNi Based HEAs

Prof. Aphichart Rodchanarowan[1], Mr. Pongpak Chiyasak[1], Mr. Sakdipat Jaturapronperm[1]

[1]Kasetsart University, 50 Ngamwongwan Rd., Ladyao, Thailand

Session 10 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 3:45 PM - 4:50 PM

High entropy alloys (HEAs) exhibit attractive mechanical and environmental performance arising from their compositional complexity. Beyond chemical composition, their properties are strongly influenced by processing pathways, which control phase stability, microstructure, and characteristics. An overview of CoCrFeNi based HEA systems fabricated through bulk, surface, and thin film routes is presented. Bulk HEAs produced by arc melting and low energy modified conventional microwave sintering are examined with emphasis on the effects of elemental additions (Cu, Al, Sn, Ti) and heat treatment on microstructure and corrosion behavior in chloride environments. Surface engineered HEAs fabricated by gas tungsten arc cladding on stainless steel substrates are discussed to explain the roles of solidification characteristics and compositional dilution in determining mechanical and corrosion performance. In parallel, HEA thin films prepared by sputtering and pulsed-current electrodeposition are presented to demonstrate processing composition tuning, nanoscale structure, and property changes associated with defects. Additional surface modification via packed aluminizing is also addressed. By comparing fundamentally different processing pathways, the structure to property relationships of HEAs are clarified. This provides a design framework for structural, surface, and thin film applications.

July 16, 2026 | 4:05 PM

Enhancing Water Vapor Corrosion Resistance of Yb_2SiO_5-Based Environmental Barrier Coatings on Nb Alloy via Oxide-Modifications

Hongkang Ou[1], Qiangang Fu

[1]Northwestern Polytechnical University, ,

Session 10 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 3:45 PM - 4:50 PM

This study investigates the water vapor corrosion behavior of Yb_2SiO_5 (YbMS)-based environmental barrier coatings (EBCs) on Nb alloy at 1500 °C. Three strategies were employed: Al_2O_3 addition, ZrO_2 toughening, and multilayer structuring with $MoSi_2$ interlayers. Al_2O_3 reacted with residual Yb_2O_3 to form $Yb_3Al_5O_{12}$, suppressing pore formation and extending service life to 30 h. ZrO_2 addition enhanced fracture toughness to 2.07 MPa·$m^{1/2}$ via phase transformation toughening, increasing lifetime to 50 h. However, prolonged exposure led to $(Zr,Yb)O_2$ solid solution formation, reducing toughness but improving corrosion resistance through stronger atomic bonding. The multilayer coating achieved 100 h protection via sacrificial SiO_2 formation and layer-by-layer spallation, effectively inhibiting oxygen and water vapor ingress. These modifications significantly improved the durability of YbMS-based EBCs under extreme environments.

July 16, 2026 | 4:20 PM

Adsorption and Corrosion Inhibition Behaviour of 1,3,4-Thiadiazole Schiff Base on Mild Steel: A Thermodynamic and Electrochemical Study

Ms Sheetal Kundu[1], Mr Ashish Kumar Singh[2], Prof Sanjeeve Thakur[1]

[1]Netaji Subhas University Of Technology, Azad Hind Fauj Marg, Sector-3, Dwarka, India, [2]Hansraj College, University of Delhi, Delhi 110007, India

Session 10 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 3:45 PM - 4:50 PM

The present investigation explores the corrosion inhibition performance of newly synthesized 5-substituted 1,3,4-thiadiazol-2-yl imino methyl phenol derivative for mild steel (MS) in acidic medium. The inhibitory behavior was systematically evaluated using electrochemical techniques, including Potentiodynamic Polarization (PDP) and Electrochemical Impedance Spectroscopy (EIS), along with thermodynamic and kinetic analyses. The results revealed that the inhibition efficiency increased significantly with increasing inhibitor concentration, indicating enhanced surface coverage and effective suppression of metal dissolution. PDP studies demonstrated a substantial decrease in corrosion current density (icorr) with a marginal shift in corrosion potential (Ecorr), confirming the mixed-type inhibitory nature of the synthesized compound. Maximum inhibition efficiency of approximately 90% was achieved at 250 mg L^{-1} concentration. EIS analysis showed a pronounced increase in charge transfer resistance (Rct) and a corresponding decrease in double-layer capacitance (Cdl), suggesting strong adsorption of inhibitor molecules onto the mild steel surface. The adsorption process was further supported by thermodynamic parameters, where an increase in activation energy (Ea) in the presence of the inhibitor indicated the formation of a protective energy barrier. The negative values of entropy change (ΔS^*) reflected the formation of an ordered adsorbed layer at the metal–solution interface. Overall, the studied thiadiazole-based Schiff base derivative exhibits excellent corrosion inhibition efficacy, attributed to the presence of heteroatoms and π-electron systems that facilitate strong adsorption on the metal surface. These findings highlight its potential as an effective corrosion inhibitor for mild steel in aggressive acidic environments.

Polydopamine Enabled Localized Boronic-Ester Vitrimer Interphase for Enhanced Interlaminar Fracture Toughness and Impact Recoverability in CFRP Laminates

Ruonan Zhang[1], Lingjun Guo[1]

[1]Northwestern Polytechnical University, No.127 Friendship West Road,, China

Session 10 - S14: Surface Treatment & Protection (STP), Sembawang - Level 3, July 16, 2026, 3:45 PM - 4:50 PM

Carbon fiber reinforced polymers(CFRP) are highly susceptible to matrix cracking and interlaminar delamination under low velocity impact because conventional thermosetting networks provide limited stress redistribution and energy dissipation in the vicinity of the crack tip. This work establishes interphase localized dynamic exchange as an effective strategy for enhancing damage tolerance and recoverability in CFRP laminates while preserving the integrity of the bulk network. To this end, a localized dynamic interphase was constructed through the synergistic combination of polydopamine surface treatment and a boronic ester based epoxy vitrimer. The polydopamine layer improves fiber surface activity, resin wettability, and interfacial anchoring, whereas the boronic ester network enriched in the near interfacial region enables local topological rearrangement through associative bond exchange under loading. Such an architecture promotes stress relaxation and energy dissipation precisely in the region where microcrack initiation, stress concentration, and delamination growth are most active.

As a result, the localized dynamic interphase significantly enhances both interlaminar fracture resistance and post impact recoverability. Relative to the baseline laminate, GIC and GIIC increase by approximately 30-40 % and 20-35 %, respectively. After thermal treatment at 160 °C, the compression after impact strength recovers to 85-90 %. Since the influence of local topological rearrangement on crack tip process zone evolution cannot be fully resolved by experiment alone, molecular dynamics and finite element analyses were further employed to elucidate the underlying multiscale mechanisms. The combined results show that localized dynamic sites strengthen interfacial interactions, enhance segmental mobility in the near interfacial region, and regulate crack tip stress fields and delamination paths. Compared with bulk matrix modification, a moderately localized vitrimer network offers a more effective route to balance strength, toughness, and recoverability in high performance repairable CFRP laminates.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Bipulse-HiPIMS Co-Sputtered CrAlN-Based Coatings with Cr/Ti/Zr Auxiliary Targets: Microstructure Control and Corrosion-Mechanical Performance

Yi-Hui Lee[1], Ying-Hsiang Lin[1], Zhi-Yan Lin[1], Kai-Shawn Tang[1], **Professor Wan-Yu Wu**[1]
[1]National United University, No.2, Lienda, Taiwan

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study investigates how auxiliary target materials (Cr, Ti, Zr) tailor plasma characteristics and film properties of CrAlN-based thin films deposited by Bipulse-HiPIMS. Plasma composition during deposition was analyzed by optical emission spectroscopy (OES), while film morphology, composition, bonding states, and crystal structure were characterized by SEM, TEM, EDS, XPS, and GIXRD. Compared with the unipolar mode, the Bipulse mode exhibited superior ionization. In the (CrAl+Cr)N condition, higher intensities of Cr^{+} and Cr^{0} were observed, and EDS indicated an N/Metal ratio of 1.04. The (CrAl+Ti)N plasma showed elevated intensities of N_2^{0}, N^{+}, N^{0}, Ar^{+}, and Ar^{0}, whereas the (CrAl+Zr)N plasma exhibited higher Al^{+} and Al^{0} intensities. SEM revealed that Bipulse-deposited films possessed finer granular surface features. Cross-sectional TEM further indicated refined columnar grains, reduced inter-columnar gaps, and smoother surfaces, suggesting enhanced densification under intensified plasma. GIXRD and SAED results showed that the CrAlN film deposited in the reference condition was dominated by (111) and (220) orientations, while Bipulse-deposited films exhibited a strong (200) preferred orientation; meanwhile, all diffraction peaks shifted to lower angles, consistent with increased compressive stress induced by enhanced ion bombardment. Mechanical properties and corrosion resistance were evaluated by nanoindentation and electrochemical measurements. The (CrAl+Cr)N film achieved a hardness of 32.0 GPa and an elastic modulus of 331.5 GPa. Notably, the (CrAl+Ti)N film delivered the best overall performance (H = 33.1 GPa, E = 286.8 GPa, H/E = 0.115, H^3/E^2 = 0.441) and the highest polarization impedance (Rp = 9.3×10^5 Ω) in 3.5 wt.% NaCl, whereas the (CrAl+Zr)N film showed reduced hardness and modulus (21.8 GPa and 208.5 GPa).

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Resolving the oxygen vacancy paradox in selective glucose valorization by redirecting hole flux to nickel centers

Xin ZHAO[1]

[1]China Agricultural University, No.2 Yuanmingyuan west road, China

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The photoelectrochemical (PEC) upgrading of biomass derivatives represents a sustainable frontier for the biorefinery carbon cycle, yet it is plagued by the competitive oxygen evolution reaction (OER) and sluggish interfacial kinetics[1, 2]. Here, we report a profound "Oxygen Vacancy Paradox" in hematite (α-Fe2O3) photoanodes: while oxygen vacancy (VO) engineering significantly amplifies the total hole flux, it leads to a catastrophic collapse in selectivity and yield rate for the glucose oxidation reaction (GOR), particularly under high-potential regimes. Mechanistic probing reveals that VO induces two distinct surface states asymmetrically distributed within the bandgap. The high-energy surface state functions as a formidable kinetic trap, possessing an overriding priority in hole capture. This rapid sequestering of holes triggers their chemical localization into high-valent Fe4+=O intermediates, which further generate non-selective radical-mediated pathways that mineralize glucose into CO2. To resolve this, we propose an interfacial active-site reconfiguration strategy by decorating VO-rich hematite with a nickel-based co-catalyst (NiOX). Acting as a kinetic interceptor, NiOX in-situ passivates the deleterious high-energy surface states and redirects the hole flow toward energetically optimized Ni2+/Ni3+ centers. Consequently, the NiOX/TFO-VO electrode transcends the "efficiency,selectivity and yield rate" trade-off, achieving a remarkable selectivity reversal across the entire potential window while sustaining high-flux photocurrents. This study provides a transformative perspective on the bias-driven activation of deleterious high-energy surface states, and establishes a new benchmark for high-selectivity and high-yield rate solar-to-chemical conversion.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Microstructure, tribological and electrochemical performances of NbMoSiCN/CNx multilayer films in simulated body fluid

Professor Fei Zhou[1], Dr. Jianguo Qian[1], Dr. Qiang Gao[1]

[1]Nanjing University of Aeronautics and Astronautics, Yudao Street 29#, China

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

By combining Nb-based nitrides and carbides with CNx thin films to create multilayer structures, single layer NbMoSiCN thin films as well as NbMoSiCN/CNx multilayer thin films with various modulation periods were prepared. The effects of the modulation period on their microstructure, mechanical properties, and friction and corrosion behaviors in simulated body fluid environments were systematically studied. Research shows that the NbMoSiCN single-layer film forms a nanocomposite structure composed of β-Nb2N, MoSi2, Si3N4, and amorphous carbon. The NbMoSiCN/CNx multilayer film is formed by alternating deposition of NbMoSiCN layers and amorphous CN layers, with the amorphous CN layers consisting of a mixed structure of sp2 and sp3 bonds. In the simulated body fluid environment, the NbMoSiCN/CNx multilayer film exhibits enhanced corrosion resistance compared to the single layer NbMoSiCN film. Furthermore, as the modulation period decreases, the interfacial shielding effect and surface passivation properties of the multilayer structure improve, significantly enhancing the film's corrosion resistance. The MF32 multilayer film with a modulation period of 108 nm exhibited the lowest average friction coefficient (0.23±0.03) and optimal wear resistance (1.24×10-6 mm3/Nm) during grinding with Si3N4 abrasive balls.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Corrosion Performance of Biomedical Ni–Ti–Cu–Cr Alloys

Boyang Pan[1,2], Yan Li[1,2]

[1]School of Materials Science and Engineering, Beihang University, , China, [2]Beihang Hangzhou International Innovation Institute (Beihang International Innovation College), Hangzhou, , China

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In the field of biomedical metallic materials, traditional titanium alloys and shape memory alloys have long faced three major challenges: mechanical mismatch, potential toxicity of nickel ion release, and biological inertness. In this study, a NiTiCuCr quaternary alloy was designed. By regulating phase transformation kinetics through copper (Cu) and achieving corrosion–biological functional synergy through chromium (Cr), a novel biomedical orthodontic wire material was developed .Nickel (Ni), titanium (Ti), copper (Cu), and chromium (Cr) were selected as raw materials and melted into alloy ingots using vacuum arc melting. After homogenization treatment, the ingots were subjected to 75% deformation rolling to obtain NiTiCuCr alloy plates. The electrochemical behavior of rolled Ni_{50}–Ti(44–x)–Cu_6–Cr_x (x = 0, 0.3, 0.6, 0.9 wt%) alloys was investigated in artificial saliva solution, Hanks' solution, and physiological saline. The corrosion behavior of the NiTiCuCr alloys was systematically studied using open circuit potential, Tafel polarization curves, and electrochemical impedance spectroscopy. Electrochemical test results indicate that the addition of Cr improves the corrosion resistance of the NiTiCuCr alloy. In all three environments, the corrosion potential initially shifted in the positive direction and then in the negative direction with increasing Cr content. Analysis of the pitting potential in the three environments shows that excessive Cr reduces the alloy's resistance to pitting corrosion. This phenomenon is mainly attributed to the significant grain refinement caused by excessive Cr addition, which generates a large number of grain boundaries and thus reduces the resistance to pitting corrosion. X-ray spectroscopy results reveal that the passive film is mainly composed of TiO_2 with small amounts of Cu oxides and Cr oxides. The addition of Cr enhances the corrosion resistance of NiTiCu alloys and improves the stability of the passive film. However, excessive Cr addition leads to a decrease in resistance to pitting corrosion.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Structure, hardness, and transparency of hexagonal AlCrN and AlCrSiN coatings prepared by energetic bombardment sputtering with different substrate temperature

Dr. Du-Cheng Tsai[1], Mr. Lung-Wei Cheng[1], Mr. Yen-Lin Huang[2], Prof. Fuh-Sheng Shieu[1]
[1]National Chung Hsing University, 145 Xingda Rd., South Dist., Taiwan, [2]Metal Industries Research and Development Centre, 1001 Kaonan Highway, Nanzi Dist., Taiwan
Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

AlCrN and AlCrSiN coatings were deposited by reactive magnetron sputtering, and the combined effects of substrate temperature (room temperature to 500 °C) and substrate bias on their microstructure, optical, and mechanical properties were systematically investigated. All crystalline coatings exhibit a wurtzite-type hexagonal close-packed structure. At room temperature, AlCrN shows porous nanocrystalline fibrous columns, while AlCrSiN exhibits a porous amorphous morphology. Increasing substrate temperature promotes grain growth, reduces intra-columnar voids, and enhances film densification, resulting in a columnar structure with open boundaries. The application of substrate bias enhances ion bombardment, improving adatom mobility and densification, while excessive bias may induce re-sputtering and defects. These structural changes significantly affect properties: grain coarsening reduces optical transmittance, especially in the infrared region, whereas densification improves hardness. The incorporation of Si suppresses grain growth and promotes a dense nanocomposite structure. Consequently, AlCrSiN coatings exhibit higher hardness than AlCrN while maintaining relatively higher optical transparency, partly due to the intrinsic transparency of Si_3N_4.

Fabrication of Functionally Graded (Ba,Sr)TiO_3 Films by Spark-Discharge Pulsed Anodization

Dr Mitsunobu Iwasaki[1], Keigo Mogi[1], Dr Takayoshi Fujino[1]

[1]Kindai University, 3-4-1 Higashi-Osaka , Japan

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In recent years, titanium-based composite oxides with electrical properties have attracted increasing attention for use in electronic devices. $BaTiO_3$ and $SrTiO_3$ in particular exhibit excellent dielectric properties, and films combining these oxides in a graded manner are expected to be promising materials for next-generation capacitors. Thin films with a continuous $BaTiO_3$–$SrTiO_3$ compositional gradient throughout are expected to enhance the temperature stability of dielectric properties, generate built-in electric fields and polarisation gradients, and are therefore well-suited to temperature-stable capacitors and RF tunable devices.

In this study, functionally graded $BaTiO_3$/$SrTiO_3$ films were fabricated using a two-step spark-discharge pulsed anodisation process. In the first step, a Ti substrate was anodised in a mixed $Ba(OH)_2$–NaOH solution to form a $BaTiO_3$ film. The anodisation conditions were 60 minutes, 0 ± 20 A/dm², 10 Hz, 75 °C, a duty ratio of 50% and a rectangular waveform. In the second step, the $BaTiO_3$-coated specimen was re-anodised in a mixed $Sr(OH)_2$–NaOH bath to produce a $BaTiO_3$/$SrTiO_3$ graded film. The conditions for the second step were anodisation times of 1–60 minutes, current densities of 0 ± 5 to 20 A/dm², frequencies of 10–50 Hz, a duty ratio of 50%, a temperature of 75 °C and a rectangular waveform.

Depth-dependent crystal structure analysis by grazing-incidence X-ray diffraction revealed that the $SrTiO_3$ content increased gradually from approximately 25% at the film surface to around 50% near the Ti substrate when the second-step anodization time was 60 min. These results suggest that $Sr(OH)_2$ particles were incorporated into the film and that $SrTiO_3$ formed near the $BaTiO_3$/Ti interface, resulting in a compositional gradient.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Steam oxidation kinetics and oxidation mechanisms of Cr/Mo bilayer coated Zr-4 alloy at 1200°C

Qining Zheng[1], professor Chengyu Zhang[1]

[1]Science and Technology on Thermostructure Composite Materials Laboratory, Northwestern Polytechnical University, , China

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

To mitigate Zr-Cr interdiffusion in Cr-coated zirconium alloy cladding at high temperatures, a Mo diffusion barrier was introduced by multi-arc ion plating. The oxidation kinetics, surface morphologies, cross-sectional microstructure and phases evolution of Cr coatings with and without a Mo layer, were investigated at 1200°C in steam. It can be found that the Cr/Mo coating exhibits superior performance. Compared to the Cr coating, the parabolic oxidation stage is prolonged, the parabolic rate constant (kp) is halved, and the effective protection time is extended from 60 min to 180 min. The Mo layer and the Zr(Mo, Cr)2 interlayer effectively suppress Zr-Cr interdiffusion and oxygen ingress, which inhibits the dominant failure mechanisms, Kirkendall voids and blister, in the Cr coating. The degradation and failure of the Cr/Mo coating results from micropore coalescence in the oxide layer and the consumption of the Cr2O3 layer by outward-diffusing Zr through a redox reaction.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Magnetically-Directed and Conductively-Randomized Bilayer Aerogels for High-Efficiency Low-Reflection Electromagnetic Interference Shielding

Mengxin Liu[1], Haoran Zhang[2], Lei Pan[2], Zhong Chen[1]

[1]Nanyang Technological University, Nanyang Avenue, Singapore, [2]Nanjing University of Aeronautics and Astronautics, 29 Jiangjun Road, China

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The rapid advancement of 5G and flexible electronics has triggered severe electromagnetic interference (EMI) pollution, while conventional EMI shielding materials are plagued by high reflection-induced secondary pollution and insufficient flexibility. Herein, an asymmetric bilayer composite aerogel is rationally designed for high-performance low-reflection EMI shielding. The upper magnetic absorption layer is fabricated from MXene@Fe_3O_4/WPU-BC via directional freezing to form vertically oriented channels, optimizing impedance matching and boosting the synergistic dielectric-magnetic loss of electromagnetic waves. The bottom conductive shielding layer is constructed from MXene/CNTs/WPU-BC through random freezing to build an isotropic porous network, enhancing electromagnetic wave multiple scattering and conductive loss. Benefiting from the unique component-orientation gradient structure, the as-fabricated bilayer aerogel delivers an outstanding EMI shielding effectiveness (EMI SE) of 83 dB and an ultralow reflection coefficient (R) of 0.15. This lightweight, flexible bilayer aerogel integrates high shielding efficiency and low reflection, offering a novel strategy for developing green high-performance EMI shielding materials for advanced flexible electronics and aerospace applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Enhanced Corrosion Resistance of Micro-Arc Oxidation Coatings on LAZ771 Mg–Li Alloy via Permanganate–Vanadate Conversion Pretreatment

Cheng-Hsien Chang[1], Master Ya-Chi Huang[1], Master Fei-Hsiu Wang[1]
[1]National Defense University, No. 75, Shiyuan Rd., Daxi Dist., Taiwan (R.O.C.)
Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In this work, a permanganate–vanadate conversion coating was employed as a pretreatment prior to micro-arc oxidation (MAO) on LAZ771 Mg–Li alloy to tailor the coating microstructure and corrosion performance. The effect of this conversion pretreatment on the surface morphology, cross-sectional architecture and electrochemical behavior of the resulting MAO coatings was systematically evaluated. The introduction of the conversion layer leads to finer pores and a more uniform surface, while cross-sectional observations reveal a denser and more compact coating compared with the MAO-only condition. Potentiodynamic polarization tests in 3.5 wt.% NaCl show that the pretreated sample exhibits a significantly lower corrosion current density (4.35 × 10^−8 A·cm^−2) than the MAO-only sample (8.81 × 10^−8 A·cm^−2), accompanied by an increase in low-frequency impedance modulus from 2.31 × 10^5 to 6.02 × 10^5 Ω·cm^2. The enhanced corrosion resistance is attributed to the modified coating architecture and the suppression of defect pathways afforded by the conversion pretreatment. These findings demonstrate that permanganate–vanadate conversion treatment provides an effective surface engineering route to improve the protective performance of MAO coatings on Mg–Li alloys.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Laser Remelting of Electrodeposited Ni–B Alloy Coatings: Microstructural Densification, Mechanical Properties, and Wear–Corrosion Resistance

Cheng-Hsien Chang[1], Master Cheng-Hsien Chang[1], Master Fei-Hsiu Wang[1], Dr Pao-Chang Huang[2]

[1]Department of Chemical and Materials Engineering, Chung Cheng Institute of Technology, National Defense University,, No. 75, Shiyuan Rd., Daxi Dist., Taiwan, [2]Department of Power Vehicle and Systems Engineering, Chung Cheng Institute of Technology, National Defense University, No. 75, Shiyuan Rd., Daxi Dist., Taiwan

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Electrodeposited Ni–B alloy coatings are attractive as environmentally sustainable alternatives to hard chromium due to their high hardness and excellent wear resistance, but the non-equilibrium nature of electrodeposition often introduces porosity and microcracks that undermine mechanical reliability and corrosion resistance. In this study, laser remelting (LR) is employed as a post-treatment to improve the performance of Ni–B coatings deposited from a nickel sulfamate bath using trimethylamine borane (TMAB) as the boron source. A Taguchi L9 orthogonal array is adopted to systematically evaluate the influence of laser power, pulse frequency, scanning speed, and spot overlap ratio. The microstructure and properties before and after LR are characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD), nanoindentation, tribological testing, and electrochemical measurements. The results show that LR does not induce significant phase transformation but promotes localized melting and rapid solidification, which effectively fills intrinsic pores, reduces microstructural defects, and increases coating densification. Consequently, the laser-remelted coatings exhibit higher hardness, reduced friction coefficient, and lower wear rate. Polarization curves further shift toward more noble potentials and lower current densities after LR, indicating markedly improved corrosion resistance. These findings demonstrate that laser remelting is an effective strategy for tailoring the structure–property relationship of Ni–B alloy coatings for advanced surface protection under demanding service conditions.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Fabrication of Sustainable Superhydrophobic Multifunctional Cotton Fabric via Pad–Dry–Cure Coating Using Rice Husk-Derived SiO_2 Nanoparticles and Stearic Acid

Tanaji Chavan[1], Sushanta Sethi[2]

[1]IIT Dharwad, Room No. 122, A1 Engineering Block, Indian Institute of Technology Dharwad, Chikkamaligawad, Dharwad - 580011, Karnataka, BHARAT (INDIA), India, [2]IIT Dharwad, A1 Engineering Block, Indian Institute of Technology Dharwad, Chikkamaligawad, Dharwad - 580011, Karnataka, BHARAT (INDIA), India

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

With the development of materials science and engineering, the superhydrophobic self-cleaning textiles have garnered loads of attention both in academia and industry. Recently, researchers have developed several fluoro-based products that demonstrate excellent self-cleaning behaviour. However, such fluoro-based materials have a certain hazardous impact on human beings. In the present study, we report a sustainable strategy to extract SiO2 nanoparticles from rice husk, an abundant agricultural waste—thereby transforming a low-value byproduct into a high-value functional nanomaterial. These nanoparticles were subsequently integrated onto cotton substrates using an industrially viable pad–dry–cure process, followed by strategic surface modification with stearic acid to achieve low surface energy. The sustainable functionalized cotton textile exhibited remarkable multifunctional properties, including superhydrophobicity with an excellent water contact angle (WCA), as well as ultraviolet resistance, antioxidant, self-cleaning and antimicrobial properties. The inherent properties, such as tensile strength, extension at break, bending length, and air permeability, were retained after coating. Moreover, the coating is biosafe, as cytotoxicity tests using the L929 cell line show viable cells of more than 70%. In contrast to environmentally unsustainable materials, this eco-friendly coating offers a promising alternative, enabling the development of a scalable, sustainable, multifunctional coating for protective textile applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effects of cyclic gradient concentration and multilayer stacking on the characterization of (ZrTa)Bx Films

Professor Li-chun Chang[1,3], Mr Guan-Ting Lu[2], Mr Li-Hsuan Tsai[2], Professor Yung-I Chen[2]

[1]Ming Chi University Of Technology, No.84, Gungjuan Rd., Taishan, Taiwan, [2]Department of Optoelectronics and Materials Technology, National Taiwan Ocean University, Taiwan, No. 2, Beining Rd., Zhongzheng Dist., Taiwan, [3]Center for Plasma and Thin Film Technologies, Ming Chi University of Technology, Taiwan, No.84, Gungjuan Rd., Taishan, Taiwan

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study investigates the characteristics of (Zr,Ta)B_x thin films deposited via direct current magnetron sputtering at 400°C, using a target power of 100 W for both ZrB_2 and TaB_2 targets. Two types of structural designs—cyclic gradient concentration and multilayer architectures—were utilized for the coating deposition. The cyclic gradient concentration was achieved by applying low substrate holder rotation speeds. The results indicate that the cyclic gradient concentration approach formed solid solution structures, yielding hardness values of 21.7–25.1 GPa and wear rates of 1–3×10^-5 mm^3/Nm. In contrast, the multilayer deposition resulted in distinct dual phases, demonstrating enhanced hardness values of 25.6–33.4 GPa and reduced wear rates of 3–9×10^-6 mm^3/Nm. Notably, no wear-through was observed for the (Zr,Ta)B_x films in either configuration, indicating excellent durability and adhesion.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Surface Treatment of Laser-Induced Graphene via PDA-Assisted SiO_2/FAS Modification for Durable Superhydrophobic and Anti-Icing Coatings

Professor Xin Zhao[1], Mr. Zihao Zhao[1], Mr. Yibo Sun[2], **Associate Professor Mian Zhong**[2]
[1]College of Aviation Engineering, Civil Aviation Flight University of China, No.46 Section 4, Nanchang Road, China, [2]College of Aviation Electronic and Electrical Engineering, Civil Aviation Flight University of China, No.46 Section 4, Nanchang Road, China

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The Development of superhydrophobic coatings on lightweight functional substrates is highly attractive for surface protection and anti-icing applications. In this study, a surface-treatment strategy based on polydopamine-assisted nanoparticle loading and fluorosilane modification was employed for laser-induced graphene (LIG) to fabricate LIG/PDA/SiO_2/FAS superhydrophobic coatings. Particular attention was given to the combined effects of PDA deposition time and SiO_2 concentration on wetting performance, as the treatment window strongly influences the final adhesion state and water repellency.

Systematic experiments were carried out with PDA deposition times of 1 h, 2 h, and 3 h and SiO_2 concentrations ranging from 0.25 to 2.0 wt%. Coating performance was highly dependent on the loading window. At a 1 h deposition, optimal repellency occurred at a SiO_2 concentration of 0.5 wt%, with performance deterioration at lower or higher concentrations. At a 2 h deposition, favorable hydrophobicity appeared at low-concentration, followed by a decrease around 0.75 wt% and a gradual recovery at higher concentrations. At a 3 h deposition, overall performance declined, with high-adhesion behavior notably in the 0.75–1.0 wt% range, recovering only above 1.25 wt%. Notably, the 2 h PDA sample with just 0.25 wt% SiO_2 achieved a water contact angle of about 151°, confirming that the key role of the LIG microstructure in achieving hierarchical roughness.

The results indicate that the final coating performance depends not solely on nanoparticle content but also on the balance among LIG microstructure, PDA-assisted interfacial anchoring, SiO_2 loading state, and surface-energy reduce. PDA acts as an both an adhesive interlayer and a modulator of the effective SiO_2 loading window, determining whether the surface exhibits low-adhesion Cassie-type behavior or a high-pinning state. This work provides a practical surface-treatment approach for adjusting the superhydrophobic and anti-icing properties of LIG-based coatings and is promising for thin-film protection applications.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Modulation Mechanism of Physical Vapor Deposition TeO_2 Passivation on the Interface and Photon-Counting Performance of CZT Detectors

Phd Candidate Xiaoyan Liang[1,2], Master student Xiangkun Zhang[1,2], Master student Bo Zhang[1,2], PhD Chen Xie[1,2], PhD Jijun Zhang[1,2], **PhD Linjun Wang**[1,2], PhD Jian Huang[1,2]
[1]State Key Laboratory of Materials for Advanced Nuclear Energy, 99 Shangda Road, Baoshan District, Shanghai, China, [2]Shanghai University, School of Materials Science and Engineering, Shanghai University, Shanghai 200444, China, China
Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Photon-counting computed tomography (CT), as a disruptive imaging technology, relies on the CdZnTe(CZT) photon-counting detector as its core component. During device fabrication, interface defects can hinder charge collection efficiency, thereby affecting the sensitivity, energy resolution, and photon-counting performance of the detector. Dry passivation, due to its ability to form a uniform and dense dielectric layer with high chemical stability, has become a key surface treatment process for achieving the long-term stable operation of these detectors. In this study, TeO_2 thin films are deposited on CZT via physical vapor deposition for passivation, with the film thickness systematically optimized. The passivated interface structure is characterized using high-resolution scanning electron microscopy (HRSEM) and X-ray photoelectron spectroscopy (XPS). Concurrently, the evolution of the leakage current conduction mechanism before and after passivation is systematically analyzed, and the interface state density (Dit) is quantitatively characterized. Furthermore, combined with gamma and alpha spectroscopy, Hecht equation fitting, and preamplifier transient waveform analysis, the improvement in carrier transport parameters, including mobility-lifetime product and preamplifier rise time, attributed to interface structure optimization is elucidated. Finally, the detectors are subjected to X-ray irradiation at varying doses to evaluate their count-rate capability and X-ray photoelectric response characteristics. The results are compared with those from oxygen plasma passivation, revealing the underlying physical mechanisms by which physical vapor deposition TeO_2 passivation enhances device performance.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Plasma-Polymerized HMDSZ Films on Medical Stainless Steel for Thermosensitive Hydrogel Grafting and Lanthanum Chloride Immobilization

Ms. Chih-yun Yeh[1], Shu-Chuan Liao[1]

[1]Tamkang University, ,

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Medical grade stainless steel is widely used due to its mechanical robustness, yet its susceptibility to corrosion and lack of inherent antibacterial properties remain critical limitations in biomedical applications. In this study, organosilane thin films were deposited on stainless steel via plasma polymerization of hexamethyldisilazane (HMDSZ) monomer using both low-temperature plasma and atmospheric pressure plasma systems. The plasma polymerized HMDSZ filmsan organosilane coating on the substrate. In the low-pressure plasma system, HMDSZ deposition is followed by oxygen plasma treatment to introduce surface activation for subsequent grafting. In contrast, in the atmospheric-pressure plasma system, HMDSZ is introduced together with air, leading to simultaneous film deposition and partial oxidative modification. This dual-mode plasma approach enables comparison between sequential and concurrent surface modification mechanisms. A thermosensitive functional hydrogel was grafted onto the plasma modified surface via UV-induced grafting polymerization, followed by immobilization of lanthanum chloride(LaCl3) solution within the hydrogel network. The effects of plasma conditions on films characteristics and subsequent grafting behaviour were systematically investigated. The modified surfaces were characterized by using X-ray diffraction (XRD), scanning electron microscopy coupled with energy-dispersive spectroscopy (SEM&EDS), wettability measurements, and corrosion analysis. The thermoresponsive behavior of the hydrogel was evaluated through temperature-dependent swelling tests. In addition,.antibacterial activity and cytotoxicity assays were assessed to examone the biomedical potential of the modified surfaces. The results demonstrate that plasma-polymerized HMDSZ derived organosilane films effectively facilitate hydrogel grafting and lanthanum incorporation, leading to enhanced wettability, corrosion resistance, and multifunctional performance. This study presents a versatile plasma-assisted thin film strategy for functionalizing metallic biomaterials.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effect of Passivation Solution Self-Circulation Mode on the Microstructure of Passivation Films Formed on Hot-Dip Galvanized Steels

Hao-long Chen[1], Effect of Passivation Solution Self-Circulation Mode on the Microstructure of Passivation Films Formed on Hot-Dip Galvanized Steels Wen-Ju Wang[1]

[1]National Pingtung University Of Science And Technology, 1, Shuefu Road, Neipu, Taiwan

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In the hot-dip galvanizing process, after the zinc layer is formed, it is usually subjected to immersion passivation treatment. The purpose is mainly to prevent white rust, improve corrosion resistance, and stabilize the zinc surface. During batch passivation, the passivation solution is usually self-circulated in the tank or flow controlled in the production line to maintain a uniform surface reaction concentration. This study investigates the differences in the surface microstructure of hot-dip galvanized coatings after passivation treatments using magnetic stirring or ultrasonic oscillation of the passivation solution in a laboratory reaction tank. The experiment used a chromium-free passivation solution, the main components of which were a mixed aqueous solution of phosphoric acid (H3PO4) and zinc acetate (C4H6O4Zn). The passivation solution temperature was room temperature, about 25°C, and the treatment times were 45, 60 and 180 seconds, respectively. The variations in surface morphology and microstructure after passivation were observed. For surface morphology analysis, a laser conjugate focal-plus-white light interferometer was used; a scanning electron microscope was used to observe the surface microstructure. The results show that the passivation zinc coating using ultrasonic oscillation can achieve a lower surface roughness and a finer zinc phosphate microstructure.

Effects of Gum Arabic Concentration on the Surface Properties and Corrosion Resistance of Electroplated Copper Foils

Yun Taehwan[1]

[1]Jeonbuk National University, 567 Baekje-daero, Deokjin-gu, South Korea

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study aimed to improve corrosion resistance by applying Gum Arabic (GA) to the electroplating process, comparing single and combined additions of HCl, MPSA, and PVP.

In the case of the group to which only GA was added singly, a tendency to make the surface uniform overall was observed. The surface roughness (Rz) increased slightly compared to the additive-free sample, and increased by about 50% when 10 ppm was added. Resistivity also increased slightly compared to the additive-free sample. In the absence of any additions, the (220) plane exhibited preferential crystal growth, whereas the (111) plane exhibited strengthened growth in the GA-only added group, resulting in a change in grain direction.

In the mixed addition group, where HCl, MPSA, and PVP were added together with GA, the surface roughness decreased due to the effect of the leveler and the accelerator. However, as with the single addition of GA, the surface roughness tended to increase with the amount of GA. The electrical resistivity was lower overall than in the single addition, reaching a minimum of about 1.83 μΩ-cm in the 5 ppm mixed addition. Unlike the single additive, the preferred growth crystal orientation changed to (200) upon introduction of the mixed additives. Potentiodynamic polarization tests showed a significant reduction in corrosion current density (Icorr) under the GA 5 ppm mixed addition condition, demonstrating excellent corrosion resistance with a corrosion rate (CPR) of 0.639 μm/year.

In conclusion, the addition of a single GA was limited in its ability to improve surface properties and corrosion resistance. However, surface smoothing, crystal structure control, and corrosion resistance were simultaneously improved under mixed-addition conditions.(This work was supported by Korea institute for Advancement of Technology (KIAT) grant funded by the Korea Government (MOTIE) (RS-2024-00410332 HRD Program for Industrial Innovation).

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effect of Surface Treatment on the Adhesion of HDPE–HDPE and Carbon Steel–Carbon Steel Couplers

Yixuan Wu[1], Dr Qi Wang[1], Dr Chen Wang[1]

[1]Singapore Institute of Manufactruring Technology, , Singapore

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

With increasing global awareness of carbon neutrality, Low-Carbon Energy Research (LCER) initiatives have gained significant attention. As part of Singapore's net-zero target by 2050, the transition towards hydrogen as an alternative energy source is being actively explored. However, this transition requires substantial upgrades to existing infrastructure, particularly gas transmission pipelines. Conventional carbon steel pipelines are susceptible to hydrogen embrittlement, raising concerns over long-term structural reliability. As full replacement can only be implemented progressively, the development of a reliable coupler for joining dissimilar materials becomes critical. This study therefore investigates the adhesive behaviour of potential coupler materials, specifically composite structures bonded to carbon steel.

This study investigates the effect of surface treatment on the interfacial bonding performance between HDPE and a carbon steel coupler. Due to the inherently low surface energy of HDPE and the relatively smooth surface of untreated carbon steel, achieving strong adhesion remains a significant challenge. To address this, atmospheric plasma treatment was applied to the HDPE surface to increase surface energy, while sandblasting was performed on the carbon steel to enhance surface roughness and promote mechanical interlocking. Both surface treatments aim to improve the wettability and adhesion of Elium® resin at the interface. The treated surfaces were subsequently bonded using Elium® resin, and the interfacial performance was evaluated through single lap shear testing, alongside material characterisation techniques to assess surface and bonding properties before and after treatment. The results provide insights into the effectiveness of surface modification strategies in improving adhesion for hybrid material coupler applications in hydrogen infrastructure.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Mo-Ni Alloy Thin Film Catalysts Synthesized by Co-Sputtering for Enhanced Hydrogen Evolution Reaction

Zhe-Yu Liu[1], Professor Wan-Yu Wu[1]

[1]National United University, No.2, Lienda, Taiwan

Poster Session - S14: Surface Treatment & Protection (STP), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

With increasing energy consumption and environmental concerns, hydrogen has emerged as a clean alternative to traditional fossil fuels. The hydrogen evolution reaction (HER) during water electrolysis is critical for hydrogen production. While noble metals, such as platinum (Pt), are highly effective HER catalysts, they are expensive. Therefore, low-cost transition metals such as molybdenum (Mo) and nickel (Ni) have attracted growing attention. This study investigates Mo-Ni thin-film catalysts for the hydrogen evolution reaction (HER), synthesized via DC co-sputtering on silicon and carbon paper substrates. Structural analysis showed that Mo and Ni films were crystalline, while Mo-Ni thin films exhibited partially amorphous or nanocrystalline structures. SEM revealed smoother surfaces in Mo-Ni thin films, and the thickness ranged from 300–700 nm. Electrochemical tests in 0.5 M H_2SO_4 showed a volcano-shaped trend in HER activity with Ni content. The best performance was observed in a film with 72.8 at% Ni, showing an overpotential of 149.0 mV at 10 mA/cm^2 and a Tafel slope of 77.5 mV/dec. Alkaline tests, which in 1M KOH, showed lower overall activity, with the best film (Ni) achieving 171.7 mV. Contact angle measurements confirmed hydrophilic surfaces, aiding electrolyte wetting and gas release. These results highlight the potential of Mo-Ni thin films as efficient, low-cost HER catalysts.

Development of a Sophisticated Cross Over Flow Atomic Layer Deposition Module for High Aspect Ratio Device Application

Dr./Mr. Ching-Chiun Wang[1], Mr. Chun-Hui Wang[2], Dr./Mr. Shih-Chin Lin[1], Mr. Kuan-Yu Lin[1], Dr./Mr. Po-Chun Yeh[1], Dr./Mr. Chih-Hung Liu[1], Dr./Mr. Meng-Chi Huang[1], Dr./Mr. Bing-Shiang Yang[1,3]

[1]Industrial Technology Research Institute, No. 195, Sec. 4, Chung Hsing Rd., Chutung, Hsinchu County 310401, Taiwan (R.O.C.), Taiwan, [2] Asahi-Utou Technology Co., Ltd., 4F.-8, No. 38, Taiyuan St., Zhubei City, Hsinchu County 302, Taiwan (R.O.C.), Taiwan, [3] Department of Mechanical Engineering, National Yang Ming Chiao Tung University, No. 1001, University Road, Hsinchu City 300093, Taiwan (R.O.C.), Taiwan

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

To overcome the scaling limits of NAND flash and fulfill the requirements for next-generation high-density storage, this study developed a sophisticated cross-over flow, low-temperature (<200°C) Atomic Layer Deposition (ALD) module specifically engineered for 3D vertical Memory fabrication. The system employed a dual-zone architecture, integrating an upper Inductively Coupled Plasma (ICP) source for high-density plasma generation with a lower thermal reaction zone optimized for 12-inch wafer uniformity (non-uniformity<2%). Experimental results demonstrated the successful deposition of oxide/oxynitride nanolaminate stacks (≥ 6 layers) within high-aspect-ratio (HAR) structures. Transmission Electron Microscopy (TEM) analysis confirms highly conformal coatings across 3D features with a depth of 6~70 μm and an aspect ratio of 10:1. A remarkable step coverage of ~93% was achieved, with film thicknesses of 42.7 nm at the surface and 39.7 nm at the trench bottom. Furthermore, preliminary evaluations of ultra-high aspect ratio (AR=50) structure samples are underway to define the process limits. Finally, the integration feasibility was validated through the fabrication and electrical characterization of multi-component memory device. By correlating electrical performance with optimized process parameters, this work establishes a standardized, pilot-scale manufacturing framework that meets stringent semiconductor industry specifications for next-generation non-volatile memory.

Study on P-Type β-Ga_2O_3 Epilayers Grown by MOCVD

Chair Prof. Ray Hua Horng[1], Cheng-Han Lee[1]

[1]National Yang Ming Chiao Tung University, , Taiwan

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

β-Ga_2O_3 is a promising ultra-wide-band-gap semiconductor for next-generation power electronics due to its large band gap and high critical breakdown field. However, achieving reliable p-type β-Ga_2O_3 remains a major challenge, which hinders the development of bipolar and homojunction device architectures. Although p-type Ga_2O_3 has previously been demonstrated through phosphorus (P) ion implantation, in-situ doped p-type β-Ga_2O_3 has not yet been successfully realized.

In this work, we demonstrate in-situ P-doped p-type conductive β-Ga_2O_3 epilayers grown by metal-organic chemical vapor deposition (MOCVD) using a P-related precursor. A bilayer structure consisting of 150 nm P-doped β-Ga_2O_3 and 150 nm unintentionally doped (UID) β-Ga_2O_3 was grown on c-plane sapphire substrates. The as-grown sample with a precursor flow rate of 10 sccm exhibited a high sheet resistance of 3.222×10^9 Ω/□. After rapid thermal annealing (RTA) for dopant activation, the sheet resistance was reduced to 6.025×10^6 Ω/□, with a resistivity of 90.38 Ω·cm, a hole concentration of 1.364×10^{17} cm^{-3}, and a mobility of 0.506 $cm^2 \cdot V^{-1} \cdot s^{-1}$. Hall-effect measurements revealed a positive Hall coefficient, confirming p-type conduction. Secondary ion mass spectrometry (SIMS) depth profiling showed that the P signal was predominantly located in the upper P-doped region, while ultraviolet photoelectron spectroscopy (UPS) analysis indicated that the Fermi level was positioned 1.84 eV above the valence band maximum. These results demonstrate the feasibility of achieving MOCVD-grown p-type conductive β-Ga_2O_3 epilayers through in-situ P doping, providing a promising route toward high-quality p-type β-Ga_2O_3 for future bipolar power device applications.

July 15, 2026 | 4:10 PM

Research on thin-film-based micro-nano photonic devices

Professor Shaowei Wang State Key Laboratory of Precision Spectroscopy, East China Normal University

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

This talk presents our group's progress in the design, fabrication, and application of micro-nano photonic devices leveraging optical thin-film platforms. It will first cover our work on perfect absorber that achieve near-unity light trapping across visible to infrared bands. We then highlight our pioneering efforts in integrated micro-cavity-based spectroscopic devices with thin-film stacks. We have realized on-chip spectral splitters and high-resolution spectral sensors. They form the core of our miniaturized spectrometer chips, which offer compact footprint, low power consumption, and CMOS-compatible fabrication, paving the way for portable spectral analysis in environmental monitoring, biomedical diagnostics, and industrial inspection. Furthermore, we discuss the interaction between low dimensional optical gain media (e.g., black phosphorus) and thin-film micro-cavities for developing micro-scale light sources. By integrating thin gain layers with high-Q film-based resonators, we demonstrate tunable, low-threshold lasing and enhanced spontaneous emission, opening avenues for on-chip coherent sources and active photonic circuits.

Research on acoustic tweezers and their manipulation

Siying Lin[1,2], Pao-Hsun Huang[1], Jia Zhou[2]

[1]Jimei University, Xiamen, Fujian 361021, China, China, [2]Fudan University, Shanghai 200433, China, China

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

Sorting highly biased populations of droplets has long been a major challenge in droplet microfluidics, where droplets are often used as independent biochemical microreactor units. One promising solution is the use of acoustic tweezers, which are lab-free, easily miniaturized, and biocompatible manipulation tools. While existing acoustic tweezers have been used to manipulate particles or cell, but the manipulation of water droplets in oil using acoustic tweezer has not been explored. The first challenge is recovering a few water droplets from a large batch is the selective manipulation of water droplets in an oil system. Acoustic tweezers based on the acoustic beam and the acoustic spherical vortex coupled with the liquid can generate 3D focused acoustic beams or 3D acoustic vortex beams, which provide larger acoustic radiation forces and superior manipulation capabilities. In this chapter, we design and preparate novel acoustic tweezers capable of trapping and manipulating single water droplets in oil using integrated focused (W0)/spherical vortexed (W1) acoustic tweezers for the first time. We demonstrate that water droplets smaller than half a wavelength are effectively trapped by acoustic vortices, while larger ones are better captured by focused acoustic beams. This represents the crucial first step in extracting the target water droplet microreactors (positive ones) in an oil system and analyzing their content. Compared to traditional techniques such as FACS, this approach is non-labeled, non-damaging to living cells, highly biocompatible, and sparse. The sampling time is proportional to the number of droplets required and is largely insensitive to the total number of microreactor, making it well suited for large-scale screening assays. This new acoustic tweezer technology can be readily adopted in biological and medical applications, including the precision medicine, single-cell sequencing, and lipid nanoparticle- based therapeutics.

Investigation of a high sensitivity pH sensor based on Graphene oxide/Gallium oxide heterostructure

Professor Shu-Bai Liu[1], Mr. Siao-Yun Cheng[1], **Mr. Bo-Yi Liu**[1], Professor Chia-Hsun Chen[2], Professor Yi-Yen Chen[3]

[1]National Kaohsiung University of Science and Technology. Department of Electronic Engineering, No. 415, Jiangong Rd., Sanmin Dist., Taiwan (R.O.C.), [2]National Formosa University. Department of Electro-Optical Engineering, No.64, Wunhua Rd., Huwei Township, Taiwan (R.O.C.), [3]National Formosa University. Department of Materials Science and Engineering, No.64, Wunhua Rd., Huwei Township, Taiwan (R.O.C.)

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

In this study, a graphene oxide (GO)/gallium oxide (Ga_2O_3) heterostructure is proposed as an interface-engineered sensing film to enhance the pH response of extended-gate field-effect transistor (EGFET) devices. Graphene oxide, featuring a high density of oxygen-containing functional groups such as hydroxyl and carboxyl groups, provides abundant active sites for protonation and deprotonation reactions described by the site-binding model. When integrated with Ga_2O_3, the resulting heterojunction modulates the interfacial charge distribution and electrical double layer (EDL) structure at the electrolyte–oxide interface, leading to enhanced surface band bending and more efficient transduction of chemical potential into electrical signals. The Ga_2O_3 thin film (140 nm) was deposited on indium tin oxide (ITO) glass via RF sputtering, followed by GO modification to form the heterostructure. The sensing film was integrated into an EGFET configuration using a commercial MOSFET and an Ag/AgCl reference electrode, and characterized in buffer solutions with pH values ranging from 2 to 12. The GO/Ga_2O_3 heterostructure EGFET pH sensor exhibits significantly improved sensing performance compared to the pristine Ga_2O_3 EGFET pH sensor, with voltage sensitivity enhanced from 45.6 mV/pH to 59 mV/pH, approaching the Nernstian limit, while maintaining excellent linearity and stable response characteristics. This enhancement is attributed to the combined contributions of increased surface functional group density and strengthened interfacial charge coupling. The proposed heterostructure enables near-Nernstian sensitivity without complex surface functionalization, highlighting a simple yet effective strategy for high-performance EGFET-based chemical sensing.

Scalable Fabrication of Ultrathin Freestanding Oxide Films for Pyroelectric Device Applications

Hanwen Chi[1]

[1]Zhejiang University, Room 1-303, Building 10, Heitongyuan, Zijingang Campus, Zhejiang University, China

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

Recent breakthroughs in ultrathin, single-crystalline, freestanding oxide systems have sparked widespread interest in their potential applications in next-generation commercial devices. However, the large-scale fabrication of such ultrathin oxide films faces significant challenges due to the technological bottleneck of inserting artificial release layers between the epitaxial layers and substrates: (1) wrinkles and damage invariably occur during graphene transfer, compromising epitaxial quality; (2) soluble sacrificial layers suffer from slow lateral etching rates and crack formation, hindering high-throughput, large-scale production; and (3) lattice mismatch issues between the buffer layer, the epitaxial layer, and the substrate remain unresolved, necessitating a universal method for fabricating freestanding oxide films. To address these challenges, we propose an atomic-scale amorphous interface-layer technology to precisely regulate interfacial defects at the epitaxial interface, thereby enabling atomic-scale precision exfoliation of ultrathin oxide membranes.

Pyroelectricity, which refers to the generation of electrical energy in polar materials through temporal temperature changes, exhibits a strong dimensional effect with reduced membrane thickness due to the freestanding effect. Remarkably, the pyroelectric coefficient of ZnO nanomembranes increases dramatically, reaching 207 times that of the bulk when the thickness is reduced to 32 nm. Based on freestanding ZnO single-crystalline nanomembranes, large-scale pyroelectric sensor arrays were fabricated, demonstrating outstanding infrared imaging performance over large areas. This study not only establishes a new paradigm for the high-throughput fabrication of scalable, ultrathin, freestanding oxide systems but also proposes a novel approach for manufacturing cooling-free infrared detectors. These advancements pave the way for potential applications of pyroelectric technology in thermal imaging and energy harvesting.

The role of oxygen vacancies induced by Ag ion implantation in promoting the electrochemical properties of BiVO4

Shilpa Chauhan[1], The role of oxygen vacancies induced by Ag ion implantation in promoting the electrochemical properties of BiVO4 Richa Saini[2], The role of oxygen vacancies induced by Ag ion implantation in promoting the electrochemical properties of BiVO4 Chung Li Dong[3], The role of oxygen vacancies induced by Ag ion implantation in promoting the electrochemical properties of BiVO4 Asokan Kandasami[4]

[1]Upes, Dehradun, India, UPES, Pin Code -248007, Dehradun, India, [2]Gurukul Kangri (Deemed to Be University), Haridwar, Uttarakhand, Haridwar, Pin Code- 249404, Uttarakhand, India, [3]Tamkang University, Tamsui 25137, Taiwan, Tamkang University, Tamsui 25137, Taiwan, Taiwan, [4]Upes, Dehradun, India, Upes, Dehradun, Pin Code -248007, India, India

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

The role of oxygen vacancies induced by Ag ion implantation in promoting the electrochemical properties of BiVO4

Shilpa Chauhan1, Richa Saini2, C.L. Dong3, Asokan Kandasami* 1

1School of Applied Engineering, University of Petroleum and Energy Studies, Dehradun-248007, Uttarakhand, India.

2Department of Physics, Gurukul Kangri (Deemed to Be University), Haridwar, Uttarakhand

3Department of Physics, Tamkang University, Tamsui 25137, Taiwan

Corresponding author Email-*asokaniuac@gmail.com

Abstract

This study investigates the influence of oxygen vacancies induced by Ag- ion implantation on BiVO4 (BVO) thin films. The BVO films were synthesized using pulsed laser deposition and implanted with Ag- ions at fluences of 0, 1×1015, 5×1015, and 1×1016 ions/cm2. Structural analysis by synchrotron-based high-temperature Grazing Incidence X-ray Diffraction (GI-XRD) and Raman spectroscopy confirmed the crystalline monoclinic phase of the thin films. Field emission electron microscopy (FESEM) with EDX was used to assess the surface morphology. Synchrotron-based X-ray Photoelectron Spectroscopy (XPS) provided detailed insights into the electronic structure, confirming the elemental composition and valence states of Bi, V, and O, along with the quantification of oxygen vacancy concentrations, thereby evidencing the chemical stability and electronic interactions within the implanted lattice. Density Functional Theory (DFT) calculations were further carried out to evaluate the electronic band gap and density of states of BiVO4. Photoluminescence (PL) spectroscopy revealed reduced charge recombination rate ovement of oxygen vacancies after

Ag ion implantation. These results demonstrate that Ag ion implantation improves the electrochemical properties of the BVO thin films, with up to 24.69%, transmittance enhancement as confirmed by UV-Vis analysis. This experimental investigation provides valuable insights into the role of oxygen vacancies in enhancing the electrochemical performance of BVO thin films, offering a promising strategy for designing high-performance materials.

Keywords: Synchrotron high temperature GIXRD, Micro Raman Spectroscopy, Synchrotron-based XPS, Bismuth vanadate

Optimization of MoO3 Transparent Electrode by Sputtering Process and Its Application in High-Performance CZT Nuclear Radiation Detectors

Zhaoran Guan[1], Yanggang Jia[1], Xinya Wang[1], Tianzhuo Wang[1], Qingzhi Hu[1], Meng Cao[1,2,3], Haofei Huang[1,2,3], Linjun Wang[1,2,3], Jian Huang[1,2,3]

[1]State Key Laboratory of Materials for Advanced Nuclear Energy, 200444, China, [2]School of Materials Science and Engineering, Shanghai University, 200444, China, [3]Zhejiang Institute of Advanced Materials, SHU, 314113, China

Session 06 - S15: Thin Film Devices (TFD), Seletar3 - Level 3, July 15, 2026, 3:30 PM - 5:45 PM

Establishing high-quality, low-resistance ohmic contacts on high-resistivity Cadmium Zinc Telluride (CZT) crystals while maintaining optical transparency remains a significant challenge for the development of room-temperature nuclear radiation detectors. In this work, pure Molybdenum Oxide (MoO3) thin films were employed as transparent conductive materials. These films were deposited on quartz substrates via RF magnetron sputtering, with systematic optimization of process parameters—including sputtering temperature, duration, power, and pressure—to regulate the film thickness, morphology, and electrical properties.The optimized MoO3 films are rich in oxygen vacancies (Mo5+), resulting in a high work function that aligns well with the energy levels of CZT. To further enhance conductivity, a thin gold (Au) layer was evaporated onto the MoO3 film to form a composite electrode. Current-voltage (I- V) characterization confirms that this composite structure exhibits excellent ohmic contact characteristics. When applied to CZT thin films and crystals, the MoO3/Au transparent electrode effectively enhances carrier transport efficiency while reducing the consumption of precious metal. γ -ray spectroscopic testing on the CZT crystals yielded a clear photopeak at room temperature with superior energy resolution. This study demonstrates that precise control of sputtering parameters enables the realization of low-cost, high-performance MoO3-based transparent ohmic contacts, providing a novel technical pathway for enhancing room-temperature CZT nuclear radiation detectors.

PEALD-grown HfO2-based thin films and their applications in thin film transistors

Xiao-Ying Zhang, Yong-Hao Luo[1], Yi-Fan Tang, Yu-Jiao Ruan, Shui-Yang Lien
[1]Xiamen University Of Technology, No.600 Ligong Road, Jimei District, Xiamen, 361024, Fujian Province, China, , [2]Xiamen Institute of Measurement and Testing, 170 Hubin South Road, Siming District, Xiamen, 361004, Fujian Province, China,
Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

Hafnium oxide (HfO2)-based thin films have attracted widespread attention due to their promising dielectric and electronic properties. In this study, HfO2-based thin films were deposited by plasma enhanced atomic layer deposition (PEALD). The structural, chemical, optical, and morphological properties of the HfO2-based thin films were systematically investigated through spectroscopic ellipsometry, X-ray reflectivity, grazing-incidence X-ray diffraction, X-ray photoelectron spectroscopy, high-resolution scanning electron microscopy, and UV–vis spectroscopy. The electrical properties of HfO2-based thin films were obtained by performing capacitance-voltage measurements on metal/HfO2-based thin film/silicon structures. The integration of the HfO2-based thin films as the dielectrics into indium–gallium–zinc oxide thin film transistors (TFTs) resulted in enhanced electrical performance, which indicates that PEALD-grown HfO2-based thin films could be a promising candidate for high-k dielectric layers in various semiconductor devices, especially in TFTs for display technologies and flexible electronics.

Conformal Ultrathin Metal Films on Curved Substrates: Fabrication and Applications

Professor Heyan Wang[1], Dr. Jianghai He

[1]Harbin Institute of Technology, No.2 Yikuang Street, China

Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

Transparent conductive films, owing to their combination of high optical transparency and excellent electrical conductivity, have become indispensable key materials in modern optoelectronic devices. Mature fabrication techniques, such as physical vapor deposition and solution-based methods, have been widely applied on planar substrates; however, achieving high-quality transparent conductors on curved surfaces remains a significant challenge. This is mainly due to the difficulty in realizing uniform film coverage, nanoscale consistency, and stable optoelectronic performance on non-planar geometries.In this work, we propose a conformal deposition model on curved substrates incorporating metal co-doping, enabling for the first time the fabrication of ultrathin (≤10 nm), highly uniform (±0.5 nm), and ultrasmooth metallic films. This study establishes a new technological benchmark for conformal ultrathin metal films, with optoelectronic performance comparable to that of conventional planar devices. With the addition of an encapsulation layer, the films exhibit an average visible transmittance of approximately 88% and a sheet resistance of about 8.1 $\Omega \cdot sq^{-1}$.Furthermore, the proposed approach can be extended to a variety of optical dielectric materials, enabling high-precision conformal coating on diverse substrates. The results presented here provide a practical and scalable solution for next-generation optoelectronic devices, with potential applications in curved transparent electrodes, three-dimensional opto-microwave integrated devices, and emerging technologies such as advanced smart glasses.

Ultra-Thin Diffractive Axicon Thin-Film Sensor Fabricated by Femtosecond Laser for High-Precision Tilt Angle Detection

Dr Shufan Li[1], Zhixuan Chen[1], Benhua Wu[1], Huatan Chen[2], Jiaxin Jiang[2], Runyang Zhang[2], Gaofeng Zheng[3]

[1]School of Opto-Electronic and Communication Engineering, Xiamen University of Technology, Jimei Li Gong Lu #600, Xiamen, China, [2]School of Mechanical and Automotive Engineering, Xiamen University of Technology, Jimei Li Gong Lu #600, Xiamen, China, [3]Pen-Tung Sah Institute of Micro-Nano Science and Technology, Xiamen University, Siming South Road #422, Xiamen, China

Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

Precise measurement of surface tilt angles and normal vector orientation remains a critical challenge in precision manufacturing, optical alignment, and semiconductor packaging. Conventional approaches, such as laser trackers and multi-probe displacement sensing, are often limited by large system footprints, high cost, restricted accessibility in confined spaces, and sensitivity to environmental disturbances. Moreover, traditional refractive axicons for Bessel beam generation are bulky and introduce lateral beam shifts under tilt, restricting their use in compact systems.

In this work, we present a compact and high-precision tilt sensing method based on a planar diffractive axicon realized as an ultra-thin thin-film lens. The device is fabricated on reduced graphene oxide (rGO) using femtosecond laser direct writing (FsLDW), enabling maskless, high-speed fabrication with sub-micron resolution. This approach yields a lightweight, flexible optical element with a thickness below 100 μm, which can be directly integrated onto target surfaces, overcoming limitations of conventional bulk optics.

The sensing principle relies on wavefront modulation. When illuminated by a collimated beam, the diffractive axicon generates a quasi-Bessel beam with extended depth of focus. Unlike refractive counterparts, the thin-film planar structure introduces negligible lateral beam shift under tilt. Instead, the tilt angle induces a predictable evolution in the beam intensity profile, transitioning from a symmetric central lobe to split lobes and more complex patterns as the angle increases from 0° to up to 30°, while the accuracy achieves an outstanding 0.2°. Quantitative analysis is achieved by extracting key optical features, including central intensity, side-lobe intensity ratios, and spatial symmetry, enabling accurate mapping to tilt angles. The fabricated device achieves a central lobe FWHM of approximately 15 μm, consistent with theoretical predictions.

This fs-laser-fabricated thin-film diffractive axicon offers a perspective non-contact, and scalable solution for high-precision tilt measurement in space-constrained applications.

Manufacturing of thin-film thermocouples on curved surfaces

Mr. Xiaoyi Zhang[1], Professor Jianqin Zhu[1], Professor Lu Qiu[1]

[1]School of Energy and Power Engineering, Beihang University, No. 37, Xueyuan Road, Haidian District, Beijing, China

Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

Due to the thin profile, non-invasive measurement capability, and compatibility with in-situ fabrication, thin-film thermocouples are regarded as a high-precision, low-disturbance temperature sensing strategy. Conventional fabrication methods, such as magnetron sputtering, suffer from limitations including difficulties in miniaturization, stringent material requirements, and poor adaptability to curved surfaces. This paper presents an inkjet-printing-based approach for fabricating thin-film thermocouples. Thermoelectric nanoparticles are uniformly dispersed in a solvent with an ultrasonic dispersion to produce a colloidal ink, which is ejected through a piezoelectric nozzle to form micrometer-sized droplets and deposit a functional coating on the substrate. To address line-deposition non-uniformity, an active control strategy by adjusting binary-solvent ratio and temperature field is employed to suppress “coffee-ring” formation. Furthermore, droplet slipping and stress concentration caused by surface inclination and curvature are mitigated through conformal printing using a five-axis motion system, enabling the fabrication of high-quality, robust thin films. High-performance ITO–In_2O_3 thin-film thermocouples were successfully fabricated on typical curved ceramic substrates (cylinders and cuboids). The resulting films exhibit a thickness below 10 μm, an interfacial adhesion strength exceeding 10 MPa, and a temperature measurement accuracy within 1% over a range up to 800 °C. For metallic curved surfaces, an insulating ink blended with YZA and Al_2O_3 was prepared. A highly insulating and densely packed insulating film was fabricated through multilayer printing, which provides electrical isolation between the functional conductive layer and the metal substrate, thereby preserving the thermoelectric characteristics of the thermocouple. This work provides a high-precision measurement method for surface temperature monitoring of devices, offering an effective solution for thermal protection and management in fields such as electronic chips and aerospace.

July 16, 2026 | 9:40 AM

High-Performance Light-Emitting Transistors with 3D Mesh Source Electrodes Fabricated by Laser Direct Writing Lithography

Qizhen Chen[1], Yuxin Yang, Shui-Yang Lien

[1]Xiamen University Of Technology, No. 600, Ligong Road, Jimei District, China

Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

Light-emitting transistors (LETs) have attracted increasing attention for their potential in flexible displays and integrated optoelectronic circuits. However, conventional LETs often suffer from low charge injection efficiency and limited emission areas due to their planar source electrode structures. In this study, we propose a fabrication strategy for LETs using laser direct writing lithography to pattern three-dimensional mesh source electrodes. The laser direct writing lithography technique offers high-resolution, mask-free patterning, enabling precise control over the geometry and size of the mesh electrode. This design significantly increases the contact area between the electrode and the organic semiconductor, optimizes the local electric field distribution, and enhances charge injection and light emission efficiency. Furthermore, the mesh structure demonstrates excellent mechanical and chemical stability across various environmental conditions. The present work demonstrates that the proposed LET design is a viable candidate for future high-performance flexible displays and integrated optoelectronic applications.

Development of novel γ-In2Se3 thin films based Electrochemical Metallization Random Access Memory

Mr. Satyam Garg[1], Dr. Anjali Sharma[1], Dr. Reema Gupta[3], Prof. Arijit Chowdhuri[4], Prof. Monika Tomar[2]

[1]Miranda House, University Of Delhi - 110007, Department of Physics and Astrophysics, University of Delhi, Delhi – 110 007, INDIA, India, [2]Department of Physics and Astrophysics, University of Delhi, Delhi – 110 007, INDIA, Department of Physics and Astrophysics, University of Delhi, Delhi – 110 007, INDIA, India, [3]Hindu College (University of Delhi), Delhi – 110 007, INDIA, Hindu College (University of Delhi), Delhi – 110 007, INDIA, India, [4]Acharya Narendra Dev College (University of Delhi), Delhi – 110 019, INDIA, Acharya Narendra Dev College (University of Delhi), Delhi – 110 019, INDIA, India, [5]Department of Physics, Miranda House (University of Delhi), Delhi – 110 007, INDIA, Department of Physics, Miranda House (University of Delhi), Delhi – 110 007, INDIA, India

Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

In contemporary digital world, data originating from diverse sources including media, social networks, scientific instrumentation, industrial machinery, defense systems etc., occupies a major chunk of our daily lives. It is envisioned that by the year 2030, over 500 trillion Gigabytes of data would be generated worldwide and each person on this planet would be sharing 60,000 Gigabytes of data. This humongous data volume necessitates development of novel universal memory devices capable of high-speed operation, high-density storage, besides non-volatile characteristics. Electrochemical Metallization Random Access Memory (ECMRAM) represents a particular category of RRAM that relies on resistive switching (RS) induced by the migration of ions of active metals such as silver (Ag) or copper (Cu) through an electrolyte.

In the present study, for ECMRAM application, γ-In2Se3 thin films have been RF sputtered onto Pt-coated SiO2/Si substrates at varied substrate temperatures (RT – 500oC). Analysis of X-ray diffraction, Raman, and PL spectra confirm the formation of γ-phase in In2Se3 thin films deposited at 400 °C and 500 °C and amorphous phase at lower substrate temperatures. Current–Voltage characteristics of the Ag/In2Se3/Pt memristor were investigated from -3 V to +3 V in DC linear double sweep mode. For In2Se3 thin films grown at a substrate temperature of 400 °C, the observed Vset and Vreset were discernably noticed at -1.5 V and 0.9 V with RHRS/RLRS ~ 19 Ω. For the In2Se3 films deposited at 500 °C substrate temperature, the memristor exhibited Vset ~ 0.35 V, Vreset ~ -1.15 V, and RHRS/RLRS ~ 263 Ω. The Endurance characteristics of the memristor were recorded for over 25 cycles. The obtained high RHRS/RLRS ratio for In2Se3 thin films

grown at 500 °C exhibits promising RS characteristics and is therefore identified as a suitable candidate for ECMRAM devices.

Development of Broadband Photodetectors using Semiconductor-based Thin Films

Dr. Y. Ashok Kumar Reddy[1], Dr. Anibrata Mondal[2], Mr. Sourav Deb[1]

[1]Indian Institute of Information Technology, Design and Manufacturing (IIITDM) Kancheepuram, Department of Physics, India, [2]Gachon University, Department of Semiconductor Engineering, South Korea

Session 07 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 8:30 AM - 10:25 AM

In the rapidly shifting paradigm of modern optoelectronics, photodetectors serve as the fundamental nexus between optical signals and electronic intelligence. These components are increasingly critical to the maturation of ultra-high-speed optical communication networks, the miniaturization of integrated nanoelectronics, and the realization of truly autonomous, self-powered sensory ecosystems. However, the transition from laboratory prototypes to commercially viable large-scale deployment is currently hindered by the challenge of achieving high sensitivity across a broad spectral range while maintaining operational efficiency under low-intensity illumination and minimal external bias. To overcome these systemic constraints, this research presents a strategic approach to broadband photodetection utilizing a heterostructured architecture composed of molybdenum trioxide (MoO3) and molybdenum disulfide (MoS2). By meticulously engineering the interface between these two transition metal oxides and dichalcogenides, we exploit their complementary bandgap alignments and synergistic charge-transfer kinetics. A transformation from grain-like to nano-like morphology is observed, accompanied by enhanced crystallinity, a higher surface-area-to-volume ratio of the device, and facilitating superior light-matter interaction and accelerated charge-carrier generation. The obtained figure-of-merit (FoM) values, including photocurrent, responsivity, external quantum efficiency, and detectivity, indicate the successful fabrication of a broadband photodetector for light-harvesting in medical devices.

Electronic synapses based on ZnTiO3 memristors

Mr. Maocheng Liao[1], Dr. Xiaolin Wang[1,2], Mr. Zeren Rong[1], Mr. Yesi Lu[1], Mr. Yuxiang Xv[1], Mr. Wenchao Huang[1], Dr. Xianda Zhou[1], **Professor Zhen Liu**[1]
[1]School of Integrated Circuits, Guangdong University Of Technology, , China, [2]School of Electrical and Information Engineering, Henan University of Engineering, , China
Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

In this work, zinc titanate memristors with a structure of Ag/ZnTiO3/fluorine-doped tin oxide (FTO) sandwich structure was fabricated and studied. ZnTiO3 thin films were fabricated using the sol-gel method and the structural properties were characterized with X-ray diffraction (XRD) and scanning electron microscope (SEM). Through electrical tests on the memristor, good memory performance including a memory window of more than 10^2, retention time of 10^4 s and endurance over 2500 cycles, was obtained. By analyzing the current conduction mechanism, it was revealed that the resistance switching process originates from Ag^+ migration, which leads to the formation and rupture of conductive filaments under applied voltage. Additionally, the synaptic plasticity of the device was investigated, demonstrating its capability for short-term and long-term plasticity, pulse facilitation (PPF) spike-timing-dependent plasticity (STDP), and "learning-forgetting-relearning". These findings indicate that Ag/ZnTiO3/FTO memristor exhibits significant potential in both memristive performance and synaptic functions, providing crucial experimental basis and theoretical support for its future applications in neuromorphic synaptic devices.

From Radical Engineering to Manufacturing: A Complete Technical Roadmap for Nitride Thin Films via Microwave Plasma-Enhanced ALD

Prof. Pao-Hsun Huang[1], Jia-Qi Xu[1], Zong-Yue Li[1], Ruo-Yan Huang[1], Yu-Quan Zhu[2], Zhi-Xuan Zhang[3], Shui-Yang Lien[4]

[1]Jimei University, , China, [2]Southeast University, , , China, [3]Fuzhou University, , , China, [4]Xiamen University of Technology, , , China

Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

Nitride thin films, particularly AlN, are foundational materials for wide-bandgap electronics, RF devices, UV optoelectronics, and advanced packaging. However, scalable fabrication is fundamentally constrained by the trade-off between thermal budget, plasma-induced damage, radical controllability, and wafer-scale uniformity. Addressing these challenges requires a paradigm shift from process optimization toward radical-level engineering.

This invited talk presents a complete technical roadmap for nitride film manufacturing based on microwave plasma-enhanced atomic layer deposition (MPALD). The strategy is structured into three key layers: (i) radical generation and control, enabled by high-density remote microwave plasma and tailored N_2/H_2 chemistry; (ii) radical transport and filtering, achieved through spatial decoupling of plasma and reaction zones to suppress ion bombardment while preserving active species; and (iii) surface reaction and interface engineering, focusing on self-limited growth, impurity suppression, and stress control in AlN films.

In situ optical emission spectroscopy (OES) is integrated as a real-time diagnostic tool to quantify radical species and guide process optimization. This framework enables low-temperature, low-damage, and high-uniformity deposition on large-area wafers, with significant improvements in radical density and process efficiency compared to conventional PEALD.

Finally, the talk discusses the development of dedicated nitride deposition platforms, highlighting system-level innovations in microwave coupling, chamber architecture, and modular integration. These advances point toward next-generation, application-specific ALD equipment for scalable nitride manufacturing.

Realization of asymmetric resistive switching (RS) characteristics in p-NiO/CFO/n-ZnO multilayers for nonvolatile memory applications

Dr Shahnaz Kossar[1]

[1]GNA University Punjab, School of Natural Sciences, GNA University Punjab, India

Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

Realization of asymmetric resistive switching (RS) behavior in p-NiO/CFO/n-ZnO multilayers for nonvolatile memory applications

Shahnaz Kossara*

a*School of Natural Sciences, GNA University, Sri Hargobindgarh, Phagwara-Hoshiarpur Road, Phagwara, Punjab 144401, India

*Email of the Corresponding author:

Shazia.rajput0505@gmail.com

Abstract

In the present research work, the asymmetric resistive switching (RS) behavior was investigated using ferroelectric and transition metal oxide-based multilayered heterojunctions. The multilayered heterostructure consisting of n-ZnO, an intermediate ferroelectric $CuFeO_3$ (CFO) layer, and p-NiO, was deposited using a cost-effective spray pyrolysis technique. The structural and morphological analysis of the deposited heterojunctions validates the formation of a multilayered structure. X-ray photoelectron spectroscopy (XPS) analysis was performed to analyze the electronic states of p-NiO and n-ZnO layers. From XPS analysis, the VO/OL ratio of p-NiO and n-ZnO were calculated, and the value is found to be 0.44 and 1.07, respectively. The p-NiO/CFO/n-ZnO heterostructure was integrated between indium doped tin oxide (ITO, bottom) and silver (Ag, top) electrodes and their RS characteristics were studied. The RS analysis shows nonlinear current-voltage (I-V) behavior with high forward current density, high rectification ratio, and stable endurance. The observed asymmetric RS behavior is attributed to the formation of the polarization-induced ferroelectric/semiconductor heterojunction, which contribute towards charge transport across the interfaces. The obtained self-rectifying RS behavior tends to solve

the sneak path current problem in the conventional memristor crossbar array for memory applications

Keywords: Ferroelectric CFO; n-ZnO; p-NiO; self-rectifying asymmetric resistive switching (RS); polarization;

Process Window and Growth Characteristics of 8-Inch TiN Thin Films by Microwave Plasma-Assisted Atomic Layer Deposition

zongyue Li[1], Pao-Hsun Huang[1], Jia-Qi Xu[1], Shui-Yang Lien[2], Guiying Zeng[1], Haili Huang[1], Siying Lin[1]

[1]Jimei University, , China, [2]Xiamen University of Technology, , , China

Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

In this work, TiN thin films were deposited using microwave plasma-assisted atomic layer deposition (MPALD), which provides a high-density plasma environment with improved radical generation efficiency. The process was systematically investigated by varying the substrate temperature from 100 °C to 500 °C, microwave power from 500 to 800 W, and precursor pulse times. Tetrakis(dimethylamido)titanium (TDMAT) was used as the titanium precursor, and ammonia (NH_3) plasma served as the nitrogen source. The results show that stable and uniform TiN films can be achieved over a wide process window. A growth rate of approximately 0.9-1.5 Å/cycle was obtained, indicating a self-limiting ALD behavior. Increasing substrate temperature enhances film density and reduces impurity incorporation, while higher microwave power improves plasma reactivity and nitrogen radical generation. However, excessive power may lead to increased ion bombardment effects, requiring careful optimization. The precursor pulse time also plays a critical role in achieving complete surface saturation and uniform film growth. High-quality TiN films were successfully deposited on 8-inch silicon wafers, demonstrating good thickness uniformity and scalability. The MPALD process enables improved radical utilization compared to conventional PEALD, contributing to enhanced film properties and process efficiency. The combination of low-temperature capability, controllable plasma conditions, and large-area uniformity makes MPALD a promising technique for next-generation semiconductor manufacturing. This study provides a comprehensive understanding of the growth characteristics and process optimization of TiN thin films using MPALD, and highlights its potential for scalable, high-quality deposition in advanced microelectronic applications.

Optimizing Li3xLa{2/3-x}TiO3 Thin Films deposited on Al2O3 substrate via Physical Vapor Deposition technique for pH Sensor Applications

Thi Thuy Linh Nguyen[1], Zhizhong Li[1], Quoc Nghi Pham[1], Michel Andrieux[1]

[1]Paris-saclay University, , France

Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

High-quality epitaxial growth of thin-film lithium lanthanum titanate (LLTO) is of great interest for solid-state electrochemical devices, including pH sensors. While epitaxial LLTO growth has been widely achieved on cubic perovskite substrates (e.g., STO, LAO), and MgO, reports on Al2O3 are scarce and typically limited to amorphous or poorly crystallized films. In the present study, LLTO epitaxial films were grown on the surfaces of single-crystal Al2O3 (006) by magnetron-assisted Physical Vapor Deposition (PVD), using a lithium-excess (10 mol%) target to compensate for Li volatility during sputtering. This work systematically identified the optimal deposition conditions for LLTO thin films, achieved at a substrate temperature of 675°C, an Ar:O2 flow ratio of 7:1 sccm, and a working pressure of 0.1 Torr. X-ray diffraction confirmed that the LLTO films exhibit out-of-plane (112)/(224) reflections aligned with the Al2O3 (006) substrate, while in-plane φ-scans demonstrated a defined crystallographic registry, consistent with epitaxial growth. Complementary structural and surface interfacial analyses are underway to elucidate the mechanism of the LLTO epitaxial films. Moreover, LLTO films also prepared on single-crystal Al2O3 (1-102), LAO, and MgO (001) substrates exhibit strong texture or partial epitaxy, depending on the substrate symmetry. These results clarify key process–structure relationships governing LLTO by PVD growth and support the development of LLTO-based solid-state electrochemical devices, including pH-sensing. Thus, we also conducted tests measuring electrical and ionic conductivity.

Keywords: LLTO, thin film, PVD, Al2O3 substrate, pH sensor

References:

1. Ohnishi, T.; et al., Chem. Mater. 2015, 27 (4), 1233–1241.
2. Aguesse, F.; et al., Solid State Ion. 2015, 272, 1–8.
3. Bharathi, K. K.; et al., RSC Adv. 2016, 6 (66), 61974–61983.

The influence of performance optimization of W doped MoO3 transparent electrode on the properties of cadmium zinc telluride nuclear radiation detector

Zhaoran Guan[1], Yanggang Jia[1], Xinya Wang[1], Tianzhuo Wang[1], Qingzhi Hu[1], Meng Cao[1,2,3], Haofei Huang[1,2,3], Jian Huang[1,2,3], Linjun Wang[1,2,3]

[1]State Key Laboratory of Materials for Advanced Nuclear Energy, 200444, China, [2]School of Materials Science and Engineering, Shanghai University, 200444, China, [3]Zhejiang Institute of Advanced Materials, SHU, 314113, China

Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

Addressing the challenge of achieving high-quality ohmic contacts on high-resistivity Cadmium Zinc Telluride (CZT) crystal surfaces, this work proposes the use of Tungsten-doped Molybdenum Oxide (W- MoO3) as a transparent conductive contact material. W-MoO3 thin films, with W doping concentrations of 10%, 20%, 30%, and 40%, were deposited onto CZT crystals using radio frequency magnetron sputtering. Their morphology, structure, electrical, and optical properties were systematically investigated. X-ray photoelectron spectroscopy (XPS) revealed that the incorporation of tungsten effectively modulated the electronic structure of the MoO3 film, inducing a transition from Mo6+ to the more conductive Mo5+ state, thereby optimizing the film's work function. Transmission Line Model (TLM) analysis demonstrated that W-doping successfully regulated the conductivity and work function of the MoO3 layer, facilitating the formation of a high-quality ohmic contact with the CZT crystal surface. Compared to the pure MoO3 contact, the optimally doped W- MoO3 contact exhibited a significantly reduced specific contact resistivity. Benefiting from enhanced carrier collection efficiency and high electrode optical transparency, the CZT photodetector utilizing a W- MoO3 interdigitated electrode showed a higher photocurrent-to-dark current ratio. γ - ray spectrum tests, excited by an 241Am source, confirmed that the optimized device demonstrated excellent charge collection capability at room temperature operation, featuring a clear Full Energy Peak (FEP). The energy resolution (FWHM) was remarkably improved compared to a control device using traditional electrodes. This study validates that precise control of W-doping can effectively tailor the conductivity and band structure of the MoO3 layer, achieving the necessary ohmic contact for CZT radiation detectors. The W-doped MoO3 transparent electrode not only excels in electrical and optical characteristics but also exhibits performance matching that of high-resolution detectors in γ - ray spectroscopy, providing a new technical path for advancing the performance of room-temperature CZT detectors.

Low-Hysteresis MoS_2 thin film Transistors with Intrinsic Carrier Switching Enabled by Polymer-Capped Gate Dielectrics

Ms Rupali Srivastava[1], Mr Saurabh Kumar, Mr Srest Somay, Dr Krishna Bharadwaj Balasubramanian

[1]Iit Delhi, Department of Material Science and Engineering, India

Session 08 - S15: Thin Film Devices (TFD), Sembawang - Level 3, July 16, 2026, 10:45 AM - 12:40 PM

A major reliability issue in large area commercial two-dimensional logic devices is unintended excess channel trap carrier density and hysteresis in charge transport in two-dimensional transistors. Currently utilized gate dielectrics including SiOx, Al2O3, and HfO2 have un-passivated interface defects that significantly contribute to mobility degradations, threshold voltage shifts, and hysteresis. In our study, we demonstrate that layers based polymer dielectrics can display a variety of characteristics that are desirable for a 2D FET. We discover that polymide is a straightforward polymer with superior chemical stability, breakdown voltage, and dielectric constants and mobility that are higher than many standard oxides, among a vast class of polymers that may be spin coated and cured over wide regions. We demonstrate through focused experiments and interface conductivity models that a polyimide gate dielectric significantly lowers the density of surface trap sites by three orders of magnitude, nearly eliminating hysteresis in transport characteristics. The molecule's strongly electronegative species drastically eliminates growth-induced electron charge density, converting as-grown N-type material into a P-type semiconductor confirmed by KPFM measurement. The MoS2 FET with PI gate dielectric has improved sub threshold swing, mobility and low leakage current compared to SiO2 as a gate dielectric. Hysteresis is a significant issue that poses significant obstacles to commercial TMD transistor technology. Hysteresis occurred as shift in threshold voltage due to trapping dynamics. We demonstrate how readily back-gated field-effect transistor arrays can be made on substrates coated with polyimide (PI),has drastically reduced the hysteresis. We then developed mathematical interface conductivity model to extract important device parameters such as defect density and trapping and detrapping rates which successfully validate our experimental results. In conclusion, we find that PI dielectric can find multiple applications in places where reduced hysteresis is required as well as places where a p-type two-dimensional layer is required.

Preparation and Properties of NiO Thin Films by Thermal ALD Using $NiCp_2/O_3$

Sir Wei-Jie Tang[1], Sir Yu-Quan Zhu[2], Sir Zhi-Xuan Zhang[3], Sir Ching-Long Wu[4], Prof Shui-Yang Lien[1]

[1]Xiamen University of Technology, , China, [2]Southeast University, , China, [3]Fuzhou University, , China, [4]Xiamen Xinyifang Technology Co., Ltd., , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Nickel oxide (NiO), a typical wide-band-gap oxide semiconductor, is promising for transparent optoelectronic devices, hole transport layers in solar cells, and related optical films because of its chemical stability, optical transparency, and tunable interfacial functionality. To overcome the limitations of conventional deposition methods in thickness control, conformality, and uniformity, NiO thin films were deposited by thermal atomic layer deposition (thermal ALD) using $NiCp_2$ as the nickel precursor and O_3 as the oxidant. Film growth, composition, surface morphology, and optoelectronic properties were characterized by ellipsometry, X-ray photoelectron spectroscopy, scanning electron microscopy, atomic force microscopy, and transmission spectroscopy. The $NiCp_2/O_3$ process showed distinct self-limiting growth and stable deposition at 150–300 °C. Film thickness increased approximately linearly with ALD cycles, although an initial nucleation delay was observed, with an average growth rate of about 0.032 nm/cycle. The deposited films were predominantly cubic polycrystalline NiO and were continuous, compact, and relatively smooth, with a root-mean-square roughness of about 0.545 nm. The films exhibited a visible transmittance of about 70%, a refractive index of about 2.04, an optical band gap of about 3.81 eV, a resistivity of approximately 2.371×10^2 Ω·cm, and a mobility of about 11.246 $cm^2 \cdot V^{-1} \cdot s^{-1}$These results demonstrate precise control of NiO thin films by thermal ALD and support their applications in optical modulation, transparent electronics, and photovoltaic functional layers.

Key words :NiO ; Thermal ALD ; $NiCp_2$; O_3

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Structural and Optical Properties of SnO_2 Thin Films Prepared by Thermal Atomic Layer Deposition

Sir Jin-Bao Liu[1], Sir Yu-Quan Zhu[2], Sir Zhi-Xuan Zhang[3], Sir Ching-Long Wu[4], Prof Shui-Yang Lien[1]

[1]Xiamen University of Technology, , China, [2]Southeast University , , China, [3]Fuzhou University, , China, [4]Xiamen Xinyifang Technology Co., Ltd., , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Tin oxide (SnO_2) thin films are attractive for thin-film transistors, transparent electrodes, and emerging photovoltaic devices owing to their high optical transparency, tunable electrical properties, and good chemical stability. In this work, SnO_2 thin films were deposited by thermal atomic layer deposition (ALD) using tetrakis(dimethylamino)tin(IV) (TDMASn) and ozone (O_3) at substrate temperatures of 50-350°C. The influence of deposition temperature on the growth behavior, microstructure, chemical states, and optoelectronic properties was systematically examined. The TDMASn/O_3process exhibited self-limiting growth in the ALD window of 100-250°C, with a growth rate of 0.8-1.0Å/cycle. The films were amorphous below 150°C, whereas polycrystalline SnO_2 with a tetragonal rutile structure formed at temperatures of 200°C and above. Crystallite size increased with deposition temperature. XPS analysis revealed that Sn was predominantly in the Sn^{4+} state, with an increasing Sn^{4+}/Sn^{2+} ratio as temperature increased, while the oxygen vacancy concentration showed a rise-and-fall trend. All films exhibited an average visible transmittance above 85%, and the optical band gap increased from 3.85 to 4.12 eV. The film deposited at 200°C delivered the best electrical performance, with a resistivity of 8.5×10^{-3} Ω·cm and a carrier mobility of 18.6 $cm^2V^{-1}s^{-1}$. These findings highlight the importance of deposition temperature in tailoring the growth and properties of ALD-grown SnO_2 thin films.

Keywords: SnO_2; Thermal ALD; Substrate temperature; Microstructure; Optoelectronic properties

Optoelectronic Reliability and Degradation Mechanisms of a-IGZO Thin-Film Transistors under Illumination, Bias Stress, and Environmental Atmospheres

Professor Wenqi Zhang[1], Mr. Li-An Cheng[2], Mr. Kuan-Yu Lai[2], Mr. Wei-Cheng (Eric) Wang[1], Mr. Cheng-Ying Lin[2], Mr. Tzu-Hsun Su[2], Prof. Yi-Lin Yang[2]

[1]Cheng Shiu University, No.840, Chengqing Rd., Niaosong Dist., Taiwan, [2]National Kaohsiung Normal University, No.62, Shenjhong Rd., Yanchao District, Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Amorphous indium–gallium–zinc–oxide (a-IGZO) thin-film transistors (TFTs) are widely used in advanced displays and photo-sensors owing to their high electron mobility, transparency, and scalability. However, their electrical stability is sensitive to light exposure, bias stress, and ambient conditions. In this work, the optoelectronic reliability and degradation behaviors of a-IGZO TFTs are systematically investigated under oxygen and vacuum environments, visible/near-UV illumination, and combined bias–illumination stresses.

The devices were fabricated by RF magnetron sputtering and PECVD, and evaluated using illumination stress (IS) and positive bias illumination stress (PBIS) with ultraviolet (365 nm), green (510 nm), and red (650 nm) light sources. The results show a strong wavelength dependence, where shorter wavelengths induce more pronounced threshold-voltage (Vth) shifts and subthreshold swing (SS) degradation. Vacuum conditions significantly aggravate photo-instability due to oxygen desorption and the absence of defect-healing mechanisms, whereas oxygen ambient enables partial recovery through dynamic oxygen re-adsorption. Furthermore, PBIS results in reduced degradation compared with illumination alone, as the applied positive gate bias produces an electric-field shielding effect that confines photo-generated electrons near the front channel and suppresses back-channel reactions. These results provide useful insights into carrier trapping, oxygen-vacancy dynamics, and interface degradation in a-IGZO TFTs under practical operating conditions.

Development of Anti-plasma Corrosion ZrO2-MgO-Y2O3 Composite Films by Sputtering

Mr. Kun-Chun Chiang[1], Yu-Wu Wang[1], Ying-Rong Ho[2], Jung-Jie Huang[2]
[1]National Changhua University of Education, No. 1, Jinde Rd., Taiwan, [2]Asia University, 500, Lioufeng Rd., Taiwan
Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study employed a yttrium (Y) and zirconium (Zr) co-sputtering method to deposit Y_2O_3-ZrO_2 composite films. The composite films formed by yttrium-zirconium co-sputtering were then etched in NF3 plasma for one hour. The surface morphology, crystallinity, and depth distribution of the Y_2O_3 films and the composite films before and after etching were analyzed. Zirconium doping in yttrium oxide can effectively improve its material properties by stabilizing its structure. Zirconium doping helps stabilize the high-temperature phase of Y_2O_3, preventing phase transitions or lattice distortions. Furthermore, zirconium doping can effectively control oxygen vacancy defects because Zr^{4+} replaces Y^{3+}; compensating for oxygen vacancies helps maintain charge neutrality, thereby stabilizing the crystal structure. In addition, zirconium can inhibit grain growth, contributing to the formation of a dense and uniform film structure. This experiment compared the etching rates of pure yttrium oxide and co-sputtered Y_2O_3-ZrO_2 composite films at different zirconium sputtering powers (30, 60, 90, and 120 W). The results showed that at 90 W power, the etching rate significantly decreased from 1.96 nm/min to 0.5 nm/min. XRD analysis indicated that appropriate zirconium doping forms high-density crystal planes, such as (222) and (440) planes. These planes have a close-packed structure and strong binding energy, making them more resistant to etchant erosion, thus significantly reducing the etching rate.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Low-Damage Deposition of AlN Thin Films by Remote Microwave Plasma-Enhanced Atomic Layer Deposition

Mr. Yihui Lin[1], Ms. Jia-Qi Xu[1], Prof. Pao-Hsun Huang[1], Ms. Ruo-Yan Huang[1], Mr. Yu-Quan Zhu[2], Mr. Zhi-Xuan Zhang[3], Mr. Zong-Yue Li[1], Prof. Shui-Yang Lien[4]

[1]Jimei University, , China, [2]Southeast University, , , China, [3]Fuzhou University, , , China, [4]Xiamen University of Technology, Xiamen, , , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Aluminum nitride (AlN) is a key wide-bandgap material for high-power electronics, UV optoelectronics, and advanced packaging due to its excellent thermal and electrical properties. However, thermal ALD requires high temperatures, while conventional PEALD suffers from low plasma density, ion damage, and poor uniformity. In this work, a large-area microwave plasma-enhanced atomic layer deposition (MPALD) system with a 2.45 GHz remote plasma configuration is developed. The system enables high-density nitrogen radical generation while suppressing energetic ion bombardment, allowing low-damage deposition. Trimethylaluminum (TMA) and a nitrogen–hydrogen (N_2/H_2) mixture are used as precursors. Process parameters, including microwave power, gas flow, and pulse timing, are systematically optimized. Optical emission spectroscopy (OES) confirms that the MPALD process produces significantly enhanced nitrogen radical (N*) intensity compared to conventional PEALD. The deposition cycle time is reduced as 800 W power. High-quality AlN films are deposited on 8-inch Si wafers, showing excellent uniformity, near-stoichiometric composition with impurity levels below 1 at.%, and high film density. The films exhibit a refractive index at 632.8 nm, and further testing dielectric constant and breakdown field. These results demonstrate that MPALD enables low-temperature, low-damage, and scalable deposition of high-quality AlN thin films.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Quantum-Inspired Thin Film Based Self-Powered Dual-Band Photodetection on Topological Insulator/p-GaN Heterojunctions

Mr. Rahul Kumar[1,2], Dr. Vishal K. Maurya[1], Dr. Sunil Singh Kushvaha[1,2]

[1]CSIR-National Physical Laboratory, New Delhi, India-110012, Dr KS Krishnan Marg, Pusa, New Delhi-110012, India, [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India-201002 , Ghaziabad, India

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

High sensitive and self-powered ultraviolet (UV) photodetection are the key requirements for applications in space communication, flame sensing, bio-imaging, and environmental monitoring. The integration of topological insulators (TIs) materials with wide-bandgap (WBG) semiconductors offers an effective platform for high-performance UV photodetection due to the efficient carrier transport and strong light-matter interactions. Despite the remarkable electrical and topological properties of TIs (Bi2Se3 and Bi2Te3 etc.), comprehensive and systematic studies of their magnetotransport and photodetection behavior in heterojunctions with WBG GaN remain relatively unexplored. Here, we have deposited Bi2Se3 and Bi2Te3 thin films on p-GaN/sapphire (0001) substrates by magnetron sputtering and investigated their magnetotransport and UV photodetectors (PDs) properties. Raman spectroscopy and high-resolution x-ray diffraction analyses revealed the formation of the rhombohedral crystalline TI thin films, while x-ray photoelectron spectroscopy confirmed their stoichiometric composition. Atomic force microscopy characterizations reveal a densely interconnected surface morphology composed of truncated triangular and hexagonal grain-like structures, indicating well-defined crystalline growth. The magneto-transport analysis reveals weak antilocalization (WAL) in Bi2Se3/p-GaN and Bi2Te3/p-GaN, with the Hikami-Larkin-Nagaoka (HLN) coefficient ‘α’ value of −1.05 and -2 at 2 K. These ‘α’ values indicate two and four decoupled transport channels arising from the topological surface states (TSS) at the top and bottom surfaces for Bi2Se3 and Bi2Te3, respectively. The fabricated metal-semiconductor-metal based Bi2Se3/p-GaN and Bi2Te3/p-GaN UV PDs exhibited self-powered with responsivity of ~1.3×103 and ~5.4×102 mA/W, respectively. Additionally, Bi2Te3/p-GaN-based PD exhibits self-powered operation in the near-infrared region. This remarkable enhancement in PDs performances is attributed to the synergistic effects i.e., strong built-in electric field at heterojunction and TSS of TIs on GaN for the development of next-generation self-powered, and high-responsive broadband photodetection applications.

Modulation Spectroscopy Investigation of Temperature-Dependent Direct-Gap Transitions for Ge1-xSnx/Ge Multiple Quantum Wells on Different Substrates

Yueh-Lin Hsieh[1], Chin-Wen Ruan[2], Bo-Liang Wu[1], Ing-Song Yu[2], Po-Hung Wu[1], Kuo-Chih Lee[3], Hung-Hsiang Cheng[3]

[1]Department of Electrical Engineering/National Dong Hwa University, No. 1, Sec. 2, Da Hsueh Rd. Shoufeng, Taiwan, [2]Department of Materials Science and Engineering/National Dong Hwa University, No. 1, Sec. 2, Da Hsueh Rd. Shoufeng, Taiwan, [3]Center for Condensed Matter Sciences/National Taiwan University, No.1, Sec. 4, Roosevelt Road, Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Group IV elements and their compounds, such as germanium (Ge), silicon-germanium (SiGe), and germanium-tin (GeSn), have attracted considerable attention in optoelectronic research due to their compatibility with existing semiconductor processes. GeSn exhibits a direct bandgap transition above 6% Sn, enhancing photoelectric efficiency. Combined with quantum confinement effect in GeSn/Ge multiple quantum wells (MQWs), it enables the operation beyond 2.0 μm, spanning NIR to mid-IR, making GeSn promising for optoelectronic applications.In this study, GeSn/Ge MQWs on different substrates, including silicon and germanium, were prepared by the technique of molecular beam epitaxy. Then, temperature-dependent modulation spectroscopy techniques, specifically photoreflectance (PR) and piezoreflectance (PzR), were employed to analyze the transitions in GeSn/Ge MQW structures. PR and PzR measurements were performed over the 15–300 K temperature range enabled the clear identification of direct-gap optical transitions within the GeSn/Ge MQWs. The temperature dependence of transition energies originating from the Ge-VS, Ge barrier, and GeSn well layers was analyzed using the Varshni equation, providing quantitative insight into their thermal behavior. Meanwhile, a key finding of this work is that PR measurements maintain high sensitivity to the GeSn well signal even at Sn concentrations below 6% in GeSn/Ge MQWs grown on different substrates. GeSn MQWs grown on Ge substrates exhibit stronger well signals than those grown on Si substrates because of better lattice matching. In addition, the PR signal positions of GeSn wells for different Sn compositions are consistent with theoretical calculations. We also verified that increasing the number of MQW periods enhances the intensity of the GeSn signal observed in PR measurements.With its high sensitivity and reliability, modulation spectroscopy provides a powerful analytical tool for advancing next-generation infrared detectors and integrated technologies, effectively bridging material research and device appli

Keywords: Germanium-tin, molecular beam epitaxy, multiple quantum wells, MQW, modulation spectroscopy, photoreflectance

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Fabrication and Photoelectrochemical Properties of FTO/graphene/CdSe Thin Films

Xinya Wang[1,2], Zhiheng Jiang[1,2], Yanggang Jia[1,2], Meng Cao[1,2,3], Haofei Huang[1,2,3], Jian Huang[1,2,3], Linjun Wang[1,2,3]

[1]State Key Laboratory of Materials for Advanced Nuclear Energy, , China, [2]School of Materials Science and Engineering, Shanghai University, , China, [3]Zhejiang Institute of Advanced Materials, SHU, , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

CdSe semiconductors have attracted considerable attention in the field of photoelectrochemistry due to their suitable bandgap and favorable visible-light absorption properties. However, photoelectrodes based on CdSe commonly suffer from severe charge carrier recombination and low interfacial charge transfer efficiency in practical applications. To address these issues, this work introduces a graphene interlayer between the FTO conductive glass and the CdSe film to construct an FTO/graphene/CdSe composite thin film structure, with a focus on investigating the regulatory role of graphene on the photoelectrochemical performance of CdSe photoelectrodes. CdSe films with different thicknesses were prepared by the close-spaced sublimation method. The morphology, structure, and composition of the films were characterized using scanning electron microscopy, X-ray diffraction, and Raman spectroscopy, while their photoelectrochemical performance was evaluated through photoelectrochemical measurements, electrochemical impedance spectroscopy, and Mott–Schottky analysis. The results show that the introduction of the graphene interlayer significantly enhances both the photocurrent density and stability of the photoelectrode. This improvement is primarily attributed to the role of graphene as an efficient electron transport layer, which effectively reduces the interfacial contact resistance, facilitates the separation and migration of photogenerated charge carriers, and thereby suppresses charge recombination. This work provides an experimental basis for the interface optimization and structural design of CdSe-based photoelectrodes.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Overcoming Leakage and Polarization in CdZnTe Thick Films via a Three-Terminal Electric Field Modulation Architecture

Haofei Huang[1,2,3], Hengzhi Xing[1,2], Ke Tang[1,2,3], Jian Huang[1,2,3], Linjun Wang[1,2,3]

[1]State Key·Laboratory·of Materials for Advanced Nuclear Energy, 99 Shangda Road, China, [2]School of Materials Science and Engineering, Shanghai University, 99 Shangda Road, China, [3]Zhejiang Institute of·Advanced Materials, SHU, 1588 Huaxiang Street, China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Cadmium Zinc Telluride (CZT) thick films deposited via close-spaced sublimation (CSS) offer a highly scalable and cost-effective pathway for large-area, room-temperature X-ray imaging. However, the translation of these thick films into practical devices is fundamentally limited by high dark currents originating from grain boundary defects and the severe polarization effect caused by space-charge accumulation under high-flux irradiation.

To overcome these inherent material bottlenecks without relying on complex purification processes, we propose a three-terminal electric field modulation architecture directly implemented on the CZT thick film. Unlike conventional two-terminal planar detectors, a surface-patterned control electrode is introduced to actively reshape the internal potential distribution. By applying a tailored critical voltage, the control electrode acts as an electrostatic sink, dynamically shunting the defect-induced dark current away from the signal collection terminal. Furthermore, this unique weighting field geometry intrinsically shields the signal electrode from the influence of slow-moving holes, effectively mitigating the polarization effect during continuous exposure.

Consequently, this architecture drastically reduces the baseline dark current by several orders of magnitude, significantly enhancing the signal-to-noise ratio (SNR) and lowering the detection limit, while maintaining long-term operational stability. This work demonstrates that advanced contact engineering and electric field modulation can bypass the intrinsic defect limitations of polycrystalline CZT, presenting a robust framework for next-generation high-sensitivity radiation sensors.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Selenization annealing-regulated structural evolution and photoelectric properties of CZTS films

Dr. Yanggang Jia[1,2], Zhaoran Guan[1,2], Xinya Wang[1,2], Tianzhuo Wang[1,2], Zhen Xu[1,2], Meng Cao[1,2,3], Haofei Huang[1,2], Linjun Wang[1,2,3], Jian Huang[1,2,3]

[1]State Key Laboratory of Materials for Advanced Nuclear Energy, , China, [2]School of Materials Science and Engineering, Shanghai University, , China, [3]Zhejiang Institute of Advanced Materials, , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

CdZnTeSe (CZTS) is a II–VI semiconductor with a wide bandgap and promising photoelectric conversion capability, making it attractive for ultraviolet photodetection and room-temperature radiation detection. In this work, CZT films were deposited on FTO substrates by close-spaced sublimation (CSS) and then converted into CZTS films by annealing in a Se atmosphere. The influence of the selenization process on structural evolution and photoelectric properties was investigated. The results show that the films remain relatively compact after selenization, while obvious Se enrichment and compositional reconstruction occur in the near-surface region. XRD analysis indicates that the selenized films still retain the CZT-based matrix structure, together with CdSe-related surface features, suggesting that Se incorporation induces surface phase evolution. Photoelectric measurements show that proper selenization improves the response to 365 nm ultraviolet light, whereas excessive treatment increases dark current and promotes the formation of surface secondary phases, thereby degrading the overall device performance. These results demonstrate that rational control of the selenization process is an effective way to optimize the near-surface structure and photoelectric properties of CZTS films.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Room-Temperature Ultraviolet Photovoltaic Self-Powered Triethylamine Gas Sensor Based on $Cs_3Cu_2Br_5$/ZnO and ZnO/In_2O_3

Miss Yuqing Tian[1], Ms Xuechun Yang[1], Mr Zheng Jiao[1], Mr Lihao Zheng[2], Ms Zhongmei Teng[2], Miss Xiaofan Li[3], Ms Yun Guo[3]

[1]Shanghai University, , China, [2]Shanghai University, , China, [3]Shanghai University, , China, [4]Shanghai University, , China, [5]Shanghai University, , China, [6]Shanghai University, , China, [7]Shanghai University, , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Currently, self-powered gas sensors have garnered extensive attention in environmental monitoring due to their low power consumption and portability. Nevertheless, they still confront several limitations, including complex fabrication approaches and degraded sensitivity at room temperature. Triethylamine (TEA) is a toxic gas that poses a substantial threat to human health. Herein, a room-temperature ultraviolet (UV) photovoltaic self-powered gas sensor for TEA detection was presented, which adopts $Cs_3Cu_2Br_5$/ZnO and ZnO/In_2O_3 as the light-absorbing layer and electron transport layer, respectively. Under UV irradiation (75 W/m^2), photo-generated carriers on $Cs_3Cu_2Br_5$/ZnO thin film and the carriers generated by adsorption on the ZnO/In_2O_3 gas sensing film are effectively separated, forming an electrical circuit, detecting sensitively 1 ppm TEA at room temperature (25 °C). Gas selectivity tests show that the response intensity of sensor to TEA is at least three times higher than that toward other interfering gases. Moreover, the sensor maintains stable operation in mixed atmospheres and high-humidity environments, with favorable long-term stability. This work provides a novel strategy for designing low-power and room-temperature self-powered gas sensors, presenting promising application prospects in environmental monitoring and air quality assessment.

Key words: Self-powered, ultraviolet photovoltaic, gas sensor, triethylamine

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Analytical Modeling and Performance Optimization of Flexible Multilayer PVDF/TiO2/ZnO Piezoelectric Nanogenerators via Electromechanical Coupling

Associate Professor Yu-Ming Peng[1,2], Student Chen-Bo Cheng[1], Student Yu-Jie Lo[1], Student Wei-Cheng Lin[1]

[1]Asia University, Department of Computer Science and Information Engineering, No. 500, Lioufeng Rd., Wufeng Dist., Taiwan, [2]Asia University, Bachelor Program of Semiconductor, No. 500, Lioufeng Rd., Wufeng Dist, Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

To address the performance limitations of zinc oxide (ZnO)-based piezoelectric nanogenerators (PENGs), including insufficient strain transfer in conventional rigid substrates and the piezoelectric screening effect associated with low-temperature hydrothermal growth, this study develops a one-dimensional composite beam analytical model. Using Python-based numerical evaluation instead of conventional finite element analysis (FEA), the electromechanical optimization mechanisms of a flexible multilayer structure are quantitatively investigated. Replacing the rigid substrate with flexible polyvinylidene fluoride (PVDF) increases the effective strain of the active layer to 2.1%, resulting in a predicted output voltage of 7.85 V. Under the theoretical assumption of ideal interfacial coupling (K = 1.0), which eliminates interlayer slip dissipation, the predicted electric potential further rises to 12.08 V. To reduce the electrical loss caused by internal free carriers in ZnO, a TiO2 buffer layer is introduced to form a TiO2/ZnO heterointerface. The analytical results suggest that this heterointerface suppresses internal carrier loss and improves charge separation efficiency, thereby raising the predicted output voltage to 16.50 V and significantly enhancing the peak power under impedance-matching conditions. These findings reveal the dual enhancement mechanisms of multilayer flexible structures through mechanical strain unlocking and heterojunction-based electrical optimization, and provide a quantitative design guideline for high-performance flexible self-powered sensing devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Flexible and Transparent Solar-Blind Neuromorphic Synapse Based on an a-Ga2O3/ZnO Heterojunction

Haichuan Zhou[1,2], Haofei Huang[1,2,3], Ke Tang[1,2,3], Jian Huang[1,2,3], Linjun Wang[1,2,3], Yibin Wang[1,2], Wei Zhang[1,2]

[1]State Key Laboratory of Materials for Advanced Nuclear Energy, 200444, China, [2]School of Materials Science and Engineering, Shanghai University, 200444, China, [3]Zhejiang Institute of Advanced Materials, 314113, China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Developing neuromorphic devices that integrate optical sensing with synaptic functions on flexible substrates is crucial for wearable and transparent electronics. This work presents a novel flexible and transparent synaptic device based on an amorphous gallium oxide/zinc oxide (a-Ga_2O_3/ZnO) heterojunction for solar-blind ultraviolet (UV) perception. The device features a vertical stack of boron-gallium co-doped ZnO (BGZO) / a-Ga_2O_3 / ZnO / BGZO on a PEN substrate. The a-Ga_2O_3/ZnO heterojunction, central to the design, serves to engineer the interface and band alignment, thereby optimizing carrier transport and confinement for enhanced synaptic modulation. The all-transparent BGZO electrodes and the flexible substrate endow the device with excellent optical transparency and mechanical robustness. Owing to the wide bandgap of a-Ga_2O_3, the device exhibits selective and stable response exclusively in the solar-blind UV region, ensuring strong immunity to ambient visible light interference. Under optical and electrical stimuli, the device successfully emulates fundamental synaptic functionalities, including excitatory post-synaptic current (EPSC), paired-pulse facilitation (PPF), and the transition from short-term to long-term plasticity (STP-LTP). The heterojunction design facilitates more efficient and stable conductance modulation (LTP/LTD) compared to single-active-layer structures. This work demonstrates the significant potential of the a-Ga_2O_3/ZnO heterojunction architecture in developing high-performance, flexible neuromorphic devices for next-generation visible-blind sensing-computing integrated systems.

Carbon Impurity Reduction in Oxide TFTs and Its Impact on Illumination Stability

Mr. Keon Joo Park[1], Dr. Churl Seung Lee[1], **Dr. Byungwook Yoo**[1]
[1]Korea Electronics Technology Institute, #25 Saenari-ro, Bundang-gu,, Republic of Korea
Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Carbon contamination originating from oxide deposition and subsequent photolithography is a critical factor limiting the reliability of oxide thin-film transistors (TFTs), because it modifies surface chemistry, increases interface trap density, and perturbs oxygen-vacancy–related defects. In this study, we integrate a carbon impurity reduction and trap-state stabilization process into oxide TFTs with passivation layer, and evaluate bias-temperature-illumination stress (BTIS) behavior of the resulting devices. The optimized TFTs maintain high field-effect mobility while exhibiting clearly improved BTIS stability, with significantly suppressed threshold-voltage shift under bias conditions.

To clarify the underlying mechanism, three types of oxide semiconductor films were prepared: a reference film, a film subjected to a full photoresist (PR) process, and a PR-processed film additionally treated by a dedicated carbon impurity reduction process. X-ray photoelectron spectroscopy depth profiling at surface, bulk, and bottom regions shows that the PR process decreases the lattice M–O component in the O 1s spectrum, enhances the oxygen-vacancy-related Vo peak, and induces surface segregation of dopant species, while carbon remains confined to the surface. After the carbon reduction process, the surface C 1s level returns to that of the reference, PR-derived oxidized carbon species (C–O, C=O) are effectively removed, and the M–O peak is reinforced, consistent with a photo-assisted cleaning and oxygen-incorporation mechanism. Dynamic SIMS confirms a substantial decrease of near-surface carbon inventory, indicating that the proposed carbon impurity reduction module efficiently cleans both surface and near-surface bulk, which directly translates into improved BTIS stability of oxide TFTs for display applications.

(Acknowledgements)
This work was supported by the Material & Components Technology Development R&D Program (RS-2025-02310308, RS-2024-00436791, RS-2025-02316118) funded by the Ministry of Trade, Industry & Energy (MOTIE) in Republic of Korea.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Controlled Dielectrophoretic Alignment of GaN Nanorods via Electric Field Engineering of Electrode Geometries

Sojung Park[1], Sohyeon Kim[1,2], Sunwoo Lim[1], Seo-Eun Kang[1], Go-Eun Bang[1], Hyeon-Jong Kim[1], Yoon-Sang Lee[1], Hyunsu Kim[2], Kyoung-Kook Kim[1,2]
[1]Department of Semiconductor Engineering, and Research Institute of Advanced Convergence Technology, Tech University of Korea, , , [2]Department of Semiconductor Engineering, Tech University of Korea, ,
Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

GaN-related nanorods (GNRs), which function as nanoscale photonic emitters, are essential for realizing high-performance photonic devices, particularly next-generation display technologies. These nanorods require precise alignment for efficient and stable device operation. Dielectrophoresis (DEP) has been widely used to assemble nanorods between patterned electrodes, such as interdigitated electrodes (IDE), by utilizing forces generated in non-uniform electric fields. However, conventional electrode designs often result in partially aligned or randomly oriented nanorods due to insufficient control over the electric field distribution and gradient.

We propose tailoring the geometry of patterned electrodes to enhance the dielectrophoretic alignment of GNRs. Electrode geometries, including asymmetric configurations, are engineered to modulate the local electric field distribution and gradient near the electrode edges. Such geometric modifications directly influence the magnitude and directionality of DEP forces acting on nanorods. Different electrode geometries are examined to investigate how structural parameters affect the electric field distribution and subsequent nanorod alignment.

The correlation between electrode geometry, electric field distribution, and nanorod alignment behavior is systematically analyzed. This study suggests that engineering electrode geometries is an effective strategy for improving alignment. This approach provides a controllable and scalable method for achieving highly ordered nanorod arrays and offers a practical pathway for fabricating nanorod-based photonic devices. The alignment behavior was investigated using scanning electron microscopy (SEM). The results show that nanorods are preferentially aligned along the electric field direction, particularly near the electrode edges, resulting in well-aligned arrays with improved uniformity.

This work was supported by Korea Institute for Advancement of Technology(KIAT) grant funded by the Korea Goverr -2024-00409639, HRD Program for

Industrial Innovation), and the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea. (No. RS2022-KP002716 Fostering professionals in carbon-free based on energy efficiency by industry of mid-sized companies)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

PEALD-Assisted Fabrication for High-Performance Multifunctional LEDs with Integrated Emission, Photodetection, and Neuromorphic Computing

Qizhen Chen[1], Jingru Duan, Shui-Yang Lien
[1]Xiamen University Of Technology, ,

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Multifunctional light-emitting diodes (LEDs) integrating emission, detection, and neuromorphic computing capabilities hold great promise for next-generation smart optoelectronic systems. However, conventional devices suffer from limited functional integration, poor organic-inorganic interfacial compatibility, and inadequate long-term stability, hindering practical applications. Here, a novel fabrication strategy is proposed that combines plasma-enhanced atomic layer deposition (PEALD) for precise charge transport layer fabrication with a P3HT:CdSe/CdZnS quantum dot hybrid heterojunction. The PEALD technique enables ultra-precise, pinhole-free interfacial engineering, ensuring efficient charge injection and transport while significantly enhancing environmental stability. The resulting device exhibits superior synergistic optoelectronic performance: operating as an efficient light emitter under forward bias while simultaneously functioning as a highly sensitive photodetector and optical synaptic device capable of emulating fundamental synaptic plasticity behaviors. This strategy enables high-level multifunctional integration in single LED architectures, demonstrating the pivotal role of PEALD in fabricating high-performance, stable hybrid optoelectronic devices.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Growth Evolution and p-type Conductivity of Nitrogen Doped Gallium Oxide Films via Supercycle Plasma Enhanced Atomic Layer Deposition

Mr. Chao-Fan Xia[1], Mr. Xin-Fa Chen[1], **Dr. Chia-Hsun Hsu**[1], Dr. Wan-Yu Wu[2], Dr. Dong-Sing Wuu[3], Dr. Chao-Nan Chen[4], Dr. Shui-Yang Lien[1,4]

[1]Xiamen Universiy Of Technology, No. 600, Ligong Rd., Jimei Distinct, China, [2]National United University, , Taiwan, [3]National Chi Nan University, , Taiwan, [4]Asia University, , Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Achieving reliable p-type conductivity in gallium oxide thin films is restricted by deep acceptor levels and strong self-compensation while the full potential of plasma-enhanced atomic layer deposition (PEALD) for effective nitrogen incorporation remains insufficiently explored. In this study, PEALD is employed to grow nitrogen-doped Ga_2O_3 thin films through alternating GaN and Ga_2O_3 sub-cycles at low temperature (250 °C), followed by post-deposition annealing to promote nitrogen diffusion and phase transformation. The GaN sub-cycle thickness is systematically varied, while keeping Ga_2O_3 sub-cycle thickness constant, to elucidate its influence on structural, optical and electrical properties. The experimental results show that a GaN sub-layers thinner than 10 cycles are fully oxidized by subsequent O_2 plasma, resulting in films nearly identical to undoped Ga_2O_3 with negligible nitrogen retention. While further increasing GaN sub-layer thickness facilitates N incorporation, the as-deposited films exhibit only weak conductivity. After annealing, stable p-type conductivity with hole concentrations of (5-9)×10^{15} cm-3 is realized for GaN sub-layer thickness between 20-25 cycles, accompanied by a low surface roughness. Ultraviolet photoelectron spectroscopy and Seebeck measurements further verify the p-type characteristic. Further increasing GaN sub-layer thickness introduces increased surface roughness, excess interstitial defects and increased oxygen vacancies that cause carrier compensation and degrade electrical performance. These findings establish a controllable PEALD approach for nitrogen doping in wide-bandgap oxides and offer new insights into the competitive plasma surface oxidation and nitridation mechanisms during alternating sub-cycle growth for advanced power electronics.

Effects of Deposition and Annealing Conditions on Carrier Mobility and Mechanical Stability of Transparent IZTO Thin-Film Transistors

Hyeon-Jong Kim[1], Min-Woo Park[1], Chang-Yong Kim[1], Sojung Park[1], Yoon-Sang Lee[1], Ji-Hyeong Park[2], Jung-Su Park[2], Kyoung-Kook Kim[1,2]

[1]Department of Semiconductor Engineering, and Research Institute of Advanced Convergence Technology, Tech University of Korea, , , [2]Department of Semiconductor Engineering, Tech University of Korea, ,

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

With the rapid advancement of flexible transparent display technologies, there is an increasing demand for thin-film transistors (TFTs) that exhibit both high optical transparency and mechanical flexibility. Especially, achieving high carrier mobility in transparent oxide semiconductor channels while maintaining stable electrical performance under mechanical deformation remains a critical challenge.

In this study, IZTO thin films used as the channel layer were deposited by RF magnetron sputtering. The film composition and electrical properties were controlled by varying the Ar:O_2 gas ratio and the RF power applied to the ITO and ZnO targets. This approach enables a controlled investigation of the relationship between deposition conditions and carrier transport characteristics. Moreover, the characteristics of post-deposition annealing processes, including rapid thermal annealing (RTA) and furnace annealing, were compared.

The effects of annealing temperature, annealing time, and annealing ambient atmosphere on the carrier mobility of IZTO thin films were analyzed. Furthermore, bending tests were conducted to evaluate the applicability of the devices for flexible display applications, and the variations in electrical performance under mechanical deformation were investigated to assess device reliability.

These results provide insight into the correlation between processing conditions and both electrical and mechanical performance of IZTO-based transparent TFTs, offering practical guidelines for the design of high-performance flexible transparent electronic devices.

XRD analysis confirmed that the a-IZTO layers remained amorphous, demonstrating structural stability after thermal annealing. The fabricated IZTO channel layer exhibited a high field-effect mobility of approximately 30 $cm^2/V{\cdot}s$.

This work was supported by Korea Institute for Advancement of Technology(KIAT) grant funded by the Korea Goverr -2024-00409639, HRD Program for Industrial Innovation), and the Kc nergy Technology Evaluation and

Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea. (No. RS2022-KP002716 Fostering professionals in carbon-free based on energy efficiency by industry of mid-sized companies)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Structural Evolution and Crystallinity of β- Ga_2O_3 Thin Films Deposited by RF Magnetron Sputtering under Controlled Deposition Conditions

Ye-Won Song[1], Chang-Yong Kim[1], Hyeon-Jong Kim[1], Yuyeon Lee[1], Jung-Su Park[2], Ji-Hyeong Park[2], Kyoung-Kook Kim[1,2]

[1]Department of Semiconductor Engineering, and Research Institute of Advanced Convergence Technology, Tech University of Korea, , , [2]Department of Semiconductor Engineering, Tech University of Korea, ,

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Gallium oxide (Ga_2O_3), a semiconductor with an ultra-wide bandgap of approximately 4.5–5.0 eV, has attracted attention as a promising material for next-generation power electronics and ultraviolet (UV) optoelectronic devices due to its high breakdown electric field and excellent chemical stability. Among its polymorphs, the β-phase of Ga_2O_3 is thermodynamically the most stable and can be supplied as single-crystal substrates, making it suitable for high-performance device applications.

In this study, β-Ga_2O_3 thin films were deposited on sapphire substrates using radio-frequency (RF) magnetron sputtering. Key deposition parameters, including substrate temperature and working pressure, were systematically varied to investigate their effects on crystallinity. Crystallization behavior was analyzed by comparing samples deposited at room temperature followed by rapid thermal annealing (RTA) with those deposited at elevated temperatures and subjected to subsequent RTA. The films were characterized using X-ray diffraction (XRD), with full width at half maximum (FWHM) analyzed to evaluate crystal quality. Surface morphology and roughness were examined using scanning electron microscopy (SEM) and atomic force microscopy (AFM). The effects of deposition temperature and working pressure on grain growth, surface morphology, and overall crystallinity were carefully compared. Post-annealing was observed to promote crystallization and the formation of high-quality β-Ga_2O_3 thin films, as indicated by XRD ω-scan analysis showing β-Ga_2O_3 (−402) peaks with FWHM of approximately 24 arcmin.

These results provide insight into the process–structure relationships in sputtered β-Ga_2O_3 thin films and suggest optimized deposition conditions for the fabrication of high-performance power electronic and UV optoelectronic devices.

This work was partly supported by Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No. RS-2024-00398115, Research on the Reliability Challenge and Advanced Network of HPC/AI Semiconductor)

HRD) grant funded by the Korea government(Ministry of Science and ICT) (IITP-2026-RS-2022-00156326, 50) and Carbon Neutrality Specialized Graduate Program through the Korea Environmental Industry & Technology Institute(KEITI) funded by the Ministry of Climate, Energy and Environment(MCEE)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Hydrothermal Synthesis of MXene/WS2 Nanocomposites for High-Performance Supercapacitor Electrodes

Ying-Rong Ho[1], Chao-Nan Chen[1], Yuan-Hsin Cheng[2], Jung-Jie Huang[1]

[1]Asia University, No. 500, Lioufeng Rd., Taiwan, [2]Da-Yeh University, No.168, University Rd., Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study synthesized MXene/WS2 composites via hydrothermal synthesis and further investigated the effects of heat treatment on their structural properties and electrochemical performance through annealing at different temperatures (400, 500, and 600 °C). Results indicate that the hydrothermal reaction successfully grows WS2 in situ on the MXene surface, forming a preliminary heterostructure. Subsequent annealing effectively fine-tunes the material's microstructure and interfacial state without compromising the overall layered architecture. Among these, the 400 °C annealed sample exhibited optimal electrochemical performance, demonstrating higher specific capacitance and superior electrochemical response in both cyclic voltammetry (CV) and constant current discharge (GCD) tests. This performance enhancement primarily stems from the fact that an appropriate annealing temperature increases WS2 crystallinity, reduces interfacial resistance, and strengthens electron transfer and synergistic effects between MXene and WS2. In contrast, excessively high temperatures may lead to degradation of the layered structure. In summary, this study demonstrates that “hydrothermal synthesis combined with moderate post-annealing” is a viable strategy for effectively optimizing the structure and electrochemical performance of MXene-based composite electrode materials.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effect of Annealing Process on the Physical and Electrical Properties of Gamma-Irradiated CdZnTeSe Thin Films

Meng Cao[1,2,3], **Xinrui Li**[1], Yanggang Jia[1], Zhaoran Guan[1], Xinya Wang[1], Tianzhuo Wang[1], Haofei Huang[1], Jian Huang[1,2,3]

[1]State Key Laboratory of Materials for Advanced Nuclear Energy, , China, [2]School of Materials Science and Engineering, Shanghai University, , China, [3]Zhejiang Institute of Advanced Materials, SHU, , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

CdZnTeSe (CZTS) thin films possess both the excellent room-temperature detection properties of CdZnTe materials and the advantages of defect modulation introduced by Se incorporation, exhibiting promising application potential in semiconductor materials for radiation environments. Nevertheless, γ-irradiation can lead to defect accumulation and local structural perturbation, thereby degrading the electrical and optoelectronic response performance of the material. In this paper, CZTS thin films under different γ-irradiation conditions were employed as the research objects, and the effects of annealing treatment at various temperatures on their structure, surface chemical states, defect characteristics and electrical properties were systematically investigated. The results reveal that the main crystalline phase of the thin films remains almost unchanged after γ-irradiation, while lattice distortion, localized structural disorder, changes in the surface chemical environments of Se and Te, as well as enhanced defect-related luminescence are observed. Proper annealing can alleviate irradiation-induced structural disturbance and defect accumulation to a certain extent, and improve the photoresponse behavior of the samples. Specifically, for the sample irradiated at 100 K, after annealing at 400 °C, its photo-to-dark current ratio increases from 6.84444 to 10.85603, which is close to that of the unirradiated sample. It is demonstrated that annealing can effectively repair partial irradiation damage in CZTS thin films and optimize their optoelectronic properties.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Microwave Plasma-Enhanced Atomic Layer Deposition of High-Quality Ga2O3 Films for Solar-Blind Photodetectors

Dr. Yu-Quan Zhu[1], Dr. Zhi-Xuan Zhang[2], Ms Jing Zhang[3], Prof. Ching-Long Wu[4], Prof. Pao-Hsun Huang[5], Prof. Neng Wan[1], Prof. Shui-Yang Lien[3]

[1]Southeast University, , China, [2]Fuzhou University, , China, [3]Xiamen University of Technology, , China, [4]Xiamen Xinyifang Technology Co., Ltd., , China, [5]Jimei University, , China, [6]Southeast University, , China, [7]Xiamen University of Technology, , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Microwave plasma-enhanced atomic layer deposition (MPALD) is a newly developed thin-film equipment and technology for the preparation of high-quality semiconductor films. In this work, gallium oxide (Ga2O3) films were deposited by MPALD on sapphire substrates, and their optical and chemical properties were systematically investigated. The films exhibited a refractive index of 1.84 at 632.8 nm, an optical bandgap of 4.96 eV, a high density of 5.38 g cm-3, and a low oxygen-vacancy ratio of 5.26%, indicating dense and low-defect Ga2O3 layers. Compared with conventional plasma-enhanced atomic layer deposition (PEALD), the MPALD provides a higher-reactive radical reaction environment, which is beneficial for suppressing defect formation and improving film quality. Based on the MPALD Ga2O3 films, metal-semiconductor-metal solar-blind photodetectors were fabricated, showing excellent performance with a dark current of 3.7 × 10-12 A, a photo-to-dark current ratio of 1.49 × 105, a responsivity of 88.96 mA W-1, and fast response/recovery times of 0.18/0.20 s. These results demonstrate that MPALD is a promising emerging technology for the growth of oxide films and the fabrication of high-performance devices.

Key words: Microwave plasma, Atomic layer deposition, Ga2O3, Photodetectors

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Low-Temperature Plasma-Enhanced Atomic Layer Deposition of AlF3 Thin Films for High-Performance Antireflective Coatings

Dr. Jing Zhang[1], Prof. Shui-Yang Lien[1], Prof. Chia-Hsun Hsu[1]

[1]Xiamen University of Technology, No. 600, Ligong Road, Jimei District, Xiamen City, Fujian Province, China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Atomic layer deposition (ALD) has attracted significant attention for the synthesis of low refractive index AlF3 thin films. In this study, we systematically investigated the growth evolution of AlF3 films via plasma enhanced ALD (PEALD) over a substrate temperature range of 100-300 °C to address the challenge of balancing film quality with optical requirements. The experimental results reveal that superior optical performance unexpectedly occurs in the low-temperature kinetically limited regime (100-150 °C), where the films exhibit a loose amorphous structure that reduces the refractive index to 1.35 and yields an average transmittance of 95%. In contrast, films deposited at 200 °C within the ALD saturation window exhibit maximum densification, highest F/Al ratio and minimum roughness, but the resulting higher refractive index degrades the antireflective performance. Higher temperatures (250-300 °C) lead to a significantly increased refractive index (>1.5) due to significant carbon incorporation. The optimized low-temperature film is applied to flexible polyethylene terephthalate substrates, where double-sided deposition reaches the broadband transmittance of 98.5%. This work highlights the advantage of operating in the sub saturated kinetic regime for specific optical applications and provides a robust pathway for fabricating high-performance antireflective coatings on heat sensitive substrates.

Keywords: AlF3, plasma enhanced atomic layer deposition, antireflective coatings

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Influence of Pulsed Laser Annealing on the properties of Ga2O3 thin films and their application in solar-blind photodetector

Miss Yuli Su[1]

[1]Xiamen University Of Technology, 600 Ligong Road, Houxi Town, Jimei District, China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Gallium oxide (Ga_2O_3) is a representative wide-bandgap semiconductor with broad applications. In this work, amorphous Ga_2O_3 thin films were grown on α-Al_2O_3 (0001) substrates at RT using pulsed laser deposition. Highly oriented crystalline Ga_2O_3 thin films were obtained by excimer laser annealing at various laser energy densities. The effects of laser annealing on the properties of Ga_2O_3 film were systematically investigated. The results indicate that laser energy density can effectively modulate the crystallization behavior, surface morphology and oxygen vacancy proprotion. Based on as-grown and annealed Ga_2O_3 films, the MSM solar-blind photodetector were fabricated. And a high performance photodetector can be achieved at a optimized laser energy density. This study provides valuable insights into the controllable fabrication and performance optimization of Ga_2O_3 films and ophotoelectric devices .

Keywords: Ga_2O_3 film laser annealing; laser energy density; film properties, solar-blind photodetector

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Temperature-Driven Growth Mode Transition and Structural Evolution of Highly c-Axis Oriented AlN Films by Microwave Plasma-Enhanced Atomic Layer Deposition

Jia-Qi Xu[1], Ruo-Yan Huang[1], Yu-Quan Zhu[2], Zhi-Xuan Zhang[3], Zong-Yue Li[1], Shui-Yang Lien[4], Pao-Hsun Huang[1]

[1]Jimei University, , China, [2]Southeast University, , China, [3]Fuzhou University, , China, [4]Xiamen University of Technology, , China

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This study presents an innovative microwave plasma-enhanced atomic layer deposition (MPALD) technology, utilizing a custom-built 8-inch wafer system for the fabrication of high-quality aluminum nitride (AlN) thin films. By employing trimethylaluminum (TMA) and 2.45 GHz microwave-excited Ar/NH3 plasma as precursors, a stable, self-limiting growth rate of ~0.08 nm/cycle was achieved. The profound impact of substrate temperature (100 °C – 350 °C) on the microstructural evolution, surface topography, and chemical states was systematically investigated to unveil the optimal thermodynamic growth window. High-resolution X-ray diffraction (XRD) reveals a highly preferred c-axis (002) orientation, with the crystalline quality peaking perfectly at 300 °C: the full width at half maximum (FWHM) narrows to an exceptional 0.4487°, accompanied by minimized internal micro-strain and dislocation density. Atomic force microscopy (AFM) further corroborates that the enhanced adatom surface mobility at this optimal temperature drives an ideal 2D layer-by-layer growth mode, yielding an ultra-smooth surface with a root-mean-square roughness of 1.58 nm. However, elevating the temperature to 350 °C triggers the premature gas-phase thermal decomposition of precursors, resulting in a sudden macroscopic stress transition from tensile to intense compressive nature, along with severe structural and morphological degradation. Furthermore, X-ray photoelectron spectroscopy (XPS) elucidates that the unavoidable oxygen incorporation predominantly exists in two chemical states: lattice oxygen and surface hydroxyls. This work not only provides fundamental defect-dynamics insights into the MPALD growth mechanism of highly oriented AlN films but also establishes a rigorous theoretical basis for optimizing process parameters. The demonstrated sub-nanometer precision and superior uniformity significantly broaden the application potential of MPALD-AlN in advanced microelectronic dielectrics and acoustic wave resonators.

On the role of Al2O3 insertion film in performance improvement of ε-Ga2O3 photodetectors

Mr. CHIHHUNG CHIEN[1], Mrs. Tsai-Yun Chang[1], Dr. Wei-Hsiang Chiang[1], Dr. Anoop Kumar Singh[2], prof. Dong-Sing Wuu[1,2]

[1]National Chung Hsing University, Department of Materials Science and Engineering, 145 Xingda Rd., South Dist., Taiwan, [2]National Chi Nan University, Department of Applied Materials and Optoelectronic Engineering, No. 1, University Rd., Puli Township, Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Gallium oxide (Ga2O3) is an ultra wide bandgap semiconductor with high thermal stability and high breakdown capability, and it has been widely studied for power and optoelectronic devices. In this work, ε-Ga2O3 thin films were deposited on sapphire substrates by metal organic chemical vapor deposition (MOCVD) and subsequently used to fabricate metal-insulator-semiconductor-insulator-metal (MISIM) photodetectors.

Our preliminary observations suggest that surface-related defects become less pronounced as the ε-Ga2O3 film becomes thicker. Specifically, the full width at half maximum (FWHM) decreased from 292 arcsec for the 200 nm film to 208 arcsec for the 1000 nm film, representing a reduction of about 28.8%, while the surface oxygen defect ratio decreased from 6.5% to 3.6%. Therefore, a 1000 nm thick ε-Ga2O3 film was selected for subsequent interface engineering, since this thickness exhibited the smallest FWHM and the lowest surface oxygen defect ratio, indicating improved crystalline quality and reduced defect density. These material characteristics suppress defect-related recombination and leakage pathways, providing a more stable environment for photogenerated carrier transport and improving device reliability. Aluminum oxide (Al2O3) was chosen as the passivation material because of its good chemical stability, excellent insulating property, and ability to reduce surface states and interfacial defects. Atomic layer deposition (ALD) was then employed to grow Al2O3 passivation layers with thicknesses ranging from 2 to 10 nm. Interdigitated electrodes were subsequently deposited on the passivation layer, forming a MISIM photodetector structure.

An optimal Al2O3 thickness suppresses interface trap-related recombination, reduces surface leakage current, and enhances the separation and collection of photogenerated carriers. Conversely, an excessively thick dielectric layer induces carrier-blocking effects and limits photocurrent output. This study aims to investigate variations in overall device performance ind nt passivation-layer thicknesses,

particularly by comparing the effects of different Al2O3 thicknesses on devices based on the optimized ε-Ga2O3 thickness.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Optimization of ε-Ga2O3 thin-film thickness and stack for enhanced polarization and memristive performance

Ms. TSAI-YUN CHANG[1], Mr. Chih-Hung Chien[1], Mr. Wei-Hsiang Chiang[1], Mr. Po-Kai Kung[2], Prof. Dong-Sing Wuu[2]

[1]National Chung Hsing University, Department of Materials Science and Engineering, 145 Xingda Rd., South Dist. Taichung 40227, Taiwan, Taiwan, [2]National Chi Nan University, Department of Applied Materials and Optoelectronic Engineering, No. 1, University Rd., Puli Township Nantou, 54561, Taiwan, Taiwan

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Gallium oxide (Ga2O3) is a promising wide-bandgap semiconductor, and ε-Ga2O3 has attracted particular attention for ferroelectric and memristor applications because of its spontaneous polarization. In this study, ε-Ga2O3 thin films were grown on sapphire substrates by metal-organic chemical vapor deposition (MOCVD). By varying the growth time, the effect of film thickness on surface defects and crystalline quality was systematically investigated. The results showed that increasing the film thickness from approximately 200 nm to 1000 nm significantly improved the overall quality of the ε-Ga2O3 films. Specifically, the full width at half maximum (FWHM) decreased from 292.5 arcsec to 208.4 arcsec, corresponding to a 28.8% reduction, while the oxygen-defect ratio decreased from 6.5% to 3.6%, indicating improved crystallinity and suppressed defect formation in the thicker film.

Under the optimized film-thickness condition of approximately 1000 nm, lateral and vertical memristor devices were subsequently fabricated to evaluate the influence of device architecture on polarization characteristics and memristive behavior. The results revealed that the vertical device exhibited a higher polarization value than the lateral device, with the polarization increasing from 0.018 μC/cm2 to 0.81 μC/cm2, corresponding to a 4400% increase. This result indicates improved polarization switching and is beneficial for ferroelectric and memristive performance. In addition, spike-voltage-dependent plasticity (SVDP) behavior was also improved in the vertical structure, suggesting a more favorable response for neuromorphic operation. These findings indicate that optimization of film quality, substrate-related growth conditions, and device architecture plays a critical role in enhancing the polarization response and memristive characteristics of ε-Ga2O3-based devices. Overall, this study demonstrates that optimization of thin-film thickness and device configuration is essential for improving ferroelectric and memristive performance and highlights the strong potential of ε-Ga2O3 thin films for future non-volatile memory and neuromorphic computing applications.

Low-Static-Power a-IGZO Amplifier Employing Adaptive Biasing and a Double-Bootstrap Load for Flexible Biomedical Sensors

Mr Mayana Yousuf Ali Khan[1], Dr Pydi Ganga M Bahubalindruni[2]

[1]Indain Institute Of Science Education And Research, AB-1C, IISER Bhopal, Bhauri bypass-462066, India, [2]Indain Institute Of Science Education And Research, AB-1C, IISER Bhopal, Bhauri bypass-462066, India

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

This paper presents a low-power double-bootstrapping amplifier on a flexible substrate for wearable biomedical applications using uni-polar (n-type) oxide thin-film transistors (TFTs). The design addresses the lack of stable complementary (p-type) oxide TFTs by employing an active load with capacitive double bootstrapping to achieve enhanced voltage gain by reducing the impact of load transconductance. An adaptive biasing scheme is incorporated to dynamically adjust current levels, enabling low quiescent power consumption with improved signal handling capability. The amplifier exhibits band-pass behaviour, with the lower cutoff frequency tunable to the millihertz range via a bootstrapping capacitance, making it suitable for analog front-end applications in wearable biomedical devices meant for continuous physiological monitoring. The circuit shows a power consumption of $\approx$ 15 µW with a bandwidth of 1 mHz to 250 kHz at a supply voltage of 2 V, demonstrating suitability for battery-powered wearable systems.

Achieving Over 390mV Open-Circuit Voltage in Co-sputtered AgBiS2 Thin-Film Solar cells via Substrate heating

Nuri Na[1], Suwhan Kim[2], Jongsung Park[1,2]

[1]Gyeongsang National University Department of Energy Systems Engineering, , South Korea, [2]Gyeongsang National University Future Convergence Technology Research Institute, , South Korea

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

In this study, the absorber layer of $AgBiS_2$ solar cells was fabricated using a co-sputtering process combined with substrate heating. The co-sputtering process is advantageous for mitigating localized atomic composition inhomogeneity, and since the process occurs in a vacuum environment, it enables the formation of relatively high-purity thin films. Substrate heating can contribute to reducing grain size increase and composition deviation during thin film growth. The $AgBiS_2$ solar cells fabricated by this process exhibited a relatively high open-circuit voltage (Voc), and the grain size of the absorber layer was observed to be in the range of approximately 300–400 nm. Furthermore, EDS analysis confirmed an Ag:Bi:S ratio of approximately 28:28:42, verifying the formation of a film with reduced compositional variation. These results demonstrate the feasibility of fabricating $AgBiS_2$ absorber layers under co-sputtering and substrate heating conditions, suggesting potential for efficiency enhancement through further optimization of process parameters and device structure control.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Improvement of compositional uniformity and performance of $AgBiS_2$ thin films through sequential Bi_2S_3/Ag_2S sputtering and sulfidation processes

Nayeong Kwon[1], Suhwan Kim[2], Jongsung Park[1]

[1]Department of Energy Systems Engineering, Gyeongsang National University, , South Korea, [2]Gyeongsang National University Convergence Future Technology Research Institute, , South Korea

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Thin-film solar cells have faced persistent limitations in long-term stability and large-area processing because of the toxicity of absorber materials, the use of scarce elements, and performance variations arising from process conditions. $AgBiS_2$ is an environmentally benign semiconductor composed of non-toxic elements and is considered a promising absorber for single-junction solar cells because of its band gap of approximately 1.3 eV and high absorption coefficient. However, most $AgBiS_2$ solar cells have been fabricated by solution processing, where difficulties in composition control and variations in film quality have limited device performance and reproducibility.

In this study, a sputtering-based process with high controllability was employed to improve the compositional uniformity and reproducibility of $AgBiS_2$ thin films. Stacked Ag–Bi–S precursor films were prepared by sequential sputter deposition using Bi_2S_3 and Ag_2S targets, and the Ag:Bi compositional ratio was systematically tuned by controlling the deposition sequence and deposition time of each layer. This approach provides a wider composition-control window than conventional single-step processing. After deposition, sulfurization in a tube furnace was introduced to promote elemental redistribution and phase formation. Under optimized sulfurization conditions, the compositional non-uniformity originating from the initial stacked structure was alleviated, resulting in $AgBiS_2$ thin films with improved crystallinity and grain growth.

The prepared films were incorporated into NIP-structured solar-cell devices, and the photovoltaic properties were comparatively analyzed as a function of process conditions. The open-circuit voltage (Voc) and short-circuit current density (Jsc) showed trends associated with composition control and film crystallinity. Structural, chemical, and optical properties were evaluated by XRD and SEM-EDS analyses. These results indicate that sputtered $AgBiS_2$ thin films are promising absorber materials for thin-film photovoltaic applications requirin roducibility.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Air-liquid interface self-assembly of ZnO particles for c-axis oriented buffer layer toward GaN blue LED on glass substrate

Seongyeon Jeong[1], Air-liquid interface self-assembly of ZnO particles for c-axis oriented buffer layer toward GaN blue LED on glass substrate Rikyeong Hong[1], Air-liquid interface self-assembly of ZnO particles for c-axis oriented buffer layer toward GaN blue LED on glass substrate Dongwon Shin[1]

[1]Korea Institute Of Energy Technology, 21, Kentech-gil, South Korea

Poster Session - S15: Thin Film Devices (TFD), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

GaN-based blue LEDs are essential components in solid-state lighting and display technologies. Conventionally, single-crystal sapphire substrates have been required for epitaxial GaN growth, offering excellent crystallinity and thermal stability. However, their high cost and limited scalability present significant barriers to large-area applications. Glass substrates offer a cost-effective and scalable alternative, but their amorphous structure prevents direct GaN nucleation, necessitating an intermediate buffer layer.

ZnO is a near-ideal buffer material, sharing the wurtzite crystal structure with GaN and exhibiting a lattice mismatch of only approximately 1.8%. While c-axis oriented ZnO films have been achieved via sputtering and MOCVD, these vacuum-based techniques require complex infrastructure and considerable energy. In this work, we present a low-cost, vacuum-free approach to fabricate a c-axis oriented ZnO particle monolayer on glass via air-liquid interface self-assembly.

ZnO particles (~1 μm diameter) were dispersed at 0.1 mg/mL in a toluene/o-xylene binary solvent with oleic acid as a stabilizing ligand. The dispersion was spread onto a diethylene glycol subphase, which provides an immiscible, flat interface for self-assembly. As the solvent evaporated, capillary forces and ligand-mediated interactions drove the particles into a densely packed, ordered monolayer, subsequently transferred onto a glass substrate under ambient conditions without vacuum or high-temperature treatment.

SEM confirmed a stable hexagonal close-packed arrangement over 0.565 cm^2 with predominantly monolayer coverage and minimal structural defects. XRD revealed a dominant (0001) diffraction peak, confirming preferential c-axis orientation perpendicular to the substrate — a critical prerequisite for subsequent GaN nucleation. These results demonstrate that air-liquid interface self-assembly enables precise crystallographic control over macroscopic areas without expensive equipment. GaN deposition onto the ZnO buffer layer via sputtering is currently underway. If validated, this approach could substantially reduce LED fabrication costs and enable large-area, glass-based optoelectronic platforr

Carbon Nanomaterials and Progress Toward International Standardization

Professor JOHN HONG[1]

[1]Kookmin University, 77 Jeongneung-ro Seongbuk-gu, South Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Carbon nanomaterials represent a promising class of materials for energy and electronic applications. While there are many potential applications and real commercial products, evaluating the quality of these materials requires globally agreed-upon analytical tools and standardization to guarantee their properties. In this presentation, two important non-destructive analytical techniques currently being advanced toward ISO/IEC standard publication will be discussed such as UV-Vis spectroscopy, proposed as a standardized method for characterizing graphene oxide (GO) and reduced graphene oxide (rGO), and coherence scanning interferometry (CSI), proposed for the surface characterization of graphene films. These standardization efforts aim to establish reliable and reproducible quality assessment protocols for carbon nanomaterials.

Laser-Based Manufacturing for Multi-functional Robotic Skins in Extreme Environments

Mr. Minchang Choi[1], Mr. Jeseong Lee[1], Mr. Jongmoon Choi[1], **Professor Bongchul Kang**[1]
[1]Kookmin University, , South Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Recent advancements in robotics have expanded their operational domains into extreme environments, such as disaster zones, deep sea, and outer space. To ensure the reliability and survivability of robots in these harsh conditions, developing "functional robotic skins" has become a critical technical requirement. This task involves creating complex multi-scale surface structures on diverse materials to achieve both high-durability protection and enhanced perception capabilities. Traditional semiconductor-based processes, such as deposition, lithography, and etching, face significant limitations in productivity and cost-efficiency for large-area fabrication. Furthermore, existing equipment often struggles to manage process inconsistencies, hindering stable quality control. To address these challenges, this study proposes a laser-based manufacturing platform for bottom-up processing techniques. By precisely controlling laser-material interactions, we realize multi-functional surface structures with high fidelity. This research provides an innovative processing solution for next-generation robotic components, offering a scalable manufacturing framework for advanced surface engineering in extreme environments.

Acknowledgement
This work was supported by the National Research Foundation of Korea (NRFK) grant funded by the Korea government (MSIT) (No. 2023R1A2C1005445, No. RS-2025-02223634). This research was also supported by the Machinery Equipment Industry Technology Development Program funded by the Korea Ministry of Trade, Industry and Energy (MOTIE) (No. RS-2024-00446120).

July 15, 2026 | 1:50 PM

Flat Object Handling Technology Based on Controllable Adhesion

Prof. Jaekang Kim[1]

[1]Kookmin University, , South Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Adhesion-controlled object handling technologies are gaining increasing attention for industrial applications, driven by advances in controllable adhesion technologies. They can be utilized in the transfer of flat objects, such as glass panels, metal sheets, and semiconductor wafers. However, achieving both reliable gripping and consistent release of the flat objects remains challenging due to variations in surface roughness, surface energy, contamination, and peeling-induced instabilities. These factors have limited the practical adoption of adhesion-based handling systems, despite their strong performance in laboratory settings. This presentation introduces two representative approaches for adhesion-controlled flat object transfer: dry-adhesion-based and electroadhesion-based methods. For dry adhesion, we examine the effects of microstructure design, contact configuration, operational conditions, and material properties on adhesion performance and transport reliability. For electroadhesion, we highlight the importance of actuation protocols, including voltage application and removal sequences, in addition to electrode and dielectric design, in controlling adhesion strength, variability, and surface sensitivity. Based on these findings, we provide design guidelines for stable operation under practical conditions and offer a framework for selecting appropriate adhesion control strategies to enable scalable and reliable implementation in industrial processes.

Acknowledgment: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2025-00516998, RS-2025-02223634)

Eutectic Gallium Indium Composite for Next-generation Wearable Biosignal Monitor

Minwoo Kim[1], Yeongju Jung[1]

[1]Kookmin University, 77, Jeongneung-ro, Seongbuk-gu, Seoul, Republic of Korea, South Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Hypertension is a widespread global health problem affecting billions of people, yet only a small fraction of patients achieve adequate control of their condition. While several non-clinical blood pressure monitoring devices are commercially available, their bulky and rigid form factors limit user convenience and make them unsuitable for continuous, long-term use. As a result, they are poorly suited for capturing blood pressure fluctuations associated with daily activities and lifestyle-related physiological changes, which may ultimately contribute to serious cardiovascular complications. Continuous monitoring in real-world settings is therefore critical for both the prevention and management of blood pressure-related disorders. In this work, we present a soft, compact system for continuous blood pressure monitoring based on laser-sintered liquid metal conductors, which combine metallic conductivity, mechanical stretchability, and biocompatibility. Owing to their high sensitivity to pulse-induced deformation and their conformal contact enabled by intrinsic fluidity, these conductors can simultaneously acquire electrical and mechanical cardiac signals to provide continuous blood pressure readouts. Importantly, the system operates non-invasively and does not require auxiliary components such as an inflatable cuff. As a demonstration, continuous cardiac activity was tracked before and after exercise, including the recovery period. This platform offers a promising approach for meeting the growing demand for practical cardiovascular monitoring technologies in daily life.

RS-2025-02223634

July 15, 2026 | 2:20 PM

Molten Lithium-Induced Gradient Copper Sulfide Interphase for Long-Cycle Lithium Metal Batteries

Mr. Min Kyeong Kim[1], Ms. Jiye Yoon[1], Prof. John Hong[1]

[1]Kookmin University, Seoul 02707, South Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Lithium metal batteries (LMBs) have attracted tremendous attention as next-generation energy storage systems owing to their exceptionally high theoretical specific capacity and low electrochemical potential. Despite their great promise, the widespread practical application of LMBs remains critically hindered by persistent challenges, including non-uniform lithium deposition and the formation of an unstable solid electrolyte interphase (SEI). These issues collectively lead to poor cycling stability, low Coulombic efficiency, and serious safety concerns, all of which must be addressed before commercialization becomes feasible. In this work, we propose a gradient sulfide interphase engineering strategy based on molten lithium infusion into copper sulfide current collectors. The infusion process induces a compositionally graded sulfide layer on the collector surface, establishing a smooth transition in both chemical composition and ionic conductivity. This gradient architecture plays a dual role: it effectively homogenizes lithium-ion flux across the electrode surface to suppress localized Li deposition, while simultaneously serving as a robust protective barrier against electrolyte decomposition and interfacial degradation. Electrochemical evaluations confirm that the engineered current collectors deliver significantly enhanced performance compared to bare copper counterparts. At a current density of 1 mA cm–2 with an areal capacity of 1 mAh cm–2, the modified electrode achieves an exceptional cycling lifespan exceeding 2,500 hours, demonstrating remarkable long-term durability. The improved performance is attributed to the synergistic effect of stabilized interfacial chemistry and uniform Li+ distribution enabled by the gradient interphase design. This study demonstrates that gradient interfacial engineering via molten lithium infusion represents a practical and scalable approach to fundamentally resolving the interfacial instability of lithium metal anodes, offering a promising direction for the development of next-generation high-performance lithium metal batteries.

July 15, 2026 | 2:35 PM

Multiscale Surface Coating Approaches for Durable and Scalable Anti-Icing Properties

Ph.d. Yujin Jeon[1], Ph.d. Sumit Barthwal[1], M.S. Student Hyeonwoo Son[2], Professor Si-Hyung Lim[3]

[1]Nanomechatronics Lab, Kookmin University, Seongbuk-gu, Korea, [2]Department of Mechanical System Engineering, Seongbuk-gu, Korea, [3]School of Mechanical Engineering, Kookmin University, Seongbuk-gu, Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

Key Words: Anti-icing, Surface coating, Photothermal effect, Phase-change surface, Superhydrophobicity, Durability

Ice accretion on aerospace and industrial surfaces under cold and humid environments poses critical threats to the performance, safety, and reliability of UAV, UAM, and energy infrastructure systems. Supercooled water droplet impingement remains one of the most challenging icing mechanisms to mitigate through conventional approaches, motivating the development of energy-efficient and scalable anti-icing surface coating technologies. This presentation introduces three representative surface engineering strategies currently pursued within our research group, each addressing distinct aspects of anti-icing functionality. The first strategy involves superhydrophobic passive surfaces, where hierarchical micro–nano structures combined with low-surface-energy coatings are employed to delay ice nucleation and reduce ice adhesion strength. The second focuses on photothermal active surfaces incorporating carbon-based nanomaterials, which enable efficient solar-to-thermal energy conversion for de-icing without external electrical power. The third explores phase-change slippery surfaces, in which lubricants infiltrated within porous substrates promote rapid ice detachment through interfacial mobility and lubricant phase transition behavior. Each strategy is independently developed and validated to demonstrate prolonged freezing delay, low ice adhesion, and durable performance under repeated icing–deicing cycles, mechanical stress, and large-area fabrication. The effectiveness of these surfaces is further assessed under realistic icing conditions, including wind tunnel experiments simulating supercooled droplet impingement, confirming meaningful suppression of ice accretion and mitigation of ice growth. Collectively, these research efforts represent a broad design perspective on next-generation anti-icing technologies, spanning passive, active, and interfacial approaches. The outcomes offer practical relevance for aerospace structures and broader engineering systems operating in harsh icing environments.

acknowledgement: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2025-02223634).

July 15, 2026 | 2:50 PM

Non-Visual Object Recognition via Active Exploration with Thin-Film Multimodal Sensory Integration

Mr. Seounghoon Jung[1], Dr. Yeongseok Lee[2], Prof. Si-Hyung Lim[3]

[1]Department of Mechanical Engineering, Kookmin University, , Republic of Korea, [2]Nanomechatronics Lab, Kookmin University, , South Korea, [3]School of Mechanical Engineering, Kookmin University, , South Korea

Session 05 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 1:20 PM - 3:05 PM

In the field of robotics, object identification in environments with limited or no visual information remains a significant challenge. In this study, we present a preliminary framework for a non-visual cognitive system that aims to recognize objects by integrating tactile, acoustic, and olfactory sensory information obtained through active exploration. The primary objective of this work is to establish an experimental platform and evaluate the feasibility of multimodal sensory fusion in visually constrained environments. The proposed system consists of a robotic hand integrated with multiple sensing modules, including tactile sensors, acoustic sensors, and gas sensors. These sensing components incorporate thin-film or thin-film-enabled structures, such as flexible tactile layers, membrane-based acoustic elements, and functional sensing films for gas detection. During interaction, the robotic hand performs exploratory actions such as reaching, pressing, rubbing, and tapping, generating diverse sensory signals. Tactile sensing is expected to provide information on contact states, compliance, and local geometry, while acoustic responses induced by contact may reflect material properties such as texture and stiffness. In addition, olfactory sensing offers complementary information by detecting volatile compounds in the surrounding environment. Since each sensing modality captures different aspects of the target object, their integration is expected to yield richer representations than single-modality sensing. In this work, we focus on system configuration, sensor integration, and initial data acquisition strategies, and explore preliminary approaches for coordinating and fusing multimodal sensory data. This study is motivated by application scenarios where visual perception is limited or unreliable, including dark, occluded, or hazardous environments.

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2025-02223634).

July 15, 2026 | 3:30 PM

Ultrafast Flame Synthesized CuRu and NiFe Catalysts for Alkaline Water Electrolysis

Donggeun Eom[1], **Mr SangWook Park**[1]

[1]Seoul National University, 1, Gwanak-ro, Gwanak-gu, South Korea

Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

Achieving carbon neutrality depends heavily on hydrogen production via water electrolysis, yet the shift to large-scale application requires electrocatalysts that offer high activity and durability, with minimal precious-metal use and scalable fabrication. Traditional production techniques such as hydrothermal synthesis, electrodeposition, and furnace annealing are often hindered by lengthy processing times and high energy requirements, limiting their industrial viability. Herein, we introduce a flat-flame synthesis approach that facilitates the second-scale manufacturing of nanostructured electrodes for alkaline water splitting. By utilizing a stabilized two-dimensional flat flame, molecular precursors are instantaneously converted into porous, mechanically robust catalytic layers on Ni foam. This method eliminates the need for post-annealing and triggers the rapid growth of nanoscale features. The flame-synthesized CuRu cathode features an ultra-low Ru loading of merely 36.4 ug/cm2 while exhibiting exceptional hydrogen evolution reaction (HER) performance. It reaches overpotentials of only 106 mV and 134 mV at high current densities of 500 mA/cm2 and 1 A/cm2, respectively. Furthermore, a NiFe anode was fabricated using the same rapid platform to conduct full-cell tests. The integrated alkaline electrolyzer (CuRu||NiFe) achieves a current density of 500 mA/cm2 at a low cell voltage of 1.671 V, maintaining stable operation for 50 hours. This ultra-fast, energy-efficient flame synthesis platform offers a scalable trajectory toward precious-metal-lean electrodes capable of sustaining industrial-grade current densities, providing a transformative route for next-generation alkaline water electrolysis.

July 15, 2026 | 3:45 PM

AI-Driven Additive Manufacturing and Packaging for TF-SOFC Integrated Drone Systems: Toward High-Endurance, Scalable Tactical Platforms

Prof Yong-Jin Yoon[1]

[1]Department of Mechanical Engineering,Korea Advanced Institute Of Science and Technology (KAIST), 34141, South Korea, [2]School of Mechanical and Aerospace Engineering, Nanyang Technological University (NTU), 639798, Singapore, [3]Department of AX, Korea Advanced Institute Of Science and Technology (KAIST), 34141, South Korea

Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

Modern autonomous systems increasingly require rapid production and high-density energy sources, such as Thin-Film Solid Oxide Fuel Cells (TF-SOFCs), to ensure extended mission endurance. This presentation by Prof. Yong-Jin Yoon introduces an AI-driven additive manufacturing (AM) and packaging framework designed for the on-demand production of TF-SOFC integrated drone platforms. While AM offers flexibility, maintaining the interfacial integrity and reliability of thin-film layers during integration remains a critical challenge.

Thin presentation addresses these limitations through four integrated pillars. First, generative design optimizes drone structures to integrate TF-SOFC modules for both electrochemical performance and flight durability. Second, autonomous process optimization leverages machine learning to capture high-dimensional relationships in thin-film deposition, ensuring consistency. Third, in-situ monitoring uses real-time AI to detect and correct defects like delamination or micro-cracks during fabrication. Finally, a distributed micro-factory architecture enables localized production from digital blueprints. The presentation highlights advancements in data-efficient learning and high-dimensional thin-film process modeling developed within Prof. Yoon's research group. By integrating AI and thin-film innovation, this research enables a direct transition from digital specifications to scalable, high-endurance physical systems for next-generation autonomous platforms.

July 15, 2026 | 4:00 PM

Thermoreflectance-Based Thermal Characterization for Semiconductor Devices and Packaging

Prof. Jungwan Cho[1]

[1]Sungkyunkwan University, 2066 Seobu-ro, South Korea

Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

Pump-probe thermoreflectance techniques are ubiquitously used for measuring thermal properties, such as thermal conductivity and thermal boundary resistance, of a broad variety of thin films and bulk materials. Time- and frequency-domain thermoreflectance (TDTR and FDTR, respectively) are the two most popular implementations of pump-probe thermoreflectance techniques, while steady-state thermoreflectance (SSTR) is a recent extension of FDTR in the low frequency limit. This talk will summarize our efforts using these techniques to measure thermal properties for a variety of the most compelling contemporary electronic devices and packaging technologies, with emphasis on the governing length scales of these techniques. One example is composite diamond-GaN substrates for wide bandgap power semiconductor devices, in which the density of defects and grain boundaries in the near-interfacial diamond complicates phonon transport analysis and data extraction using thermoreflectance techniques. Another example is heterointegration of ultrawide bandgap Ga2O3 with high-thermal-conductivity substrates such as SiC and diamond, where the intrinsically low thermal conductivity of Ga2O3 poses a significant challenge to thermal management of devices composed of it. Furthermore, specific attention will be given to the ability of these techniques to create spatially resolved thermal property areal maps or images, particularly promising for advanced packaging applications.

Direct Laser Writing of CuOx Nanoparticle Inks: Reductive Sintering for Functional Thin Film Fabrication

Professor Daeho Lee[1]

[1]Gachon University, 1342 Seongnamdaero, Sujeong-gu, South Korea

Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

Direct laser writing (DLW) of solution-processed nanoparticle thin films offers a photolithography-free route to fabricating low-cost, customizable metal and metal oxide electrodes. The highly localized thermal profile generated by focused laser irradiation makes this approach well-suited for flexible substrate applications. Early demonstrations of DLW focused on noble metal nanoparticles such as Au and Ag, which maintain oxidation resistance at the nanoscale. The technique has since been extended to metal oxide nanoinks, where functional additives including reducing agents and dispersants enable in-situ conversion of metal oxides to their metallic states under ambient conditions. Beyond simple reduction, fine-tuning of laser parameters provides deliberate control over physical and chemical defect structures within metal oxide films, yielding semiconductor properties that are not readily accessible through conventional thermal annealing. Laser treatment can also produce surface morphologies that are difficult to replicate with traditional heat-based processing. In this presentation, I will discuss recent work on DLW applied to CuOx nanoink-based thin films, with emphasis on how laser processing conditions govern film microstructure and functional properties.

(This research was financially supported by the National Research Foundation of Korea (NRF) grant funded by the Korean Government (MSIT) (RS-2024-00352425, RS-2025-02223634).)

July 15, 2026 | 4:30 PM

Numerical assessment of residual stress in hardfaced layers formed by metal additive manufacturing process

Professor Dong-Gyu Ahn[1], Ph.D Kwang-Kyu Lee[1]

[1]Chosun University, Dept. of Mechanical Engineering, Chousn University, 10, Chosundae-1gil, Dong-gu, South Korea

Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

To be uploaded later

July 15, 2026 | 4:45 PM

Polypyrrole-coated 3D Printed Highly Porous Graphene Electrodes for Bio-Photovoltaic Energy Generation

Mr. Jinwook Moon[1], Dr. Mirkomil Sharipov[1], Mr. JongHyun Kim[1], Dr. JaeHyoung Yun[1], Dr. Nikolay Ryzhkov[2], Dr. Artur Braun[2], **Professor Wonhyoung Ryu**[1]
[1]Yonsei University, , South Korea, [2]Laboratory for High Performance Ceramics, Empa - Swiss Federal Laboratories for Materials Science and Technology, , Switzerland
Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

Living photosynthetic microorganisms can serve as biological catalysts in bio-photovoltaic (BPV) systems, converting solar energy directly into electrical current without combustion or toxic byproducts. However, widespread adoption of this technology has been hindered by persistently low output densities and the inability to sustain electrode performance over extended periods. To address these challenges, we developed a three-dimensionally printed reduced graphene oxide (rGO) lattice anode functionalized with polypyrrole (PPy) as a high-performance BPV electrode platform. The lattice architecture was deliberately engineered to balance internal void fraction and active surface area, enabling both efficient light distribution and enhanced interaction between cyanobacteria and the electrode surface. PPy deposition was carried out through electropolymerization using cyclic voltammetry, and the number of deposition cycles was systematically varied to identify conditions yielding optimal microbial attachment, conformal polymer coverage, and superior photocurrent output. Notably, the geometric configuration of the printed scaffold—specifically the density and arrangement of internal openings—played a critical role in governing photoelectrochemical behavior by controlling how deeply light penetrated the structure and how freely soluble mediators could migrate through it. Performance was benchmarked across two distinct operational formats: one employing surface-attached biofilms and another utilizing freely suspended cyanobacterial cultures. The suspension-based configuration achieved a maximum power density of 40 μW m^{-2} under a current density of 235 μA m^{-2}. When mediators were eliminated from the system entirely, current densities reaching 300 μA m^{-2} were recorded at a biomass concentration of 25 μg chlorophyll mL^{-1}. Repeated cycling experiments confirmed that the PPy/rGO electrode retained its functionality across three successive operational days.
Collectively, these findings suggest that architected 3D carbon scaffolds with tailored surface chemistry represent a viable path toward scalable, durable BPV devices capable of sustained solar-driven bioelectricity production.

Motion-Adaptive SMP Skin Patches for Wearable Electronics

Professor Hoon Eui Jeong[1]

[1]Unist, UNIST-gil 50, South Korea

Session 06 - SS1: Korea-Singapore Research Collaboration, Changi - Level 4, July 15, 2026, 3:30 PM - 5:15 PM

Skin-interfaced electronics have emerged as a promising frontier in personalized healthcare. However, existing skin-interfaced patches often struggle to simultaneously achieve robust skin adhesion, adaptability to dynamic body motions, seamless integration of bulky devices, and on-demand, damage-free detachment. Here, we introduce a hybrid strategy that synergistically combines these critical features within a thin, flexible patch platform. Our design leverages shape memory polymers (SMPs) arranged in a tessellated array, comprising both rigid and compliant SMPs. This configuration enables exceptional deformability, motion adaptability, and ultra-strong, repeatable skin adhesion while offering on-demand adhesion control. Furthermore, the design facilitates seamless integration of large-scale electronics without compromising skin adhesion. By incorporating sizeable electronics including signal acquisition circuits, sensors, and a battery, we demonstrate that the proposed tessellated patch can be securely mounted on the skin, accommodate dynamic body motions, precisely detect physiological signals with an outstanding signal-to-noise ratio (SNR), wirelessly transmit data, and be effortlessly released from the skin.

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2025-02223634/RS-2026-25470021/ RS-2024-00432685).

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Vacancy-Rich Ceramic-Coated Cu for Anion-Regulated Interfaces in Anode-Free Lithium Metal Batteries

Mr DaeHyun Kim[1], Ms. NaYoung Kim[1], Prof. John Hong[1]

[1]Kookmin University, 77, Jeongneung-ro, Seongbuk-gu, Seoul, 02707, Republic of Korea, South Korea

Poster Session - SS1 Korea-Singapore Research Collaboration (by invitation only), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Anode-free lithium metal batteries (AFLMBs) are considered promising candidates for ultra-high-energy-density energy storage because they eliminate the need for excess lithium metal. However, their practical application remains limited by several critical issues, including uneven lithium nucleation, persistent electrolyte decomposition, and unstable interfacial reactions at the Cu current collector. Here, we introduce a vacancy-rich ceramic-coated Cu current collector (VRC@Cu) as an interfacial platform that regulates anion behavior and stabilizes lithium deposition in AFLMBs. Oxygen vacancies in the ceramic layer generate coordinatively unsaturated sites that serve as strong Lewis acidic centers and preferentially interact with electrolyte anions. This selective anion interaction modifies the interfacial solvation structure by reducing solvent-dominated coordination and promoting anion-enriched interfacial chemistry. As a result, VRC@Cu promotes the formation of a robust inorganic-rich solid electrolyte interphase (SEI), thereby suppressing continuous electrolyte consumption and parasitic reactions during lithium plating. In addition, oxygen vacancies in the ceramic interlayer induce interfacial charge redistribution, increasing the polarization of lattice oxygen and creating lithiophilic sites that facilitate rapid Li+ adsorption and lower the nucleation barrier. The vacancy-rich framework also provides favorable diffusion pathways for Li adatoms, promoting lateral growth rather than dendritic deposition. Consequently, VRC@Cu enables uniform lithium nucleation and dense, planar lithium growth. Owing to these synergistic effects, anode-free cells based on VRC@Cu exhibit improved cycling stability, reduced voltage polarization, and higher coulombic efficiency compared with bare Cu. This study demonstrates that vacancy-engineered interfaces provide an effective route to integrate anion-regulated interfacial chemistry with vacancy-induced charge polarization and Li diffusion, offering a rational strategy for stabilizing anode-free lithium metal batteries.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Separator Surface Modification with Insulating Materials for Enhanced Cycling Stability and Dendrite Suppression

Mr Junyeong Lee[1], Ms. Yihye Jo[1], Prof. John Hong[1]
[1]Kookmin University, 77, Jeongneung-ro, South Korea

Poster Session - SS1 Korea-Singapore Research Collaboration (by invitation only), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Aqueous zinc-ion batteries (AZIBs) face critical challenges, including zinc dendrite growth that penetrates the separator and causes short circuits, hydrogen evolution reaction (HER), and zinc anode corrosion. In particular, commercial glass fiber (GF) separators, despite their high ion conductivity and excellent electrolyte wettability, are fundamentally vulnerable to dendrite penetration because of their large and non-uniform pore structure.

In this study, a Janus BN@GF separator was fabricated by spray-coating electrically insulating hexagonal boron nitride (h-BN) onto the anode-facing side of a GF separator. The electrically insulating h-BN layer blocks electron transport at the interface between the separator and dendrite tips, thereby suppressing Zn2+ reduction at the dendrite tip. In addition, the hydrophobicity of BN@GF inhibits the transport of free water molecules, reducing side reactions such as HER.[3]

As a result, the Zn||Zn symmetric cell using the BN@GF separator exhibited stable cycling for over 1750 h at 5 mA cm^-2 and 1 mAh cm^-2. Moreover, the Zn||V2O5 full cell using the BN@GF separator retained more than 60% of its initial discharge capacity after 2500 cycles at 15 A g^-1.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Dual-Polymer Interphase Engineering for Durable Zinc Metal Powder Anodes in Aqueous Zinc-Ion Batteries

YUNAH AHN[1], John Hong[2]

[1]Kookmin University, 77 Jeongneung-ro, South Korea, [2] 국민대학교, 77 Jeongneung-ro, South Korea

Poster Session - SS1 Korea-Singapore Research Collaboration (by invitation only), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Aqueous zinc-ion batteries (AZIBs) are hindered by dendrite growth, corrosion, hydrogen evolution, and progressive contact loss at zinc metal powder (ZnMP) anodes, which are often accompanied by the formation of sulfate-derived byproducts such as $Zn_4SO_4(OH)_6{\cdot}3H_2O$ (ZHS), leading to rapid interfacial deterioration and capacity fading. Here, we report a dual-polymer interphase on ZnMP anodes based on carboxymethyl cellulose (CMC) and poly(acrylic acid) (PAA), applied either individually or as a mixed CMC/PAA coating. CMC mitigates water-driven parasitic reactions through hydrophilic hydroxyl groups and weak Zn affinity, thereby suppressing corrosion, hydrogen evolution, and contact loss, although excessive coverage can hinder Zn^{2+} transport. By contrast, PAA offers abundant carboxylate moieties that serve as zincophilic coordination sites, homogenizing interfacial Zn^{2+} flux and promoting uniform Zn deposition, but shows limited ability to regulate interfacial water chemistry when used alone. Notably, the mixed CMC/PAA interphase combines water-chemistry regulation with Zn^{2+} transport modulation, overcoming the intrinsic trade-off among interfacial protection, ion transport, and electronic contact retention while substantially suppressing ZHS formation. As a result, the CMC/PAA-coated ZnMP anode delivers stable Zn//Zn symmetric-cell cycling for over 1200 h at 2 mA cm^{-2}/1 mAh cm^{-2} and retains ≈75% of its initial capacity after 1500 cycles in V_2O_5-based full cells. This work presents a practical dual-polymer interphase strategy for mitigating interfacial degradation and contact loss in ZnMP anodes, offering useful guidance for durable and high-performance AZIBs.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Sonochemically Synthesized Ultrathin Carbon Films Enable Dendrite-Free Zinc Anodes

Mr. DongIl Kim[1], Prof. Jin Pyo Hong[1], Prof. John Hong[2]
[1]Hanyang University, 222 Wangsimni-ro, Seongdong-gu, South Korea, [2]Kookmin University, 77 Jeongneung-ro, Seongbuk-gu, South Korea
Poster Session - SS1 Korea-Singapore Research Collaboration (by invitation only), Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Aqueous zinc-ion batteries (AZIBs) have emerged as promising candidates for large-scale energy storage systems due to their intrinsic safety, cost-effectiveness, and high volumetric energy density. However, their practical application is severely hindered by uncontrolled Zn dendrite growth and parasitic side reactions at the Zn anode, which lead to poor cycling stability.

To address these challenges, we developed a non-aqueous sonochemical deposition method that enables the direct synthesis of an ultrathin carbon film on Zn substrates under ambient conditions. This approach utilizes acoustic cavitation to decompose the carbon source, p-xylene, leading to the formation of an amorphous–crystalline hybrid carbon structure with a thickness of a few nanometers.

This unique hybrid structure provides abundant and uniformly distributed Zn nucleation sites while maintaining high Zn^{2+} ion permeability, thereby promoting homogeneous Zn deposition and effectively suppressing dendrite formation. Furthermore, the conformal coating enhances interfacial stability and mitigates parasitic reactions between the Zn surface and electrolyte. As a result, the modified anode demonstrates outstanding cycling stability, sustaining over 2000 hours of stable operation in symmetric cells. These findings highlight the potential of sonochemically derived ultrathin carbon films as an effective interfacial engineering strategy for high-performance Zn anodes.

A new thin-film protonic ceramic fuel cell based on a Mg-doped perovskite electrolyte

Prof. Zongping Shao[1]

[1]Curtin University, , Australia

Session 01 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 10:50 AM - 12:35 PM

In this study, we report the development of a new thin-film B-site Mg-doped and Y-free perovskite electrolyte without the abnormal thermal expansion behavior at 500-700oC and with outstanding proton conductivity for reduced temeprature protonic ceramic fuel cells. and thermo-mechanical compatibility with other cell components. The main researches include the rational design of materials compositions, thin film fabrication, and single cell test in terms of both cell performance and thermal-cycling stability. Specific importance was paid tihe origin of superior conductivity and thermo-mechanical stability. We then further report a new joule-heating concept for in-situ ammonia decomposition with the development a new direct ammonia feed protonic ceramic fuel cell with conventional nickel-based anode. The combination of innovations in electrolyte materials , joule-heating ammonia catalytic decomposition and thin-film electrolyte technology provide a new opportunity of the application of protonic ceramic fuel cells as power source fin the mobile sectors.

Ultrasonic Spraying of Ceria based nano-catalysts for Highly efficient LSGM based Electrolysis Cells; with a Particular Focus on CO2 Electrolysis

Dr Tae Ho Shin[1], Dr. Sang Won Lee[1], Prof. Tatsumi Ishihara[2], Prof. John T.S. Irvine[3]
[1]Korea Institute Of Ceramic Engineering & Technology, Jinju-Si, 52851, Rep. of Korea, Rep. of Korea, [2]Kyushu University, International Institute for Carbon Neutral Energy Research, Kyushu University, Fukuoka, 819-0395, Japan, Japan, [3]University of St Andrews, St Andrews, Fife, KY16 9ST, United Kingdom, School of Chemistry, University of St Andrews, St Andrews, Fife, KY16 9ST, United Kingdom, United Kingdom
Session 01 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 10:50 AM - 12:35 PM

Solid oxide electrolysis cells (SOECs) are promising devices that can be used not only for green hydrogen production but also for electrochemical CO2 reduction, contributing to a carbon-neutral society. As a state-of-the-art electrolyte material with superior ionic conductivity, La(Sr)Ga(Mg)O3 (LSGM) has been successfully validated in various solid oxide electrochemical cells (SOCs) including SOEC 1. However, Ni-based electrodes still encounter various challenges when used with LSGM, including chemical compatibility, low durability during electrolysis, and the absence of a cost-effective manufacturing process, which hinders their commercial viability 2. Herein, we have pioneered the various innovative cathode comprising a Ni-based electrode decorated with nanosized doped ceria, aiming to enhance electrochemical performance. Furthermore, we applied the encapsulation technique of ultrasonic spraying to incorporate and coat ceria-based nano-dot over cathode surface, resulting in a highly uniform distribution of nano-catalysts.

Particularly, the outstaning electrolysis performance (3.89 A cm^2 at 1.5 V in CO_2 electrolysis at 850°C) is attributed to the doped ceria nano-dots, which features a regulated nano-structured perovskite/fluorite interface, enhancing CO2 adsorption and enabling a synergistic cataltytic effect 3. The LSCM@nano-CMF electrode demonstrated excellent performance in both the H2 fuel cell mode and CO2 electrolysis mode, highlighting its potential to advance CO2 reduction and contribute to global carbon neutrality.

Investigating SOFC Electrode Reaction Mechanism Using Atomically Flat Thin Films

Professor Di Chen[1]

[1]The Hong Kong Polytechnic University (PolyU), , China

Session 01 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 10:50 AM - 12:35 PM

Understanding electrode reaction mechanisms in fuel cells is essential for improving performance. Thin films, with better microstructural control than porous electrodes, are widely used in mechanistic studies. However, current thin films have difficulties achieving atomic-level surface control, making it difficult to gain atomic-scale insights into certain fundamental issues.

This talk presents our recently developed atomically flat epitaxial thin-film electrochemical cells, integrating in-situ pulsed laser deposition, RHEED and synchrotron-based APXPS/XAS. We investigated two key SOFC materials: fluorite-structured CeO_2 and perovskite oxides $(La_{0.5}Sr_{0.5})FeO_3$. For ceria, we found that, like d band in metals and p-band in perovskites, the f-band position significantly influences reaction rates of rare earth oxide. For perovskites, precise SrO coverage control could enhance surface reaction rate by orders of magnitude, contradicting traditional views. Microkinetic modeling revealed a switch in the rate-determining step at a monolayer SrO, while DFT calculations explained the energetic origins of these changes.

Key Technologies to Overcome the Limitations of Solid Oxide Cells (SOCs)

Prof. Jae-ha Myung[1]

[1]Incheon National University, 119 academyro, yeonsu-gu, South Korea

Session 01 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 10:50 AM - 12:35 PM

The fields of hydrogen production and utilization are among the most critical research areas for advancing toward a hydrogen society. Over the years, fuel cells have played a key role in hydrogen utilization, steadily growing in importance. In particular, solid oxide fuel cells (SOFCs) have attracted significant attention due to their high efficiency and ability to operate not only on hydrogen but also on hydrocarbon-based fuels and ammonia.

Recently, research on reversible solid oxide cells (R-SOCs), which can perform both fuel cell reactions (producing electricity from hydrogen) and electrolysis reactions (producing hydrogen by splitting water), has rapidly advanced, driven by their high efficiency and stability.

However, solid oxide cells still face major challenges related to the intrinsic brittleness of ceramic materials, as well as their limited conductivity and catalytic activity. In this presentation, I will introduce the research progress from our group aimed at overcoming ceramic brittleness through the development of flexible electrolytes. By optimizing the composition and processing of zirconia-based cubic electrolytes traditionally used in SOFCs, we have developed a tetragonal-phase electrolyte that exhibits high mechanical strength, improved flexibility, and excellent ionic conductivity. Moreover, by studying the exsolution phenomenon, we have controlled the metal composition, number, size, and morphology of metallic nanoparticles. Through modeling, we have elucidated the underlying mechanisms, enabling the application of these insights not only to fuel cells but also to a wide range of energy devices.

Tuning the electrochemical properties of oxide nanostructures for energy applications using surface modification

Prof. Dr. Matthías T. Elm[1]

[1]Justus-Liebig-University Giessen, Heinrich-Buff-Ring 16, Germany

Session 02 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

High surface-area mixed ionic–electronic conducting (MIEC) oxide nanostructures are central to the performance of a broad range of energy storage and conversion devices. Porous electrodes in lithium-ion batteries, for instance, facilitate rapid lithium-ion transport between electrode and electrolyte, while highly porous solid oxide fuel cell electrodes enable fast oxygen exchange with the surrounding atmosphere. However, the very features that enhance reactivity – high surface area and porosity – often compromise structural and chemical stability, leading to performance degradation over time.

A promising strategy to overcome these limitations is surface modification through ultrathin protective coatings. Here, we present recent advances demonstrating how nanometer-scale coatings on MIEC cathodes significantly suppress deleterious surface reactions in both conventional lithium-ion and emerging all-solid-state batteries [1,2,3]. Beyond stabilization, surface modification offers a pathway to engineer artificial mixed conductors with tunable ionic and electronic transport, paving the way for next-generation electrochemical devices based on oxygen-ion conductors [4,5]. These insights provide a design framework for combining high surface area with robust functional stability in energy conversion materials.

References:

[1] R.S. Negi, et al., ACS Appl. Mater. Interfaces 12, 314392 (2020), 10.1021/acsami.0c06484

[2] R.S. Negi, Chem. Mater. 33, 6713 (2021), 10.1021/acs.chemmater.1c01123

[3] R.S. Negi, Adv. Mater. Interfaces. 9, 2101428 (2022), 10.1002/admi.202101428

[4] E. Celik, Phys.Chem. Chem. Phys. 23, 10706 (2021), 10.1039/D1CP00834J

[5] E. Celik, ACS Nano 16, 3182 (2022), 10.1021/acsnano.1c11032

July 14, 2026 | 1:45 PM

Nanoscale Oxygen Exchange at Solid Oxide Cell Electrodes: Insights from Model Thin Films and Operando Characterization

Professor WooChul Jung[1]

[1]Seoul National University, 33-203, Gwanhak-ro 1, Gwanhak-gu, South Korea

Session 02 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Understanding oxygen exchange reactions at solid oxide cell (SOC) air electrodes remains a central challenge, largely because practical porous electrodes involve complex microstructures, heterogeneous interfaces, and evolving surface chemistry. Model thin-film platforms provide a powerful route to decouple these effects and enable mechanistic insight at well-defined nanoscale interfaces.

In this invited talk, I will present our recent work employing epitaxial thin-film SOC electrodes integrated with monodisperse metal nanocatalysts as simplified yet realistic model systems. Particular focus will be placed on (La,Sr)(Co,Fe)O3-based air electrodes, where asymmetric thin-film electrochemical cells combined with operando X-ray spectroscopy, electrochemical analysis, and density functional theory allow quantitative evaluation of intrinsic catalytic activity and identification of active reaction sites under operating conditions.

These studies reveal a bias-dependent shift in active sites: oxygen reduction occurs primarily at the nanocatalyst–perovskite interface, whereas oxygen evolution is dominated by reactions on the nanocatalyst surface. This finding leads to a revised understanding of catalyst functionality, highlighting Ag as an unexpectedly effective catalyst for (La,Sr)(Co,Fe)O3 electrodes.

Finally, I will discuss how thin-film model systems coupled with operando characterization provide a general framework for systematically probing surface defects, electronic structure, and catalyst–oxide interfaces, offering guidance for the rational design of next-generation SOC electrodes.

July 14, 2026 | 2:10 PM

Characterisation of ion transport processes in solid oxide thin films

Prof Stephen Skinner[1]

[1]Imperial College London, Exhibition Road, United Kingdom, [2]Imperial Global Singapore, #11-01, CREATE Tower, Singapore

Session 02 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Developing thin film oxides for application in solid oxide cells has received considerable attention due to the potential of these to exhibit strain that induces fast ion transport. However the transport at and along microstructural features such as dislocations abd grain boundaries presents challenges in unambiguous determination of fast pathways. Much focus has been directed towards understanding the anion transport, using isotopic labels, but more recently the segregation of cation species has received more attention. To achieve detailed understanding of these processes a range of techniques that have nanoscale resolution have been employed to probe both structure and chemistry, including low energy ion scattering, secondary ion mass spectrometry and atom probe tomography. Here these techniques will be briefly introduced and the application of these to common solid oxide cell compositions such as (La,Sr)(Co,Fe)O3-d will be discussed.

July 14, 2026 | 2:35 PM

Tailoring Interfacial Oxygen Kinetics via Defect-Engineered Ceria Interlayers for Advanced SOCs

Prof. Kang Taek Lee[1]

[1]KAIST, N7-4, #6108, KAIST, Korea (the Republic of)

Session 02 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 1:20 PM - 3:00 PM

Solid oxide electrochemical cells (SOCs) are promising for sustainable energy conversion, yet their widespread deployment is hindered by performance degradation at reduced operating temperatures due to severe interfacial resistances. To overcome this, we present a rationally engineered thin-film ceria interlayer designed to accelerate interfacial oxygen exchange kinetics. By utilizing a highly doped gadolinium-doped ceria (GDC) composition (40 mol% Gd), we maximize the density of oxygen vacancy-related defect sites. The accompanying decrease in bulk ionic conductivity is effectively mitigated by confining the material to a dense thin-film geometry. Density functional theory (DFT) calculations reveal that excessive Gd doping induces tensile lattice strain and weakens cation-oxygen bonding. These effects synergistically lower the oxygen vacancy formation energy and promote highly reactive surface vacancy clusters, significantly enhancing oxygen incorporation and evolution kinetics. Consequently, SOCs integrated with this defect-rich ceria interlayer demonstrate remarkable electrochemical performance in both fuel cell and electrolysis modes, significantly outperforming conventional ceria-based systems. This work establishes vital design principles for advanced interlayer engineering in next-generation SOCs.

July 14, 2026 | 3:30 PM

Quantitative framework for interface analysis and engineering in protonic ceramic electrochemical cells

Professor Wonyoung Lee[1]

[1]Department of Mechanical Engineering, Sungkyunkwan University, , South Korea, [2]SKKU Institute of Energy Science and Technology (SIEST), Sungkyunkwan University, , South Korea

Session 03 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

The low-temperature operation of reversible protonic ceramic electrochemical cells (PCECs) is desirable for efficient and sustainable electricity generation and green hydrogen production. However, significant interfacial resistance originating from structural discontinuities at the electrode/electrolyte interface remains a key hurdle, contributing to both ohmic and polarization resistance and limiting further improvements. This talk presents a quantitative framework for interface analysis and engineering that correlates interfacial contact coverage and interface extension with electrochemical performance, supported by impedance modeling based on equivalent circuits. Using scalable and practical interface engineering strategies, including thin and dense interlayers, tailored particle size and distribution near the interface, and heterointerface designs that extend reaction sites, we show how contact coverage and specific surface area can be improved to reduce interfacial losses while enhancing interfacial mechanical integrity and preventing delamination. The framework highlights improved thermal and electrochemical durability, long-term operational stability, and fuel flexibility under demanding operating conditions. This presentation provides a practical pathway for rational optimization of PCECs by quantitatively linking interface descriptors to performance and durability outcomes.

July 14, 2026 | 3:55 PM

Application of Nickel and Rare Earth Metal co-doped Ceria for Direct Ammonia Solid Oxide Fuel Cells

Ms Minhyeong Seo[1,2], Mr Hosik Hahn[3], Mr Jong Kyu Woo[1,4], Prof Jeong Woo Han[3], **Dr. Jong-Eun Hong**[1,4]

[1]Korea Institute of Energy Research, 152 Gajeong-ro, Yuseong-gu, South Korea, [2]Korea University, 145 Anam-ro, Seongbuk-gu, South Korea, [3]Seoul National University, 1 Gwanak-ro, Gwanak-gu, South Korea, [4]University of Science and Technology, 217, Gajeong-ro, Yuseong-gu, South Korea

Session 03 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

For the deployment of direct ammonia-solid oxide fuel cells (DA-SOFCs), it is necessary to develop an anode material with high activity and durability for ammonia decomposition. In this study, we synthesized fluorite-structured CeO_2 catalysts co-doped with Ni and rare earth metals (Sm, Nd, Pr, or La) and analyzed the characteristics of ammonia cracking and the performance of DA-SOFCs incorporating these catalysts. The substitution of rare earth metals affected formation of oxygen vacancies on CeO_2 surface and exsolution behavior of Ni particles. In particular, La doping increased oxygen vacancy formation on the CeO_2 surface due to high segregation energy, resulted in the increase in Ni exsolution. As a result, La and Ni-doped CeO_2 (LNDC) indicated enhanced ammonia decomposition reaction, led by promotion of electron donation via exsolved Ni nanoparticles. When the developed catalyst was applied to a fuel electrode-supported SOFC via an ultrasonic spray infiltration process and evaluated under direct ammonia operation, the maximum power density at 650°C increased by approximately 28% compared to that of a cell without catalyst, reaching 0.8 W/cm², due to a reduction of polarization resistance. Furthermore, high durability was observed without performance degradation over 100 hours. Accordingly, this study demonstrates that an approach based on a simultaneous substitution strategy of Ni and rare earth metals is effective for designing highly active and durable catalysts for the direct utilization of ammonia in intermediate temperature SOFCs.

July 14, 2026 | 4:20 PM

Surface and Interface Engineering for Performance Enhancement of Protonic Ceramic Fuel Cells

Professor Chung-jen Tseng[1,2], Ph.D. Student Po-Kai Lan[1], Ph.D. Student Tzu-Yun Lin[1]
[1]National Central University, , Taiwan, [2]Academia Sinica, , Taiwan

Session 03 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

Protonic ceramic fuel cells (PCFCs) are promising energy-conversion devices because of their high efficiency, reduced operating temperature, and fuel flexibility. However, their performance is strongly governed by electrode and electrolyte layer quality and interfacial microstructure. This talk summarizes recent advances of our laboratory's research from electrolyte processing to interface design and fuel-electrode surface engineering for performance enhancement of PCFCs.

First, nanomilling was used to reduce BCZY particle size from 297 to 131 nm, lowering the co-sintering temperature, which enabled a peak power density of about 490 mW cm-2 at 800 °C, representing a 38% improvement over the conventional process. Then a porous BCZY interface layer was introduced between the electrolyte and cathode to extend the triple-phase boundary and improve oxygen reduction kinetics. With optimized calcination, the cell reached 517 mW cm-2 at 800 °C, while polarization resistance decreased by 32.7% at 700 °C. Further optimization of cathode functional layers raised the peak power density to 1073 mW cm-2.

Recently, we applied a porous NiCu anode decomposition layer (ADL) on fuel electrode. For methane-fueled PCFCs, the ADL design delivered 1122 and 847 mW cm-2 at 700°C and 600 °C, respectively, and maintained stable operation for 70 h at 600 °C under humidified CH4. For ammonia-fueled PCFCs, the optimized ADL achieved 1159, 1786, and 2163 mW cm-2 at 600, 700, and 800 °C under NH3. These results demonstrate that thin-film and surface-coating strategies are key tools for reconstructing electrochemical interfaces and enabling efficient multi-fuel PCFC operation.

July 14, 2026 | 4:45 PM

High-entropy nanocomposite for stabilizing oxygen electrode enables robust solid oxide cells beyond 2 W cm-2

Dr Chengcheng Wang[1]

[1]Shenzhen Polytechnic University, ,

Session 03 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 14, 2026, 3:30 PM - 5:10 PM

Solid oxide cells (SOCs) at the hydrogen-electricity nexus offer promising solutions for solving the challenge of volatile renewable energy. Nevertheless, their practical deployment is still hindered by the activity-stability trade-off of current oxygen electrodes and need of robust solid oxide cells beyond 2 W cm-2. Here, we address this limitation through a universal high-entropy nanocomposite strategy that enables robust solid oxide cells beyond 2 W cm-2. A new high-entropy nanocomposite oxygen electrode of La0.2Ba0.2Sr0.2Ca0.2Gd0.2CoO3-δ-Gd0.2Ce0.8O1.9 with rich heterointerfaces as a proof-of-concept is developed. Density functional theory calculations reveal that these heterointerfaces significantly reduce the oxygen vacancy formation energy in high-entropy perovskite lattice, leading to increased oxygen vacancy concentration and markedly enhanced oxygen evolution and reduction kinetics. A corresponding SOC delivers a power density of 2.08 W cm−2 at 750 °C and achieves an electrolysis current density of 2.0 A cm−2 at 1.5 V. Moreover, the electrode exhibits exceptional chromium tolerance during hundreds of hours of accelerated poisoning test, attributed to the high-entropy effect and the synergistic interaction between the two phases in the nanocomposite. This achievement opens up a road for accelerating SOC practical deployment in volatile renewable energy industry.

The integration of cryo atom probe tomography and transmission electron microscopy to study light elements important for the energy transition.

Prof Finn Giuliani[1]

[1]Imperial College London, , UK

Session 04 - SS3:Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Critical materials for future technologies are often highly complex across multiple length scales and are therefore extremely difficult to characterise using a single technique. They commonly involve low–atomic weight, mobile elements (e.g., hydrogen, lithium, carbon, sulphur) that are particularly challenging to quantify in their in-operando state due to their high diffusion rates, reactivity, and often very low contrast in conventional imaging techniques.

To address these challenges, this facility has been established around a cryo hub that enables samples to be transferred under high vacuum and cryogenic conditions between three instruments:

(i) an atom probe, uniquely suited to quantitatively measure the chemical composition of light, mobile elements;

(ii) a transmission electron microscope equipped with a vacuum–cryo holder and optimised to measure the structure and defects of sensitive samples, as well as their local bonding environment;

(iii) a plasma FIB for preparing samples for both the atom probe and TEM, offering low contamination, minimal damage, and the capability for large-scale 3D imaging.

In this talk, I will discuss examples including isotope labelling in fuel cell materials, imaging the lattice position of hydrogen in magneto-caloric cooling materials, and ion distributions around frozen liquid–solid interfaces.

Improving Conductivity of Protonic-Ceramic Electrolytes via Thin-Film Transient Lanthanum-Based Sintering Layers

Distinguished Professor Ryan O'Hayre[1], Pete Rand[1], Professor Sandrine Ricote[1], Dr. Youdong Kim[1], Chris Martin[1], Professor Neal Sullivan[1]

[1]Colorado School of Mines, 1301 Arapaho St., United States

Session 04 - SS3:Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Protonic ceramic electrolysis cells have the potential to efficiently generate hydrogen via intermediate temperature (500-600 oC) water-splitting. Unfortunately, the fabrication of dense, large-grained protonic-ceramic electrolytes requires high-temperature sintering around 1500 °C that promotes barium volatilization. Barium loss during sintering leads to an array of undesirable effects such as reduced conductivity, material instability, and insulating secondary phase formation at grain boundaries. Often, this barium loss is mitigated by fabricating electrolytes with super-stoichiometric amounts of barium or adding a secondary "sacrificial" source of barium vapor that thermodynamically suppresses barium vaporization from the perovskite.

These solutions are difficult to control and can also lead to deleterious second phases, consume expensive sacrificial electrolyte powders, and lead to non-uniform surface morphologies. Here, we introduce the concept of modifying the sintering of $BaCe_{0.7}Zr_{0.1}Y_{0.1}Yb_{0.1}O_{3-\delta}$ (BCZYYb) electrolytes with various lanthanum-containing overlayers such as lanthanum oxide (La_2O_3, LO) and lanthanum cerate ($La_2Ce_2O_7$, LCO). The addition of LO/LCO suppresses barium loss from the perovskite during high temperature sintering by forming a transient Ruddlesden-Popper $La_{2-x}Ba_xNi_{1-y}Y_yO_{4+\delta}$ (LBNY) surface phase. LBNY forms via reaction with volatilized nickel and barium species from BCZYYb. Upon nickel- and barium-saturation and densification of the sinter-layer, barium loss from the electrolyte surface slows and grain growth can be carried out without risk of perovskite phase decomposition due to barium loss. Finally, the transient LBNY phase reincorporates into the perovskite lattice at the latter stages of the sintering process, further accentuating grain growth and creating a uniform, low-lanthanum-content surface phase.

The result of implementing La-containing sinter-layers is an exceptionally large-grained (> 10 μm) single-phase perovskite electrolyte without the need for burying the cell in sacrificial powders or modulating the cation stoichiometry. Cells fabricated using this method show negligible phase segregation, uniform cation distributions, and high conductivity.

Emerging Carbon-Coupled Electrochemical Systems for Energy-Efficient Hydrogen Production and CO_2 Utilization

Professor Guntae Kim[1], Professor BingBing Niu[1], Mr Yaowei Liu[1]

[1]Shanghai Institute of Applied Physics, Chinese Academy Of Sciences, , China

Session 04 - SS3:Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Electrochemical technologies that integrate CO_2 into energy conversion processes are attracting increasing attention as a route toward sustainable hydrogen production. However, in most existing systems, CO_2 remains a passive reactant, offering limited impact on overall energy efficiency and system performance.

Here, we introduce an emerging class of carbon-coupled electrochemical systems in which CO_2 actively participates in regulating reaction thermodynamics and kinetics. By integrating system-level optimization with HER catalyst engineering, we demonstrate that the local reaction environment can be precisely controlled to stabilize carbonate and bicarbonate species while simultaneously enhancing hydrogen evolution under near-neutral conditions.

This approach enables improved energy efficiency and operational stability, and suggests a new paradigm in which CO_2 is not merely utilized, but fundamentally redefines the electrochemical process. Such carbon-coupled architectures open new opportunities for designing low-energy, carbon-integrated systems beyond conventional electrolysis concepts.

These findings provide a general framework for next-generation electrochemical technologies, offering scalable pathways toward efficient hydrogen production coupled with meaningful CO_2 utilization.

Engineering NiFe-based Cermet Anodes for High-Performance and Durable Direct Ammonia Solid Oxide Fuel Cells

Haipeng Zhang[1], Chenghui Li[1], Professor San Ping Jiang[2], Professor Chengzhi Guan[3], **Professor Kongfa Chen**[1]

[1]College of Materials Science and Engineering, Fuzhou University, , China, [2]National Energy Key Laboratory for New Hydrogen-Ammonia Energy Technologies, Foshan Xianhu Laboratory, , China, [3]Department of Hydrogen Technique, Shanghai Institute of Applied Physics, Chinese Academy of Sciences, , China

Session 04 - SS3:Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 10:50 AM - 12:30 PM

Direct ammonia solid oxide fuel cells (DA-SOFCs) suffer from Ni-based anode degradation due to nitridation. We developed two efficient NiFe-based cermet anodes to overcome this. First, a self-assembled NiFe-Gd0.1Ce0.9O1.95 (NiFe-GDC) nanocomposite with a unique encapsulation structure was fabricated via a sintering-free route. It provides abundant active sites and resists nitridation. DFT confirms NiFe alloy lowers reaction barriers. An electrolyte-supported cell achieved 0.61 W cm−2 at 800°C and stable operation for 100 h. Second, an in situ gradient-driven strategy was employed in anode-supported cells: Fe migration during sintering forms NiFe alloys after reduction, boosting activity and nitridation resistance. This cell delivered 1.45 W cm−2 at 750 °C with 100 h stability. These approaches offer new, cost-effective pathways for developing active and durable nickel-based anodes, significantly advancing the practical application of DA-SOFCs.

References

[1] H. Zhang, R. Xiong, Z. Chen, Z. Cheng, J. Huang, B. Sa, N. Ai, L. Zhang, S.H. Chan, C. Guan, Y. Chen, S.P. Jiang, K. Chen, Efficient and Robust Nanocomposite Cermet Anode with Strong Metal–Oxide Interaction for Direct Ammonia Solid Oxide Fuel Cells, Advanced Functional Materials, 35 (2025) 2501223.

[2] C. Li, H. Zhang, J. Qian, Z. Cheng, Z. Chen, S. Luo, C. Lin, N. Ai, D. Tian, S.P. Jiang, C. Guan, K. Chen, In situ gradient-driven engineering of stable Ni-based anodes for durable direct ammonia solid oxide fuel cells, unpublished.

Strain-induced structure and oxygen-vacancy distribution in solid-oxide fuel-cell cathode materials

Dr. zaoli zhang[1]

[1]Erich Schmid Institute, Austrian Academy of Sciences, , Austria

Session 05 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 1:20 PM - 3:00 PM

Solid Oxide Fuel Cells (SOFCs) have gained significant attention in the scientific community as an effective technology for energy conversion with a much smaller environmental impact than fossil fuels. However, SOFCs typically operate at high temperatures (~ 1000 °C), which poses several challenges, including high operating costs, material degradation, and thermal expansion mismatch. To address this issue, the operating temperature needs to be reduced to the intermediate level (IT-SOFCs), which operate at 500°C to 800°C. Among the materials for IT-SOFCs, doped LaGaO3 has emerged as a promising candidate due to its high ionic conductivity and favorable electrochemical properties. In particular, doping with Sr for the La site and Mg for the Ga site (La1−xSrxGa1−yMgy03−δ, LSGM) yields the best oxygen ion conductivity. Replacing La3+ with Sr2+ and Ga3+ with Mg2+ at their respective lattice sites creates oxygen vacancies to maintain charge neutrality in the material. By HRTEM and iDPC imaging, two domains were captured, one with 90° symmetry and the other with non-90° symmetry. Additionally, ordered oxygen vacancies were observed in the non-90° domain, whereas vacancies in the 90° domain were randomly distributed [1].

Mixed conducting La0.6Sr0.4CoO3-δ (LSCO) is among the most promising SOFC cathode materials, particularly for reduced operation temperature. The different structures of LSCO thin films grown under tensile and compressive strain conditions were confirmed by HRTEM. It is caused by the oxygen vacancies ordering affected by strain from the substrate. The pronounced domain structure of the Brownmillerite phase was found in tensile-strained LCSO grown on the STO substrate. The tracer diffusion coefficient D* varies significantly with the strain state of LSCO [2].

[1]. Sergej Ražnjević, et al. APL Mater. 13, 071112 (2025)
[2]Yurii P. Ivanov, et al COMMUNICATIONS MATERIALS, (2020) 1:25.
This work is financially supported by the Austrian Science Fund (FWF P36581-N)

Mass and charge transport in thin oxide films driven by an external voltage

Professor Manfred Martin[1]

[1]RWTH Aachen University, Institute of Physical Chemistry,, Germany, [2]Seoul National University, Department of Materials Science and Engineering,, Korea

Session 05 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 1:20 PM - 3:00 PM

Mixed ionic-electronic conducting thin oxide films exposed to an external voltage show a transition between a high-resistive OFF state and a low-resistive ON state (resistive switching), which is due to the coupled motion of oxygen ions and electrons. Here we report our theoretical and experimental results for strontium titanate (SrTiO3). At elevated temperatures, we use the classical Hebb–Wagner polarization setup with an ion-blocking and a reversible electrode. As driving force, we apply an AC-voltage instead of a DC-voltage that was used in the original seminal papers by Hebb and Wagner. The system is simulated numerically in terms of a defect chemical and a transport model. We observe resistive switching caused by the motion of oxygen vacancies and electronic defects within the bulk of SrTiO3. The phenomenon does not require a set-voltage. The effects of surface exchange kinetics, p-n transition, sample thickness, and frequency of the applied voltage are investigated in detail. Prove of principle experiments confirm the simulation results. In contrary, at room temperature we find filamentary switching where the filaments consist of decomposed SrTiO3. This behaviour can be explained in terms of coupled motion of oxygen vacancies and electrons in the space charge regions adjacent to grain boundaries and decomposition of highly nonstoichiometric SrTiO3 [3].

[1] N. Ahr, M. Martin, Adv. Eng. Mater. (2023) 2201741.
[2] N. Ahr, M. Martin, Solid State Ionics 386 (2022) 116057.
[3] D.-H. Kwon, S. Lee, C.S. Kang, Y.S. Choi, S.J. Kang, H.L. Cho, W. Sohn, J. Jo, S.-Y. Lee, K.H. Oh, T.W. Noh, R.A. De Souza, M. Martin, M. Kim, Adv. Mater. 31 (2019) 1901322.

July 15, 2026 | 2:10 PM

Microstructure and performance of dense nanostructured Sc2O3 doped ZrO2 thin film deposited by ultrasonic spraying pyrolysis for metal supported solid oxide fuel cells

Chengxin Li[1]

[1]Xi'an Jiaotong University, , China

Session 05 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 1:20 PM - 3:00 PM

As Solid Oxide Fuel Cells (SOFCs) trend toward intermediate-to-low temperature operation (500-700 °C), Metal-Supported SOFCs (MS-SOFCs) have garnered significant attention due to their exceptional thermal cycling stability, robust mechanical strength, and rapid start-up capabilities. Gadolinium-doped ceria (GDC) is a preferred electrolyte for MS-SOFCs owing to its high ionic conductivity at lower temperatures and excellent thermal expansion compatibility with ferritic stainless-steel supports. However, GDC exhibits significant electronic conductivity under reducing atmospheres, leading to internal short-circuiting and a subsequent reduction in fuel cell efficiency.

In this study, dense nanostructured Scandia-Stabilized Zirconia (ScSZ) electron-blocking layers were successfully deposited onto metal-supported GDC electrolyte films using Ultrasonic Spray Pyrolysis (USP). The results demonstrate that the approach yielded continuous, dense films with a thickness of only a few hundred nanometers and minimal surface roughness. Scanning Electron Microscopy (SEM) characterization revealed that the as-deposited ScSZ films exhibit distinct nanocrystalline features, with average grain sizes ranging from 15 to 25 nm. Electrochemical performance testing indicated that the thin-film composite electrolyte maintains excellent activity at 650 °C, benefiting from the enhanced ionic transport at nanocrystalline grain boundaries and the high intrinsic conductivity of ScSZ. Compared to pure GDC cells, the cells integrated with the SSZ blocking layer exhibited a significantly enhanced Open Circuit Voltage (OCV) while maintaining an ohmic resistance comparable to that of pristine GDC. This research confirms the feasibility of using USP to fabricate high-quality, ultra-thin SSZ barrier layers, providing critical technical support for the commercialization of high-performance, low-cost MS-SOFCs.

July 15, 2026 | 2:35 PM

Intermediate-temperature proton-conducting solid oxide fuel cells and electrolyzers for Taiwan's multi-fuel clean energy future

Professor Sheng-wei Lee[1], Professor Chung-Jen Tseng[1], Professor Szu-yuan Chen[1]
[1]National Central University, No. 300, Zhongda Rd., Zhongli District, Taiwan

Session 05 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 1:20 PM - 3:00 PM

In recent years, extensive efforts have been devoted to the development of proton-conducting solid oxide cells (P-SOCs) operating in the low-to-intermediate temperature range (400-700 °C). Compared with oxygen-ion-conducting SOCs (O-SOCs), which typically require higher operating temperatures (800-1000 °C), P-SOCs enable more reliable sealing, the use of lower-cost interconnect materials, and improved control over electrode-electrolyte interactions, thereby significantly prolonging device lifetime. Furthermore, in response to Taiwan's future multi-fuel energy landscape, including green hydrogen, cracking-methane, and ammonia, P-SOCs are expected to play a crucial role in enabling flexible and sustainable energy conversion systems.

In this presentation, a variety of nanostructured electrode for P-SOCs is demonstrated via nano-engineering and have demonstrated their excellent cell performance. For example, we present a nanofiber-derived functional anode and cathode for proton-conducting SOFCs. The significantly lower polarization resistance elements indicate that the nano-fibrous electrode has superior catalytic activity for HOR and ORR. We also use PS nanospheres as pore former to fabricate an LSCF cathode with graded porosity, thus greatly improving the cell performance. In addition, we employ spin-coating technique and pulsed laser deposition (PLD) with doping strategy to fabricate thin-film electrolyte for P-SOCs. A bulk heterojunction GCCCO- or PBSCF-BCZYYb layer with a domain width of ~5 nm by PLD via spontaneous phase separation is demonstrated as an electrolyte/cathode interlayer, which effectively increases the interfacial area between the two distinct phases and facilitates proton transport across the interface. Furthermore, doping strategies are applied to optimize the charge carrier transport properties of the interlayer. Finally, the performance of P-SOCs is evaluated under various operating conditions, including hydrogen, cracking methane, and ammonia fuels, as well as in electrolysis mode using seawater. The results demonstrate the strong potential of nano-engineered architectures for achieving high-performance, fuel-flexible P-SOCs.

July 15, 2026 | 3:30 PM

Oxygen Electrodes for Reversible Protonic Ceramic Electrochemical Cells

Professor Yu Chen[1]

[1]South China University of Technology, , China

Session 06 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Reversible protonic ceramic electrochemical cells (R-PCECs) have the potential to be the cleanest and most efficient option for direct conversion to electricity from a wide variety of fuels, from hydrogen to hydrocarbons, coal gas, and bio-derived fuels. When operated in reverse mode, on the other hand, they are very efficient for the low-cost production of hydrogen from splitting water. Thus, R-PCECs are ideally suited for large-scale energy storage and conversion, which are vital to the deployment of renewable energies. However, the commercialization of R-PCECs hinges on the rational design of novel electrode materials of exceptional functionalities at lower temperatures to dramatically reduce the cost while enhancing performance and durability. A key challenge is developing bifunctional electrodes/catalysts, especially for the oxygen electrodes, to include efficient, active bifunctional catalysts in an electrode layer designed for effective dual-mode operation. Meanwhile, the R-PCECs working in modes of fuel cell and electrolysis cell must have sufficient durability when cycling, with high Faraday efficiency, which requires electrodes/electrolytes to have high stability (against steam). This presentation will highlight the critical scientific challenges facing the development of a new generation of R-PCECs based on proton-conducting electrolytes, the latest development of oxygen electrodes, the strategies for enhancing electrode activity and durability of oxygen reduction/evolution reactions in R-PCECs, and the outlook for future-generation energy storage systems that exploit nano-scale materials of significantly improved performance.

Mass transportation optimization in air electrode of scaled-up protonic electrolysis cells fo high faradaic efficiency

Prof. Bin Chen[1]

[1]Shenzhen University, , China

Session 06 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Proton ceramic electrolysis cells (PCECs) hold great promise for efficient water splitting but suffer from the low Faradaic efficiency (FE) due to electronic leakage in electrolyte under steam starvation—a critical problem exacerbated at large size cells. Most reported high FEs of PCECs are based on button-sized cells (area<0.5 cm2) operating with excessive steam supply, which under-represents the two-dimensional (2D) limit of steam transportation—vertically from oxygen electrode towards the electrolyte and laterally along the flow direction in large cells. To break this limit, here we propose a hydration-enhancing strategy to improved water absorption and storage capacity of oxygen electrode by nanocompositing water-absorbing BaCeO3 phase through reassembly of original BaFe0.5Co0.3Ce0.1Cu0.1O3-δ as the oxygen electrode (BCWA-BFCCCu0.1). This strategy achieves a reliable increase of FE from 71.42% to 82.1% at low H2O concentration (10 vol% H2O) in a large-sized PCEC of 15.2 cm2 by direct metering the produced H2 flowrate. Further scaled up to a 3-cell short stack with total area of 45 cm2, a practically high FE of 83.3% at a high current of 10 A was achieved, validating the effectiveness of the hydration-enhancing strategy for boosting FE. These findings address the key scalability and efficiency barrier for PCECs as the next generation technology for hydrogen production.

July 15, 2026 | 4:20 PM

Conformally coated scaffold electrode for reversibe solid oxide cells and its operational robustness

Dr. Hanchen Tian[1]

[1]Xi'an Jiaotong University, No.28 Xianning West Road, China

Session 06 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Protonic ceramic electrochemical cells (PCECs) have potential as long-duration energy storage systems. However, their operational stability is limited under industrially relevant conditions due to the intrinsic chemical instability of doped barium cerate-based electrolytes and oxygen electrodes against H2O, as well as the poor electrode–electrolyte interfacial contact. Here we present a conformally coated scaffold (CCS) design to comprehensively address these issues. A porous proton-conducting scaffold is constructed and conformally coated with electrocatalyst, which has high chemical stability against H2O, triple conductivity and hydration capability, and protects vulnerable electrolytes from H2O. The CCS structure consolidates the electrode–electrolyte interfacial bonding to enable fast proton transfer in the percolated network. This design enables PCECs to reach electrolysis stability for 5,000 h at $-1.5\ A\ cm^{-2}$ and 600 °C in 40% H2O. This work provides a general strategy to stabilize PCECs and offers guidance for designing resilient and stable solid-state energy storage systems.

July 15, 2026 | 4:45 PM

Inkjet Printing of Thin Film Electrochemical Applications

Sung Min Kang, Kyung Chan Min, Sun Beom Kim, **Professor Joon Hyung Shim**[1]
[1]Korea University, 145 Anam-ro Seongbuk-gu, South Korea

Session 06 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Inkjet printing, a well-established technique in electronics and advanced manufacturing, is increasingly recognized as a promising method for the fabrication of thin-film electrochemical devices, particularly fuel cells and electrolyzers. These systems require precisely controlled, multi-layered architectures composed of electrodes, electrolytes, and functional interlayers, where film thickness, composition, and microstructure critically influence performance. Inkjet printing enables the direct deposition of functional materials - including catalytic layers, ion-conductive electrolytes, and interface-modifying coatings - with high spatial resolution and minimal material waste. This capability is especially advantageous for fabricating thin, dense electrolyte films and engineered electrode structures, which are essential for improving reaction kinetics and overall device efficiency in fuel cell and electrolysis systems. Recent progress in ink formulation and printing strategies has enabled the stable deposition of ceramic and composite materials, allowing for the fabrication of uniform, crack-free thin films with controlled morphology and composition. In addition, the inherent flexibility of inkjet printing facilitates precise patterning and localized material tuning, enabling optimization of electrochemical interfaces and triple-phase boundary structures. The application of inkjet printing to fuel cells and electrolyzers offers significant advantages in terms of reduced material consumption, lower processing complexity, and compatibility with scalable manufacturing. This presentation highlights recent advances in inkjet-printed thin-film electrochemical systems, with a focus on fuel cell and electrolysis applications. Key challenges - including ink stability, print resolution, film densification, and long-term durability - are discussed, along with potential strategies to address them. Overall, inkjet printing presents a viable pathway toward high-performance, cost-effective, and scalable fabrication of next-generation electrochemical energy devices for efficient energy conversion and hydrogen production.

July 15, 2026 | 5:10 PM

Hierarchical Core-Shell cathode with Triple Conductivity: Toward Efficient and Durable Protonic Ceramic Fuel Cells

Prof. Wenlu Li[1]

[1]Hubei University, No. 368 Youyi Avenue, Hubei University, China

Session 06 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 15, 2026, 3:30 PM - 5:35 PM

Protonic ceramic fuel cells (PCFC) are highly efficient and eco-friendly electrical energy production devices at 450-700°C. The cathode in PCFC requires exceptional triple (H+/O2−/e−) conducting properties to ensure efficient oxygen reduction reaction (ORR) kinetics at low temperatures. However, conventional single-phase cathode could not simultaneously be thermal expansion and chemical compatible with electrolytes under high-humidity and oxygen conditions. Also, single phase triple-conductors are insufficient in proton-conducting capability thus limits the cell efficiency. To address these limitations, we propose constructing a hierarchically core-shell electrodes with triple conductivity. Recently, we have been working on fabricating a high-porosity proton-conducting scaffold as the structural backbone to ensure mechanical robustness and rapid proton transport. And then e precision decoration of a mixed oxygen-ion/electron-conducting phase via solution infiltration successfully extends the triple-phase boundary (TPB) across the electrode. Furthermore, surface modification with a robust Ruddlesden-Popper (R-P) perovskite layer could enhance the oxygen surface exchange kinetics on the cathode while imparting CO2/Cr-poisoning resistance. This presentation will highlight focuses on the development of construction of hierarchical core-shell air electrodes with triple conductivity and mechanistic insight on the enhanced catalytic activity by the heterogeneous interfaces, and discuss emerging materials and fabrication strategies to advance the development of high-efficiency and durable PCFCs.

Atomic Layer Surface Engineering of Solid Oxide Cell Electrodes

Professor Jihwan An[1]

[1]POSTECH, Cheongam-ro 232, Namgu, South Korea

Session 07 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

The continued miniaturization of electronic devices has intensified the demand for highly controlled fabrication processes, thereby driving growing interest in atomic-level engineering within the research community. Beyond electronics, this approach holds significant potential for advancing energy conversion and storage technologies, particularly electrochemical systems where surface and interfacial phenomena play a critical role.

For example, solid oxide cells (SOCs), which can operate in both fuel cell mode (generating electricity from hydrogen) and electrolysis mode (producing hydrogen using renewable electricity), represent a promising platform for realizing a future hydrogen-based energy infrastructure. Nevertheless, their broader deployment remains limited by challenges such as inadequate electrochemical performance and durability issues arising from surface and interface degradation.

In this presentation, we will discuss how atomic layer processing techniques can be leveraged to optimize the design and fabrication of interfacial components in energy conversion and storage devices, including SOCs. By utilizing advanced thin-film deposition methods, it becomes possible to enhance both the mechanical and chemical stability of these systems, while simultaneously improving their electrochemical performance.

July 16, 2026 | 8:55 AM

Solid Oxide Fuel Cells: From Materials Research to Industrial Fabrication

Professor Zhipeng Li[1]

[1]Northwestern Polytechnical University, Chang'an campus of Northwestern Polytechnical University，1 Dongxiang Road, Chang'an District , China

Session 07 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Solid oxide fuel cells (SOFCs) can directly convert the chemical energy stored in fuels into electrical energy, achieving power generation efficiencies of 50-60% (LHV). Combined cycle systems can attain efficiencies as high as 60-70%. SOFCs can utilise a diverse range of fuels including low-purity hydrogen, natural gas, coal gas, biogas, propane, methanol, ethanol, and diesel for power generation, effectively addressing fuel purity and transportation challenges at the supply end. In the United States and Japan, SOFCs have seen widespread application in unmanned aerial vehicles, autonomous vehicles, submarines, portable power sources, domestic combined heat and power systems, and data centre power supply. China possesses years of accumulated research in SOFC materials and components, yet lags significantly in practical application and industrialisation. There is an urgent need to increase investment in the large-scale production of SOFC single cells and in the R&D of stack and system technologies. This will enable the development of proprietary SOFC products and advance the practical implementation of SOFC technology within China. This lecture provides an overview of fuel cell materials, fabrication processes, and industrial development. It analyses critical technical challenges in transitioning from laboratory-scale production to industrial manufacturing, explores the application of advanced industrial manufacturing techniques within the SOFC sector, and offers technical support for SOFC industrialisation.

Alloy-Based Electrode Active Materials for Solid-State Fluoride Batteries

Dr. Munekazu Motoyama[1], Akihisa Tanaka[2], Takashi Nakagawa[2], Dr. Katsutoshi Sakurai[2], Dr. So Fujinami[3], Prof. Zempachi Ogumi[3], Prof. Takeshi Abe[4]

[1]Kyushu University Platform of Inter-/Transdisciplinary Energy Research, Kyushu University, , Japan, [2]Research Center of Excellence, Honda R&D Co., Ltd., , Japan, [3]Office of Society-Academia Collaboration for Innovation, Kyoto University, , Japan, [4]Graduate School of Engineering, Kyoto University, , Japan

Session 07 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

There is a growing demand for advanced rechargeable batteries beyond conventional lithium-ion systems. Among the emerging candidates, fluoride-shuttle batteries (FSBs) have attracted attention due to their potential for higher energy densities. In FSBs, both cathode and anode active materials are typically metal fluorides (e.g., CuF_2 and AlF_3). However, their low electronic and fluoride-ion conductivities lead to significant capacity fading during repeated charge-discharge cycles.

We previously evaluated Cu-Ni alloys with various compositions as cathodes for FSBs using thin-film solid-state cells.[1] This thin-film platform enables systematic composition control and well-defined electrode/solid-electrolyte interfaces, making it suitable for fundamental electrochemical analysis. The $Cu_{0.7}Ni_{0.3}$ alloy exhibited superior performance compared with pure Cu and Ni, owing to the formation of a NiF_2 interfacial layer between LaF_3 and the alloy film. This layer suppresses interfacial delamination and promotes fluoride-ion transport, likely via Cu-modified diffusion pathways.

Despite these advantages, $Cu_{0.7}Ni_{0.3}$ does not show sufficient performance at room temperature. Thus, the development of cathode materials for efficient room-temperature operation is essential. Although Ag-based electrodes enable reversible operation at room temperature,[2] their capacities remain lower than those of conventional lithium-ion materials such as graphite and $LiCoO_2$. Hence, new electrode materials that exceed these benchmarks are required. In this study, we present recent progress in alloy-based electrode materials for high-capacity, room-temperature solid-state FSBs.

Acknowledgments:
This paper is based on the results obtained from projects JPNP16001 and JPNP21006, commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

References:
1. Motoyama et al., ACS Appl. Mater. Interfaces, 16, 53631 (2024).
2. Yamamoto et al., ACS Appl. Energy Mater., 8, 108 (2025); Sakurai et al., ACS Appl. Energy Mater., accepted.

Dense Thin-Film BZCYYb Electrolyte via Perovskite-Assisted Low temperature-Sintering for High-Performance Protonic Ceramic Cells

Kwangho Park[1], Su Pei-Chen[1]

[1]Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore

Session 07 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Achieving fully dense, crack-free BaZr1-xCexO3-based thin electrolyte films at reduced temperatures is a major fabrication challenge for protonic ceramic cells (PCCs). The refractory nature of this proton-conducting oxide demands sintering temperatures exceeding 1450°C to reach full densification, imposing severe constraints on co-firing compatibility with porous fuel electrode substrates and limiting the scalability of thin-film cell manufacturing.

While sintering aids incorporated directly into the electrolyte film have been explored, these additives frequently segregate to grain boundaries, disrupting protonic conduction pathways and degrading intrinsic ionic transport. Here, we report an alternative thin-film co-sintering strategy in which a mixed electronic–protonic conducting perovskite is introduced into the fuel electrode support layer, acting as a remote sintering aid that promotes densification of the electrolyte film without contaminating its bulk microstructure. This approach enables co-sintering of the complete cell — thin electrolyte film on porous electrode substrate — at 1250°C, a reduction of approximately 200°C relative to conventional routes, while yielding a well-densified electrolyte film with minimal interlayer delamination and magnified interfacial active sites.

The perovskite additive simultaneously forms a tri-phase composite microstructure within the fuel electrode, extending the electrochemically active zone and enhancing both electronic and protonic percolation. The resulting cell achieves a peak power density of 1.64 W·cm−2 in fuel cell mode and a current density of 2.7 A·cm−2 at 600°C in electrolysis mode (1.3 V). Long-term stability over approximately 700 hours across fuel cell and electrolysis operation confirms the structural integrity of the thin electrolyte film and electrode–electrolyte interfaces under cyclic electrochemical loading.

These results establish perovskite-assisted co-sintering as a scalable thin-film processing route for PCCs, bridging the gap between laboratory-scale performance and manufacturable cell architectures.

Keywords : Thin film electrolyte, BZCYYb, Co-sintering, Electrolyte densification, Protonic ceramic cells

July 16, 2026 | 10:00 AM

Enhanced Stability and Electrocatalytic Activity of Nanoporous Silver Cathodes via Two-Step Electrochemical Deposition of PrOx Overlayers

Dr. Hyunseung Kim[1], Soyeon Shin, Professor Pei-Chen Su

[1]Nanyang Technological University, , Singapore

Session 07 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 8:30 AM - 10:15 AM

Thin-film solid oxide fuel cells (SOFCs) have been extensively investigated to lower operating temperatures and enhance device cost-competitiveness. While nanoporous silver (Ag) is a highly attractive cathode material due to its exceptional oxygen reduction reaction (ORR) activity at lower temperatures, its practical application is severely hindered by thermal instability and agglomeration. Building upon our previous work that utilized cathodic electrochemical deposition (CELD) for structural stabilization, here we propose an advanced, two-step CELD strategy employing a praseodymium oxide (PrOx) overcoat to further enhance both the stability and electrochemical performance of Ag electrodes. Although the Ag framework serves as an outstanding electronic conductor with high ORR activity, the addition of the PrOx layer provides exceptional mixed ionic and electronic conduction and further accelerates surface oxygen exchange kinetics. By systematically controlling the deposition variables, the two-step CELD process not only effectively suppresses the thermal agglomeration of the underlying nanoporous Ag framework but also maximizes the specific surface area of the PrOx overcoating. This precise microstructural optimization dramatically increases the density of active reaction sites. Consequently, the PrOx -decorated Ag cathodes exhibit significantly enhanced ORR kinetics, achieving a low activation energy of 0.80 eV and an impressively low area-specific resistance of 1.71 Ω·cm2 at 400°C. Furthermore, the electrodes demonstrate outstanding long-term durability at temperatures up to 550°C, highlighting the profound potential of this advanced deposition strategy for high-performance, low-temperature SOFCs.

Toward Understanding and Regulating the Electrode-Electrolyte Interfacial Chemistry of Layered Oxide Cathodes under High-Voltage Operation for Sodium-Ion Batteries

Zhigao Chen[1]

[1]Northwestern Polytechnical University, 127 West Youyi Road, China

Session 08 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Sodium-ion batteries (SIBs) have attracted significant attention for large-scale energy storage due to their resource availability and cost-effectiveness. However, a substantial energy density gap remains between SIBs and commercial lithium-ion batteries (LIBs), posing challenges for practical applications. Layered-oxide cathodes (LOCs) have emerged as a promising cathode for SIBs due to their advantages in specific capacity and cost-effectiveness. Elevating the charging cut-off voltage without altering the cathode chemistry is a straightforward and efficient approach to increase both reversible capacity and working voltage, thereby boosting the energy density of SIBs. Nevertheless, LOCs face interfacial parasitic reaction challenges at high voltages, including irreversible phase transitions, migration and dissolution of metal cations, and loss of reactive oxygen. These issues severely impede the stable operation of LOCs. Although extensive efforts have been made to improve the compatibility between LOCs and electrolytes, achieving stable operation beyond 4.3 V remains challenging. Thus, there is an urgent need for comprehensive research into the high-voltage stability of LOCs for SIBs, with particular emphasis on understanding their failure mechanisms and exploring relevant interfacial modification techniques. In our work, we mainly research includes investigate the underlying mechanisms of performance degradation, the development of employing advanced characterization methods, and design novel structures for LOCs, aiming to shed light on the key challenges and failure mechanisms encountered by LOCs when operated in high-voltage regions. Additionally, the corresponding strategies for improving the high-voltage stability of LOCs are comprehensively summarized. Generally, unstable structures and electrode/electrolyte interfaces pose tough challenges for LOCs operating at high voltages, and there is still a challenge in improving both the energy density and cycle life of SIBs. We firmly believe that with the continuous joint efforts and cooperation of academia and industry, the application and large-scale implementations of viable high-energy SIBs are in the near future.

Rare-Earth Nd-Doped Sr2Fe1.6Cu0.4O6-δ Double Perovskite Cathode: Mechanistic Insights into Oxygen Electrocatalysis for Reversible LT-SOFCs

Yuzheng Lu Lu[1], Mushataq Naveed[1], Haijun Wang[1]

[1]Nanjing Xiaozhuang University, ,

Session 08 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

The development of efficient and durable oxygen electrodes is critical for advancing reversible low-temperature solid oxide fuel cells (LT-SOFCs). In this work, a rare-earth-engineered double perovskite, Nd-doped Sr2Fe1.6Cu0.4O6-δ, is investigated as a high-performance cathode material with enhanced oxygen electrocatalytic activity. The partial substitution of Sr2+ with Nd3+ induces lattice distortion and modulates the electronic structure, leading to an increased concentration of oxygen vacancies and improved charge transfer kinetics. Comprehensive structural, microstructural, and electrochemical analyses reveal that Nd incorporation stabilizes the perovskite structure while promoting mixed ionic/electronic conductivity. Electrochemical impedance spectroscopy demonstrates significantly reduced polarization resistance, highlighting accelerated oxygen reduction and evolution reactions (ORR/OER) under both fuel cell and electrolysis modes. Mechanistic investigations suggest that the synergistic interaction between Fe/Cu redox couples and Nd-induced defect chemistry facilitates rapid oxygen surface exchange and bulk diffusion. As a result, Nd-doped Sr2Fe1.6Cu0.4O6-δ exhibits excellent electrochemical performance and stability at reduced operating temperatures (≤ 600 °C), outperforming the undoped counterpart. This study provides fundamental insights into rare-earth-driven defect engineering and establishes Nd-doped Sr2Fe1.6Cu0.4O6-δ double perovskites as promising cathode candidates for next-generation reversible LT-SOFCs.

Efficient Fabrication of LaGaO3-Based SOFCs via Low-Temperature Electrode Co-sintering

Hye Young Kim[1,2], Yeon Seo Jung[1], Prof. Younki Lee[2], Dr. Tae Ho Shin[1]

[1]Korea Institute Of Ceramic Engineering And Technology, , South Korea, [2]Gyeongsang National University, , South Korea

Session 08 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Fabricating high-performance LaGaO3-based solid oxide fuel cells (SOFCs) presents significant manufacturing challenges. A primary issue is the potential for deleterious interfacial reactions between the electrolyte and electrodes during sintering. To mitigate this, conventional methods often require separate firing steps for the anode and cathode. This multi-step process inevitably increases both fabrication time and energy costs. In this study, we propose a streamlined solution using a (Gd,Yb,Bi)CeO2 (GYBC) buffer layer. This novel interlayer enables the simultaneous co-sintering of both the anode and cathode in a single thermal cycle at a reduced temperature of 1000 °C. The GYBC layer functions as a robust barrier, effectively preventing the formation of resistive secondary phases. Furthermore, it ensures excellent chemical compatibility and adhesion at the electrode-electrolyte interface. The electrochemical performance of the resulting cells was exceptional. We achieved maximum power densities of 1.19 W cm-2 at 800°C and 1.70 W cm-2 at 850°C. These results indicate that the GYBC layer facilitates oxygen ion transport. Consequently, our low-temperature electrode co-firing strategy offers a highly efficient pathway for reducing production complexity while maintaining superior cell outp

Enhanced proton transport and chemical stability in multi-cation doped perovskites enabled by grain boundary engineering and bilayer electrolyte design

Baoshui Wu[1]

[1]China University Of Mining And Technology, ,

Session 08 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Proton-conducting oxides show great potential for intermediate-temperature electrochemical devices. However, their performance is often limited by grain boundary transport resistance and the trade-off between conductivity and chemical stability. In this work, we design and synthesize a multi-cation B-site doped perovskite proton conductor, BaZr0.4Ce0.2Y0.14Gd0.13Sc0.13O3-δ (4214). The material exhibits high conductivity in the intermediate temperature range. Impedance analysis combined with brick-layer model normalization shows that the enhanced grain boundary conductivity is not only due to increased grain size, but also originates from the intrinsic improvement of grain boundary transport properties. Further analysis based on the space charge layer model reveals that 4214 possesses a lower grain boundary potential barrier ($\Delta\varphi_0$) and a narrower space charge layer width, which facilitates proton transport across grain boundaries. Charge carrier analysis indicates that proton conduction dominates at intermediate temperatures, while mixed conduction appears at elevated temperatures. Based on these characteristics, we construct a bilayer electrolyte using 4214 and BZCYYb1711. The stable layer protects the high-conductivity layer, enabling a balance between conductivity and chemical stability. The resulting single cell shows good electrochemical performance and long-term stability at 550-700 °C. This work provides an effective strategy to overcome the trade-off between conductivity and stability in proton-conducting electrolytes through grain boundary engineering and structural design.

DIRECT AMMONIA TUBULAR PROTONIC CERAMIC FUEL CELLS

Prof. Ting Chen[1], Prof. Shaorong Wang[1], **Zichen Zhuang**[1]
[1]China University of Mining and Technology, , China
Session 08 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Protonic ceramic fuel cells (PCFCs) have attracted increasing attention due to their high efficiency, all-solid-state configuration, low operating temperature, and environmentally friendly characteristics. However, their practical application remains limited by several critical issues, including the poor sinterability of electrolytes, insufficient air electrode stability, inadequate mechanical strength, and the lack of mature large-scale fabrication technologies. To address the mechanical weakness of conventional cells, tubular PCFCs offer a promising solution because of their superior structural robustness, improved thermal tolerance, easier sealing, and better suitability for scale-up.

In this work, a simple and efficient extrusion method was developed to fabricate high-performance tubular PCFCs with excellent long-term stability. In addition, longer tubular cells were successfully prepared and evaluated, further demonstrating the feasibility of this fabrication strategy for practical application.

Ammonia is considered an ideal fuel for PCFCs because of its high energy density, low storage and transportation cost, carbon-free nature, and well-established infrastructure. However, direct ammonia-fueled PCFCs still suffer from sluggish anode catalytic activity, poor stability, and low ammonia conversion at intermediate and low temperatures. To overcome these limitations, a PSNFM ammonia anode catalyst was designed. Under reducing conditions, this catalyst can in situ exsolve core-shell FeOx@NiFe alloy nanoparticles, providing enhanced catalytic activity for ammonia decomposition and improved durability. When applied to tubular PCFCs operated directly with ammonia, the PSNFM catalyst significantly improves cell performance and enables excellent stability at intermediate and low temperatures. This work provides an effective strategy for developing robust and efficient tubular PCFCs for direct ammonia utilization.

Hydrogen-free exsolution of Ir–Fe nanoalloys on the surface of solid oxide cell perovskite air electrodes

Dr Jiyoon Shin[1], Myung-Jin Jung[2], Dr Se-Hun Kwon[2], Dr Pei-Chen Su[1]

[1]Nanyang Technological University, , Singapore, [2]Pusan National University, , Republic of Korea

Session 08 - SS3: Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Seletar2 - Level 3, July 16, 2026, 10:45 AM - 12:00 PM

Metastable oxygen vacancies govern oxygen exchange kinetics in perovskite oxide cathodes but rapidly annihilate under high-temperature oxidizing conditions, leading to performance degradation. Stabilizing these intrinsically unstable defects without sacrificing activity remains a critical challenge. Here, we present a thin-film strategy that exploits atomic layer deposition (ALD) chemistry to imprint nitrogen and stabilize a defect-rich TiOx overlayer on $Sr_2Fe_{1.5}Mo_{0.5}O_6-\delta$ (SFMO) cathodes.

By tuning the growth temperature of tetrakis(dimethylamido)titanium (TDMATi), we control precursor decomposition and defect formation pathways. Low-temperature ALD (120 °C) kinetically traps ligand-derived nitrogen within an amorphous TiOx matrix, whereas higher-temperature growth (200 °C) produces nitrogen-deficient films. Upon annealing at 800 °C in air, the nitrogen-imprinted TiOx evolves into a disordered anatase phase while retaining a high concentration of oxygen vacancies, in contrast to the near-stoichiometric rutile TiO_2 formed at higher growth temperatures.

Spectroscopic analysis confirms that retained nitrogen stabilizes distorted Ti–O coordination and suppresses vacancy annihilation by forming a defect-pinning scaffold. Transmission electron microscopy reveals conformal ~3 nm coatings with preserved interfacial integrity and no evidence of Sr-derived secondary phases after annealing. Electrochemical impedance spectroscopy shows that the nitrogen-stabilized TiOx coating reduces polarization resistance to 0.276 $\Omega \cdot cm^2$, outperforming both bare SFMO and stoichiometric TiO_2-coated electrodes. Distribution of relaxation times analysis further attributes this enhancement to accelerated surface charge transfer and oxygen incorporation kinetics. Simultaneously, Sr surface segregation is effectively suppressed, indicating improved interfacial stability.

This work establishes ligand-derived nitrogen imprinting as a generalizable thin-film design principle for stabilizing metastable defect architectures under extreme conditions. By transforming ALD precursor chemistry into a defect-engineering tool, this approach enables durable, high-performance oxide interfaces for solid oxide electrochemical systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Initial Surface Control via Impurity-Free Accelerators for Low-Resistivity, Ultrathin ALD-Ir Films in Advanced Interconnects

Myungjin Jung[1], Se-Hun Kwon[1]

[1]Pusan National University, 2nd Engineering Bldg, 2, Busandaehak-ro 63beon-gil, Geumjeong-gu, Republic of Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Iridium (Ir) has recently been spotlighted as a potential copper (Cu) alternative interconnect material for next-generation semiconductor devices due to its low figure of merit ($\rho_0 \times \lambda$) and a high cohesive energy. In particular, atomic layer deposition (ALD) enables the deposition of ultrathin, conformal, and uniform films with excellent step coverage, even in highly complex or narrow trench structures of several-nm dimensions, due to its inherent self-limiting characteristic. In this regard, ALD-Ir is considered one of the most suitable metallization processes for advanced semiconductor interconnect applications.

To develop a reliable ALD-Ir process with improved film quality, considerable efforts have been made. Recently, an ALD-Ir process exhibiting low electrical resistivity and negligible oxygen impurities was reported using Tricarbonyl (1,2,3-η)-1,2,3-tri(tert-butyl)-cyclopropenyl iridium (TICP or $C_{18}H_{27}IrO_3$) precursor and oxygen [1]. However, despite these advantages, this TICP precursor exhibits a long incubation period and high nucleation delay, making it difficult to deposit extremely thin and continuous Ir films on dielectric substrates.

Therefore, in this study, we propose an initial surface control strategy via impurity-free accelerators to reduce incubation time and promote nucleation on dielectric surfaces. This approach preserves the impurity-free nature of the process while enhancing surface reactivity without altering the underlying device structure. Furthermore, we systematically compare the nucleation behavior, growth characteristics, and film properties of ALD-Ir with and without the proposed surface control.

As a result, ultrathin ALD-Ir films with thicknesses below 10 nm were successfully achieved, exhibiting excellent uniformity, low surface roughness, and low resistivity even on dielectric substrates. These results demonstrate that impurity-free accelerator-assisted surface control provides a viable pathway for advanced interconnect metallization and future nanoscale semiconductor device integration.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Structural Optimization of ALD Al_2O_3/ZrO_2 Nanolaminate Thin Films for Improving the Corrosion Resistance of SUS304 Stainless Steel

JaeHyun Kim, SeHun Kwon[1]

[1]Pusan National University, 2, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan, 46241, Republic of KOREA

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Stainless steel(SUS304) is a corrosion-resistant alloy widely used in mechanical, electronic, and marine applications. Its chromium oxide–based passive film provides good corrosion resistance under normal conditions, but micro-defects and Cr-rich precipitates formed during processing act as corrosion initiation sites, reducing long-term stability. To improve durability, various surface protective coatings have been developed, among which oxide coatings. However, conventional physical vapor deposition (PVD) methods, based on line-of-sight deposition, have difficulty achieving uniform nanometer-scale coatings and often leave pinholes and grain boundaries that allow corrosive ion penetration. In this study, Al_2O_3/ZrO_2 nanolaminate coatings were fabricated using ALD to form dense, conformal oxide films. Amorphous Al_2O_3 serves as a chemical barrier against ion diffusion, while ZrO_2 improves interfacial stability. Lamination structure creates tortuous diffusion paths, effectively slowing corrosive ion transport. Unlike single-layer coatings, the laminated structure maintains protection even when one layer is damaged, enhancing long-term corrosion resistance. Electrochemical analyses confirmed that the ALD-based nanolaminate films exhibited significantly higher resistance to saline corrosion than single-layer coatings.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Preparation and High-Temperature Thermal Stability Study of Si/DLC nano-multilayer films

Yongxian Lin[1], Chuan dong Zhang[1], Ding Chen[1], **Zhen huai Yang**[1], Wei Dai[2]
[1]Jihua Laboratory, , China, [2]Guangdong University of Technology, , China
Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Diamond-like carbon (DLC) films, due to their high hardness, chemical inertness, low friction coefficient, and tunable electrical properties, have been applied in the semiconductor field as etching hard masks, diffusion barrier layers, passivation layers, and anti-sticking coatings, demonstrating broad application prospects. However, pure DLC films suffer from high internal stress, sp^3-C to sp^2-C transformation and graphitization under high temperature, and insufficient thermal stability, severely limiting their application in high-temperature semiconductor manufacturing. To address this bottleneck, this study proposes a method combining magnetron sputtering with filtered cathode vacuum arc (FCVA): magnetron sputtering of a silicon target yields a dense Si layer, while FCVA effectively filters neutral atoms and macroscopic ions, with high-ionization plasma assisting in preparing high-quality DLC layers. By alternating these techniques, Si/DLC nano-multilayer films were fabricated on cemented carbide and silicon wafer substrates, achieving periodic growth of Si and DLC layers and constructing a nano-multilayer structure with uniform structure and tight film-substrate bonding. Using Raman spectroscopy, transmission electron microscopy (TEM), and nanoindentation, the films' microstructure, mechanical properties, and high-temperature thermal stability were systematically studied, focusing on the ID/IG ratio, hardness, and surface/section changes after high-temperature annealing. The results show that compared to pure DLC, the Si/DLC nano-multilayer exhibits a smaller change in ID/IG ratio after 700°C annealing; with a thinner Si layer and reasonable multilayer cycles, the ID/IG ratio remains as low as 0.6. This study clarifies the synergistic enhancement mechanism of the Si/DLC multilayer structure on film thermal stability, optimizes preparation parameters, and provides theoretical and technical support for the engineering application of Si/DLC nano-multilayer films in high-temperature fields such as semiconductors and aerospace.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Application of Nickel and Rare Earth Metal co-doped Ceria for Direct Ammonia Solid Oxide Fuel Cells

Dr. Jong-Eun Hong[1,2], Ms Min-hyeong Seo[1,3], Mr Hosik Hahn[4], Prof Jeong Woo Han[4]
[1]Korea Institute Of Energy Research, 152 Gajeong-ro, Yuseong-gu, South Korea, [2]University of Science and Technology, 217 Gajeong-ro, Yuseong-gu, South Korea, [3]Korea University, 145 Anam-ro, Seongbuk-gu, South Korea, [4]Seoul National University, 1 Gwanak-ro, Gwanak-gu, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

For the deployment of direct ammonia-solid oxide fuel cells (DA-SOFCs), it is necessary to develop an anode material with high activity and durability for ammonia decomposition. In this study, we synthesized fluorite-structured CeO_2 catalysts co-doped with Ni and rare earth metals (Sm, Nd, Pr, or La) and analyzed the characteristics of ammonia cracking and the performance of DA-SOFCs incorporating these catalysts. The substitution of rare earth metals affected formation of oxygen vacancies on CeO_2 surface and exsolution behavior of Ni particles. In particular, La doping increased oxygen vacancy formation on the CeO_2 surface due to high segregation energy, resulted in the increase in Ni exsolution. As a result, La and Ni-doped CeO_2 (LNDC) indicated enhanced ammonia decomposition reaction, led by promotion of electron donation via exsolved Ni nanoparticles. When the developed catalyst was applied to a fuel electrode-supported SOFC via an ultrasonic spray infiltration process and evaluated under direct ammonia operation, the maximum power density at 650°C increased by approximately 28 % compared to that of a cell without catalyst, reaching 0.8 W/cm², due to a reduction of polarization resistance. Furthermore, high durability was observed without performance degradation over 100 hours. Accordingly, this study demonstrates that an approach based on a simultaneous substitution strategy of Ni and rare earth metals is effective for designing highly active and durable catalysts for the direct utilization of ammonia in intermediate temperature SOFCs.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Inhibiting CO2-Driven Carbon Deposition in Dry Reforming of Methane

Taein Lee[1], Corresponding Author Jeong Woo Han[1]

[1]Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Dry reforming of methane (DRM) converts two greenhouse gases, CH4 and CO2, into syngas, a practical feedstock for solid oxide fuel cells and other energy conversion systems. While catalyst deactivation through carbon deposition and metal sintering has long been recognized as a central challenge, most prior efforts have focused on CH4-derived coking. CO2-driven coke formation remains comparatively underexplored, despite its distinct mechanistic origin and equally detrimental consequences.

To address these challenges, we designed a Pt-decorated Ni catalyst supported on La-doped CeO2, denoted Pt–Ni/LaDC, where Pt drives CO2 activation and Ni handles CH4 dissociation. This division of labor balances both reaction pathways simultaneously. The catalyst sustained methane conversion activity of 159.6 μmol CH4 per g catalyst per second over 100 hours at 600 °C, to our knowledge the highest reported at this temperature.

Comparison across reference catalysts, including Ni/CeO2, Ni/LaDC, and Pt–Ni/CeO2, isolated the role of each component. La incorporation into the CeO2 lattice generated oxygen vacancies, reduced crystallite size, and tightened metal–support interactions, together suppressing Ni sintering and preserving its metallic, active state. Critically, multi-modal operando characterization combined with DFT and machine learning interatomic potential simulations uncovered a CO2-specific coking pathway. In the absence of Pt, CO2 accumulates at Ce–vacancy–La surface sites and undergoes Boudouard-type conversion to deposited carbon. This coke disperses across the CeO2 support and directly blocks CO2 activation sites, creating a self-reinforcing deactivation loop that further impairs coke gasification. Pt decoration breaks this cycle by reshaping surface basicity, enabling efficient CO desorption before carbon nucleation can occur.

This work repositions CO2-driven coking as a mechanistically distinct and underappreciated deactivation pathway, and offers a catalyst design framework for suppressing it in reforming systems integrated with sustainable energy conversion.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Effect of Rotation Speed on the Microstructure, Surface Properties, and SOFC Performance of DC-sputtered GDC Functional Layers

Geonhyeop Kim[1], Kiwon Hong[1], Gu Young Cho[1]

[1]Dankook University, 152 Jukjeon-ro, Suji-gu, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Solid oxide fuel cells (SOFCs) have attracted considerable attention as next-generation energy conversion devices because of their high efficiency and fuel flexibility. However, their high operating temperature remains a major drawback, and thin-film SOFCs have been actively studied to address this issue. In this context, sputtered functional layers have been widely investigated because they can increase the electrochemical reaction area and improve interfacial reaction activity.

In this study, a GDC functional layer was formed on a YSZ electrolyte substrate by DC sputtering using a Gd_Ce metal target, and the relationship between the structural characteristics of the film and SOFC performance was analyzed by controlling the substrate rotation speed as a process parameter. As the rotation speed increased, the GDC particles became finer and the structure became denser. Accordingly, the surface roughness tended to decrease. However, under an excessively high rotation speed, structural instability occurred, which resulted in performance degradation. These behaviors were examined by SEM, AFM, XRD, residual stress analysis, and crystallite size analysis based on the Scherrer equation. The electrochemical properties were evaluated by J–V–P and EIS measurements. As a result, the Middle RPM condition showed the best performance, which was attributed to a balanced combination of particle refinement, appropriate surface characteristics, and structural stability. This study goes beyond a simple performance comparison and suggests that controlling the deposition process of a Gd_Ce-based GDC functional layer can improve the feasibility of thin-film SOFC fabrication. It also shows that substrate rotation speed can act as a key process parameter that simultaneously affects the microstructure, stress state, and electrochemical performance of the functional layer.

ACKNOWLEDGEMENT

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT). (No. RS-2023-00213741)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Engineering electrode surface via Cerium-coating for High-Performance Protonic Ceramic Fuel Cell

Mr. Yoon Seo Park[1], Dr. Kwangho Park[1], Prof. Pei-Chen Su[1]

[1]Nanyang Technological University, 50 Nanyang Avenue, 639798, Singapore

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Protonic ceramic fuel cells (PCFCs) operating in the intermediate temperature range (400–650 °C) hold significant promise due to their high theoretical efficiency. However, their practical performance remains constrained by sluggish oxygen reduction reaction (ORR) kinetics and instability at the electrode–electrolyte interface. Addressing these challenges requires electrode materials that simultaneously exhibit high catalytic activity and a low thermal expansion coefficient (TEC) compatible with the electrolyte. Cobalt-based perovskite materials are widely recognized for their superior catalytic performance, due to their high oxygen non-stoichiometry and excellent charge-transfer properties. Nevertheless, a critical drawback of cobalt-based oxides is their substantially elevated TEC relative to BZCYYb electrolyte, which can lead to delamination or poor interfacial adhesion. Mitigating TEC mismatch is necessary for ensuring the long-term structural integrity of the full cell.

Among various candidates, PBSCF ($PrBa_{0.5}Sr_{0.5}Co_{1.5}Fe_{0.5}O_{5+\delta}$) has emerged as an exceptionally promising cathode material with well-defined crystallographic channels for oxygen-ion transport and rapid surface oxygen exchange kinetics. Moreover, the optimized co-substitution of Sr and Fe at the Ba and Co sites enhances electrical conductivity while improving both chemical and thermal compatibility with the electrolyte. Despite these advantages, the high cobalt content of PBSCF results in high TEC, giving rise to a persistent performance–stability trade-off.

To overcome these limitations, we introduce a powder coating treatment in which cerium (Ce)-based coating is applied to the PBSCF cathode for the modification of the electrode surface and the cathode/electrolyte interface. During sintering, Ce ions react with PBSCF constituents to form BaCe-based thin film, which act as buffer layers at the interface, mitigating TEC mismatch and preserving structural bonding. Furthermore, the surface modification introduces supplementary active sites for oxygen reactions, effectively expanding the electrochemical reaction zone and enhancing overall catalytic activity. This integrated strategy offers a practical and robust pathway toward high-performance PCFCs with improved long-term durability.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Entropy-driven B-site disorder in La0.6Sr0.4Co0.2Fe0.8O3-δ-based perovskites: DFT insights into surface oxygen reactivity and Sr segregation suppression

Ms. Hwakyoung Seo[1], Dr. Hyunmin Kim[2], Pf. Jihwan An[2], Pf. Jeong Woo Han[1]
[1]Seoul National University, 1, Gwanak-ro, Gwanak-gu,, South Korea, [2]Pohang University of Science and Technology, 77, Cheongam-ro, Nam-gu,, South Korea
Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Perovskite oxides are the material of choice for solid oxide cell (SOC) air electrodes owing to their balanced electrocatalytic activity and mixed ionic-electronic conductivity at elevated temperatures. Among these, $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$-δ (LSCF) has been widely studied, given its high conductivity and compatibility with common electrolytes. However, its long-term performance is compromised by Sr surface segregation, which forms insulating SrO phases that block active sites and accelerate degradation. B-site cation substitution has been identified as a route to stabilize Sr within the bulk via internal lattice strain, while simultaneously tuning oxygen vacancy concentration and surface reactivity. This work investigates a series of B-site-doped LSCF derivatives, $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.7}Ni_{0.1}O_3$-δ (LSCFN) and $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.6}Ni_{0.1}Mn_{0.1}O_3$-δ (LSCFMN), extending this strategy to multi-element co-doping.

Experimentally, progressive B-site doping improved full-cell electrochemical performance and operational stability: peak power density increased from 0.48 W cm^{-2} (LSCF) to 1.11 W cm^{-2} (LSCFN) and 1.33 W cm^{-2} (LSCFMN) at 750°C in fuel cell mode. Under electrolysis conditions, LSCFMN delivered 1.26 A cm^{-2} at 750°C. To rationalize these trends, density functional theory calculations were performed across the LSCF, LSCFN, and LSCFMN slab models. Oxygen vacancy formation energies decrease progressively with increasing dopant contents, consistent with the experimentally observed enhancement in ionic conductivity. Sr surface segregation energies become less favorable along the same series, in agreement with the suppressed Sr segregation observed experimentally. O_2 adsorption and dissociation energies were further evaluated, along with surface oxygen migration barriers, providing a computational basis for the improved surface reaction kinetics.

Taken together, the results indicate that entropy-driven B-site disorder simultaneously suppresses Sr segregation and lowers the energy barriers relevant to oxygen electrocatalysis, offering a design principle for durable SOC air electrodes.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Characteristic Time Integration to Characterize Gas Diffusion and Surface Reaction Step of Oxygen Reduction Reaction via Porous Electrocatalyst for Solid Oxide Fuel Cell

Ning Pan[1]

[1]University of Science and Technology of China, No. 96 Jinzhai Road, Hefei, Anhui Province, 230026, P. R. China., China

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

An analytical method, characteristic time integration (CTI), is proposed to characterize the gas transportation and surface reaction steps of high-temperature oxygen reduction reaction (ORR) in porous composite electrocatalysts for solid oxide fuel cells. The new method is developed from the previously reported characteristic time distribution (DCT) theory that is proposed to analyze the ORR kinetics in porous electrode materials based on the electrical conductivity relaxation (ECR) experiments. This method considers all the characteristic time in the DCT spectrum, gives weighted average characteristic time, defines the minimum characteristic time, and thus calculates the intrinsic surface exchange coefficient as well as the hindrance factor of gas diffusion. This method is demonstrated with porous composites consisting of mixed electron-ion conductor of Sr2Fe1.5Mo0.5O6−δ (SFM) as the electrocatalyst and oxygen-ion conductor Sm0.2Ce0.8O1.9 (SDC) as the additives. The composites have close porosities in the range of 0.345-0.38 and similar pore size distributions but different SDC contents and thus various densities in three-phase boundaries (TPBs), which are obtained through three-dimensional reconstruction using electron microscopy back-scattered images. The effective surface oxchange coefficients of the composites are determined with the CTI method based ECR profiles, and the surface exchange coefficient at TPBs and the activity per unit length of the three-phase line are calculated. At SDC content of 9.06 vol%, the composite exhibits the highest ORR rate and TPB activity. In addition, the gas diffusion effect is calculated with the minimum characteristic time, which proves that the attenuation effect of gas diffusion in pores on ORR process can reach 15.5% in the porous composite.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Understanding and mitigating Cr-induced surface electron depletion on La0.6Sr0.4Co0.2Fe0.8O3-δ oxygen electrodes

Hosik Hahn[1], Jeong Woo Han[1]

[1]Seoul National University, 1 Gwanak-ro, Gwanak-gu, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

The long-term operational stability of solid oxide fuel and electrolysis cells (SOFCs/SOECs) is critically hindered by Cr poisoning, originating from the volatile Cr species released by Fe–Cr metallic interconnects. While La0.6Sr0.4Co0.2Fe0.8O3-δ (LSCF) is a premier oxygen electrode material due to its high mixed ionic-electronic conductivity and catalytic activity, its surface specific vulnerability to Cr species requires a fundamental atomistic understanding to develop effective mitigation strategies.

In this study, we employed density functional theory (DFT) calculations to study the impact of Cr poisoning at the LSCF electrode surface. Electronic structure analysis reveals that Cr adsorption induces a significant downward shift of the O 2p band center relative to the Fermi level, which serves as a descriptor for the substantial loss of surface catalytic reactivity. Simultaneously, the strong electron-withdrawing nature of the acidic Cr species triggers severe surface electron depletion. This electronic restructuring promotes the preferential formation of oxygen vacancies at the gas-electrode interface rather than within the bulk lattice. The resulting redistribution leads to a disproportionately high concentration of surface vacancies, which subsequently serves as an electrostatic driving force for Sr segregation due to the attractive interaction between positively charged vacancies and negatively charged Sr dopants.

To mitigate Cr poisoning, we investigated basic oxide coatings as a surface functionalization strategy. Our calculations reveal that these basic layers effectively suppress the observed adverse trends by preventing surface electron depletion and stabilizing the O 2p states. By neutralizing the fundamental driving forces for vacancy accumulation and Sr segregation, the basic oxide layer preserves the structural and electronic integrity of the LSCF surface. These results provide a comprehensive atomistic basis for Cr-induced degradation and highlight the importance of precise surface engineering with basic oxides to enhance the longevity of next-generation SOFC/SOEC systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Scale-Dependent Transport Behavior Governed by Electrode Morphology in Solid Oxide Fuel Cells

Donghyun Kim[1], Sangcheol Jang[1], Hyunho Lee[1], Hyunwoo Cho[1], Wonjong Yu[1]
[1]Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Solid oxide fuel cells (SOFCs) are promising energy conversion devices because of their high efficiency and fuel flexibility. Their performance is determined not only by intrinsic material properties but also by electrode morphology, particularly when the characteristic dimensions are reduced to the micro-scale and nanoscale. In this study, a three-dimensional multiphysics simulation was performed to examine how key electrode morphological parameters, including porosity, electronic phase tortuosity, and thickness, influence transport phenomena and electrochemical performance in SOFCs. The results show that the dominant resistance mechanism changes with electrode thickness. For sub-micron electrodes, ohmic loss becomes increasingly governed by in-plane electron transport limited by electronic phase tortuosity. As the electrode becomes thicker, the dominant performance-limiting mechanisms shift toward porosity-related effects, with reaction kinetics and gas transport contributing more strongly to the overall overpotential. Area-specific resistance analysis further reveals a trade-off between structural dimensions and transport efficiency. In addition, reducing electrolyte thickness increases the sensitivity of cell performance to electrode morphology by lowering ionic resistance and amplifying the relative importance of electronic transport limitations. These results highlight the importance of morphology-aware electrode design and provide practical guidelines for improving the performance of structure-optimized SOFC electrodes.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Engineering of Heterointerface Structure for Highly Active Alkaline HER Catalysts

Do Yeon Kim[1], Ms. Seulgi Choi[1], Prof. Kyeounghak Kim[1]

[1]Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Alkaline hydrogen evolution reaction (HER) is an attractive way for economical green hydrogen production. However, its performance is limited by sluggish reaction kinetics due to the additional water dissociation step under alkaline conditions. In this study, we designed a Ni–NiO–CoO/MoO3-x heterointerface by integrating metallic Ni with the NiO–CoO/MoO3-x catalyst, which was reported as a promising heterointerface structure for HER. To investigate the effect of metallic Ni deposition on HER activity at the NiO–CoO interface, we calculated H adsorption free energy (ΔGH*) as a catalytic descriptor of HER using density functional theory (DFT). The calculated results showed that, in the NiO–CoO/MoO3-x model, the CoO–MoO3-x interface exhibited the ΔGH* value closest to 0 eV (−0.16 eV), followed by the CoO site, NiO, and NiO-MoO3-x site. In the Ni–NiO–CoO/MoO3-x model, the CoO–MoO3-x interface still exhibited a near-optimal ΔGH* value, indicating that this interface continued to contribute to HER activity. However, the Ni–NiO interface was identified as the optimal active site, with a ΔGH* value of 0.09 eV, which was closer to the thermodynamic optimum than that of the NiO–CoO/MoO3-x. These results indicate that the introduction of metallic Ni does not simply provide a new metallic active site but rather enables more precise tuning of the hydrogen adsorption free energy through the formation of the Ni–NiO interface. Furthermore, this study highlights multi-heterointerface engineering as an effective strategy for highly active alkaline HER catalysts.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Computational Approach to Insights into Binary Oxide Infiltration for PCFC Electrode

Uchan Jeon[1], Jeong Woo Han[1]

[1]Seoul National University, , Republic of Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Previous research has shown that basic binary oxide infiltration can effectively mitigate degradation and promote the recovery of protonic ceramic fuel cell (PCFC) electrode performance. Despite these remarkable effects, a detailed understanding of the underlying surface modifications remains limited because of the complex interactions associated with oxide treatments. This study aims to clarify the phenomena induced by surface treatments, including the formation of oxygen vacancies, work function changes, and electron exchange. Considering experimental conditions, we constructed a realistic heterostructure model using a density functional theory (DFT)-based approach. The model reveals a linear correlation between the work function of binary oxide-treated electrode surfaces and the acidity of the binary oxides. Density of states (DOS) and Bader charge analyses further detail the charge transfer between the electrode surface and the binary oxides. Applying this theoretical framework to specific degradation mechanisms, we investigated the effects driven by acidic oxides. We observed that CrO_3 infiltration induces Ba deficiency within the electrode, which subsequently accelerates degradation and increases the work function. Furthermore, a comparative analysis of $BaCrO_4$ and CrO_3 revealed that $BaCrO_4$ is not the direct cause of this performance degradation. These theoretical insights are corroborated by experimental electrochemical impedance spectroscopy (EIS) measurements, which systematically verify the electrode degradation caused by acidic oxides alongside the performance enhancement driven by basic oxides. This combined theoretical and experimental work provides a robust basis for strategies to mitigate degradation and promote the enhancement of PCFC electrode performance.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Enhancing SOFC Electrode Activity via Surface Modification of Perovskite Oxides Electrodes

Dr. Hao-yang Li[1], Prof. Pei-Chen Su[1]

[1]Nanyang Technological University, , Singapore

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Solid oxide cells (SOCs) are highly efficient electrochemical energy conversion devices, in which perovskite oxides are widely used as mixed ionic–electronic conducting (MIEC) electrodes. However, regardless of whether they function as cathodes or anodes, their electrochemical activity is often limited by sluggish surface exchange kinetics and a scarcity of highly active catalytic sites.

In this work, surface modification is employed as an effective strategy to enhance the intrinsic activity of perovskite electrodes. The coatings of catalytically active nanoparticles are introduced onto the electrode surface to tailor surface chemistry and accelerate surface electrochemical processes. These coatings generate additional active sites and promote more efficient gas adsorption, dissociation, and incorporation.

As a result, the modified electrodes exhibit significantly improved electrochemical activity, as evidenced by reduced polarization resistance and accelerated surface reaction kinetics under typical SOC operating conditions. The enhanced performance is attributed to the synergistic interaction between the nanoparticles and the underlying perovskite, which facilitates charge transfer across the electrode surface.

This study demonstrates that rational surface modification provides a powerful and general approach to activating perovskite electrodes, offering valuable insights for the design of high-performance SOC systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Computational Insights into the Impact of Sr Segregation on Oxygen Exchange Reactions in Solid Oxide Cells

Wonjun Lee[1], Jeong Woo Han[1]

[1]Seoul National University, quasedorx@snu.ac.kr, South Korea, [2]Seoul National University, jwhan98@snu.ac.kr, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Sr segregation is a well-known degradation phenomenon in perovskite air electrodes of solid oxide cells, where Sr cations migrate toward the surface and form secondary phases such as SrO. This process significantly deteriorates oxygen exchange kinetics, yet the underlying atomistic mechanisms governing the degradation remain unclear. In particular, the electronic structure evolution induced by Sr segregation and its impact on charge transfer during oxygen exchange reactions are not fully understood.

In this study, we investigate the effects of Sr segregation on the oxygen exchange reaction activity of LSCF ($La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$-δ) electrodes using a multi-scale computational framework combining machine learning interatomic potential simulations and density functional theory calculations. Our results reveal that Sr segregation induces the formation of Sr vacancies, which generate hole carriers for charge compensation. This hole compensation leads to the downshift of the Fermi level in LSCF, thereby reducing the availability of electronic states near the Fermi level and suppressing electron transfer kinetics.

Furthermore, we find that Sr vacancies act as negative space charges near the surface, forming an inward-pointing dipole toward the bulk. This dipole modifies the electrostatic potential by upshifting the vacuum level, which in turn results in a pronounced additional downshift of the Fermi level. Consequently, the combined effects of hole compensation and dipole-induced vacuum level shift lead to a substantial suppression of charge transfer during oxygen exchange reactions.

Beyond Sr vacancy effects, the formation of segregated SrO phases further perturbs the electronic structure, amplifying the downshift of the Co, Fe d-band center and exacerbating the degradation of catalytic activity.

These findings provide a comprehensive atomistic understanding of how Sr segregation alters the electronic structure of LSCF electrodes, ultimately governing oxygen exchange reaction kinetics in SOC systems.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Profile Control of Deep Silicon Trenches Fabricated by DRIE for Membrane Structures

Yoon-Sang Lee[1], Sohyeon Kim[1,2], Sung-Yun Byun[1], Byeong-Jin Jang[1], Sojung Park[1], Hyeon-Jong Kim[1], Soo-Min Lee[2], Kyoung-Kook Kim[1,2]

[1]Department of Semiconductor Engineering, and Research Institute of Advanced Convergence Technology, Tech University of Korea, , , [2]Department of Semiconductor Engineering, Tech University of Korea, ,

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Deep silicon trenches are widely used for membrane-based microfabrication. However, achieving deep trenches with vertical sidewalls remains challenging due to profile degradation during deep reactive ion etching (DRIE) using the Bosch process. In particular, deep trench etching often results in defects such as sidewall bowing, bottom rounding, and silicon grass formation. In addition, the alternating etching and passivation cycles in the Bosch process inherently produce scalloped sidewall profiles, which limit precise control of trench geometry and degrade structural integrity.

In this study, DRIE-based deep silicon trench fabrication is investigated to improve trench profile control for membrane structure fabrication. Deep silicon trenches with target depths of approximately 150 μm are explored using the Bosch DRIE process. To address scallop-induced surface roughness and profile non-idealities, a sidewall smoothing approach based on thermal oxidation followed by HF wet etching is proposed. During thermal oxidation, silicon at high-curvature scallop peaks is preferentially consumed due to enhanced oxidation kinetics, enabling effective sidewall planarization after oxide removal.

The influence of the proposed smoothing process on sidewall morphology and trench profile is systematically analyzed. This approach provides an effective strategy for improving the trench profile of DRIE-fabricated deep silicon trench structures for membrane-based microfabrication, offering enhanced dimensional control and surface quality for subsequent device integration. Sidewall scalloping was effectively reduced through optimization of DRIE process conditions combined with thermal oxidation and oxide removal, leading to smoother sidewalls and improved trench profiles.

This work was supported by Korea Institute for Advancement of Technology(KIAT) grant funded by the Korea Government(MOTIE) (RS-2024-00409639, HRD Program for Industrial Innovation), and the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic

of Korea. (No. RS2022-KP002716 Fostering professionals in carbon-free based on energy efficiency by industry of mid-sized companies)

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

A-site high-entropy engineering for a highly efficient and stable air electrode of Pr1/6La1/6Sm1/6Ba1/6Sr1/6Nd1/6CoO3-δ perovskite in reversible solid oxide cells

Jiaxing He[1], Shaorong Wang[1], Ting Chen[1]

[1] 中国矿业大学, 江苏省徐州市铜山区中国矿业大学南湖校区化工学院, China

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Reversible Solid Oxide Cells (RSOCs), as devices capable of interconverting chemical energy and electrical energy, have attracted significant attention [1]. They feature the ability to operate reversibly in both Solid Oxide Fuel Cell (SOFC) mode and Solid Oxide Electrolysis Cell (SOEC) mode. Consequently, RSOCs hold great potential as an alternative technology in the field of energy conversion and storage.

This paper introduces a novel A-site high-entropy perovskite air electrode material, Pr1/6La1/6Sm1/6Ba1/6Sr1/6Nd1/6CoO3-$_{\delta}$ (PLSBSNC), and presents a systematic study on its ORR/OER activities. Compared with PrBaCo2O5+δ (PBC), PLSBSNC exhibits higher electrical conductivity and oxygen vacancy concentration. The RSOC with PLSBSNC as the air electrode delivers a peak power density of 1.54 W cm-2 in SOFC mode at 750 °C, and achieves a high electrolysis current density of 1.17 A cm-2 in SOEC mode at the same temperature under 1.3 V. Additionally, PLSBSNC demonstrates excellent durability in both SOFC and SOEC modes. These results confirm that PLSBSNC is a high-efficiency and stable air electrode material applicable for RSOCs.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Elucidating Structural Design Effects Across Scales in Solid Oxide Fuel Cells via Multi-Fidelity Learning

Hyunho Lee[1], Sangcheol Jang[1], Donghyun Kim[1], Hyunwoo Cho[1], Professor Wonjong Yu[1]
[1]Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Solid oxide fuel cells (SOFCs) are high-efficiency electrochemical devices that directly convert the chemical energy of fuels into electricity. Their performance is strongly influenced by structural design parameters such as layer thickness, porosity, and particle size, which interact in a complex and nonlinear manner. However, the scale-dependent roles of these parameters, particularly when transitioning from microstructured to nanostructured thin-film architectures, remain insufficiently understood. In this study, we develop a data-driven framework that integrates multi-fidelity neural networks with explainable machine learning to systematically analyze structure–performance relationships across different structural scales. By combining physics-based simulations with experimental data, the model achieves robust predictive capability while preserving physical consistency. The results reveal a fundamental shift in performance-governing mechanisms between micro- and nanostructured SOFCs. While microstructured systems follow conventional trends where reduced thickness and particle size enhance performance, nanostructured SOFCs exhibit counter-intuitive behavior, including a positive correlation between electrolyte thickness and performance. This finding suggests the presence of an optimal structural window governed by trade-offs between transport efficiency and structural stability. Furthermore, interaction analysis demonstrates that nanostructured systems operate in an interaction-dominated regime, where coupled effects between structural parameters significantly influence performance, emphasizing the necessity of integrated design strategies. This work provides new insights into the structural design of SOFCs across scales and establishes a quantitative framework for guiding future optimization of thin-film SOFC architectures.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Nanocolumnar Perovskite Cathodes via Glancing Angle DC Sputtering for Exceptionally High-Performance Low-Temperature Thin-Film Solid Oxide Electrochemical Cells

Sangcheol Jang[1], Hyunho Lee[1], Donghyun Kim[1], Hyunwoo Cho[1], Wonjong Yu[1]
[1]Kyunghee University, 1732 Deogyeong-daero, Giheung-gu,, South Korea

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Solid oxide electrochemical cells (SOCs) offer high efficiency and fuel flexibility but are limited by high operating temperatures (≥800 °C), which increase cost and degrade durability. Thin-film solid oxide electrochemical cells (TF-SOCs) enable reduced operating temperatures (400–500 °C); however, sluggish oxygen reduction reaction (ORR) kinetics in this regime lead to significant polarization losses. Although sputtering-based TF-SOCs provide precise nanoscale control over electrode and electrolyte structures, conventional sputtering typically yields dense films with insufficient porosity for efficient ORR. Here, we report a glancing angle deposition (GLAD) DC sputtering approach to fabricate highly porous and crystalline perovskite nanocolumnar cathodes using a single target. By controlling the deposition angle, an atomic shadowing effect was induced, enabling the formation of nanofibrous, highly porous electrode architectures. The resulting electrodes exhibit a high concentration of oxygen vacancies and uniform crystallinity, leading to enhanced charge transfer and ORR kinetics. When applied to TF-SOCs, the cells demonstrate lower polarization resistance and higher power density at 400 °C compared to conventional sputtered electrodes, achieving record-high electrochemical performance at low operating temperatures.

July 14, 2026 | Poster Session | 5:00 PM - 7:00 PM

Life cycle assessment of the protonic ceramic electrolysis stack manufacturing

Zheng Li[1], Prof. Pei-Chen Su

[1]Nanyang Technological University, ,

Poster Session - SS3 Nanoscale Surfaces, Interfaces, and Thin Films for Next-Generation Solid Oxide Cells, Atrium Ballroom - Level 4, July 14, 2026, 5:00 PM - 7:00 PM

Protonic ceramic electrolysis cell (PCEC) is one of the potential electrolysis technologies for realizing green hydrogen production. However, the environmental footprint and expenditures related to the manufacturing of PCEC is still unclear. This study presents an integrated study of PCEC stack manufacturing by performing both life cycle assessment (LCA). The cathode is identified as the most environment-detrimental ceramic component, 22.6% higher than the anode. The frame is the most influential metallic component in PCEC stack, accounting for 43.5% of CO2 emissions. Reducing the utilization of metallic material in PCEC manufacturing is underlined as they accounts for over 80% of material costs. Importantly, decreasing cathode thickness is highlighted as an effective strategy to lower both environmental impacts and manufacturing costs simultaneously. This work provides a comprehensive assessment of PCEC stack production in terms of environmental influences and economic attainability, offering several useful strategies for PCEC stack improvement.