Determination of Harmful Substances in Cosmetic Packaging Inner Coating by XRF combined Infrared Spectroscopy

by Qili Jiang | BJAST

Abstract ID: 10093
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Cosmetic; Inner Coating; XRF; Infrared Spectroscopy; Safeguard Legitimate Rights of Health

In recent years, there are numerous illegal and irregular incidents of food, medicine, and cosmetics. The safety of related materials has already become a widely concerned issue for livelihoods. Different technologies in the field of cosmetics healthy regulation has always been a hot topic in the industry. The detection of a series of cosmetic lining coatings employed a combination of X-ray fluorescence and near-infrared spectroscopy was investigated. Three samples of lipstick bucket inner coatings were analyzed, and appropriate calibration was performed during the analysis to demonstrate the stability and applicability of these linings. In addition, the environmental friendliness of this method was explored by applying different existing indicators. This result helps guide the selection of materials and coating processing techniques for cosmetic container. The research provides corresponding support for products orientation and safeguard legitimate rights of health.

Exploring the Surface Characteristics and Corrosion Resistance of MoS_2-Zn-Doped TiO_2 Coatings on Ti-6Al-4V via Plasma Electrolytic Oxidation

by Han-Cheol Choe | Sidra Sadaf Nisar | Chosun University, South Korea | Chosun University, South Korea

Abstract ID: 10584
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Corrosion resistance., MoS2, Plasma electrolytic oxidation, Ti-6Al-4V, TiO2, Zn

This study investigates the surface characteristics and corrosion properties of MoS_2-Zn-doped TiO_2 coatings deposited on Ti-6Al-4V substrates using the plasma electrolytic oxidation (PEO) technique. The incorporation of MoS_2 and Zn into TiO_2 coatings aims to enhance their performance in terms of corrosion resistance, surface, and mechanical properties. Scanning electron microscopy (SEM), X-ray diffraction (XRD), and atomic force microscopy (AFM) were employed to analyze the surface morphology, structure, and roughness of the coatings. Electrochemical corrosion tests, including potentiodynamic polarization (PDP) and alternating current (AC) impedance measurements, were conducted to evaluate the corrosion resistance of the coatings. The results demonstrate that the MoS_2-Zn-doped TiO_2 coatings exhibit improved surface roughness and homogeneity compared to undoped coatings. XRD analysis confirms the presence of desired phases in the coatings, with enhanced crystallinity observed in the doped samples. AFM measurements reveal improved surface roughness and increased hardness upon doping with MoS_2 and Zn. Moreover, corrosion tests indicate that the MoS_2-Zn-doped TiO_2 coatings possess superior corrosion resistance compared to undoped counterparts. The enhanced performance is attributed to the synergistic effects of MoS_2, which provides excellent mechanical properties, and Zn, which acts as a corrosion inhibitor. This study underscores the potential of MoS_2-Zn-doped TiO_2 coatings for biomedical and dental applications, offering a promising route to extend the lifespan and reliability of Ti-6Al-4V dental implants in corrosive environments with improved osseointegration potential. (This research was supported by NRF: 2023R1A2C1005748; RS-2023-00222390, hcchoe@chosun.ac.kr).

Multifunctional HA Coatings with Ag-Nanoparticle-Functionalized Multi-Walled Carbon Nanotubes on Ti6Al4V Alloy via Plasma Electrolytic Oxidation for Enhanced Physicochemical and Biological Properties for Dental Implants

by Mahendran Logesh | Han-Cheol Choe | Advanced Functional Surface and Biomaterials Research Lab, Department of Dental Materials and Convergence Research Center for Treatment of Oral Soft Tissue Disease (MRC), College of Dentistry, Chosun University, Korea | Advanced Functional Surface and Biomaterials Research Lab, Department of Dental Materials and Convergence Research Center for Treatment of Oral Soft Tissue Disease (MRC), College of Dentistry, Chosun University, Korea.

Abstract ID: 10583
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Corrosion., Hydroxyapatite (HA), Multiwall carbon nanotubes, Plasma electrolytic oxidation, Silver nanoparticles, Titanium alloy

Carbon nanotubes are materials exhibiting exceptional mechanical, chemical, and physical properties, making them suitable candidates for coating titanium implants. The current study focuses on examining the microstructural and biological features and characteristics of a multi-walled carbon nanotube (MWCNT) layer adorned with silver nanoparticles (Ag NPs) deposited on the Ti6Al4V alloy, intended for use in long-term implantable devices. The study employed plasma electrolytic oxidation (PEO) to deposit coatings with varying concentrations of a MWCNT/Ag NP composite on a Ti6Al4V alloy in electrolytes containing Ca and P ions for hydroxyapatite (HA) formation. Comprehensive characterization of the coatings was conducted using field emission scanning electron microscopy (FESEM), X-ray diffraction (XRD), Fourier-transform infrared (FTIR) spectroscopy, and Raman spectroscopy. Electrochemical techniques, including potentiodynamic polarization (PDP) and electrochemical impedance spectroscopy (EIS), were employed to evaluate the corrosion behavior of the coatings. Physiological assessments revealed enhanced surface roughness and wettability properties of the coated samples. Exploiting the synergistic effects of MWCNTs and Ag NPs, the antibacterial activity of the composite coatings was investigated against *Escherichia coli (E. coli)* bacteria. Collectively, the fabricated MWCNT/Ag NP composite coatings demonstrate promising potential for dental implant applications. (This research was supported by NRF: 2023R1A2C1005748; RS-2023-00222390, hcchoe@chosun.ac.kr).

MXene-based Wearable Thermoelectric Respiration Sensor

by Peng-an Zong | Nanjing Tech University

Abstract ID: 10251
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: MXene, Respiration rate, electromagnetic shielding, self-heating, sensor, thermoelectric

Respiration rate (RR) holds a pivotal status as a vital sign, with its deviation serving as a significant marker for grave clinical occurrences. Contemporary methods for RR detection involve the utilization of complex and costly apparatus, potentially disrupting the innate breathing process. An imperative arises for the development of wearable respiratory sensors that exhibit attributes of cost-effectiveness and efficiency. This study introduces a pioneering investigation featuring an MXene/CNT/PEDOT:PSS composite film, which leverages the thermoelectric effect for sensing RR. After integrating with heart rate monitoring, real-time human health surveillance becomes achievable. Additionally, a notable enhancement in tensile strength by a factor of 2.4 is observed, along with an improved electromagnetic shielding efficiency of 59 dB, representing a 1.5-fold increase, as well as a commendable self-heating capability. The construction of the mortar-structured MXene-based film shows promising potential for respiration sensing, offering additional healthcare functions such as electromagnetic shielding and self-heating. This innovation expands the application scope of MXene within the sensor field, contributing to the advancement of healthcare technologies.

Neuromorphic Electro-Stimulation Based on Atomically Thin Semiconductor for Damage-Free Inflammation Inhibition

by Shuiyuan Wang | Fudan university

Abstract ID: 10026
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Atomically thin semiconductor, Electro-stimulation, Inflammation, Neuromorphic bionic spikes

Inflammation, caused by accumulation of inflammatory cytokines from immunocytes, is prevalent in a variety of diseases. Electro-stimulation emerges as a promising candidate for inflammatory inhibition. Although electroacupuncture is free from surgical injury, it faces the challenges of imprecise pathways/current spikes, and insufficiently defined mechanisms, while non-optimal pathway or spike would require high current amplitude, which makes electro-stimulation usually accompanied by damage and complications. Here, we propose a neuromorphic electro-stimulation based on atomically thin semiconductor floating-gate memory interdigital circuit. Direct stimulation is achieved by wrapping sympathetic chain with flexible electrodes and floating-gate memory are programmable to fire bionic spikes, thus minimizing nerve damage. A substantial decrease (73.5%) in inflammatory cytokine IL-6 occurred, which also enabled better efficacy than commercial stimulator at record-low currents with damage-free to sympathetic neurons. Additionally, using transgenic mice, the anti-inflammation effect is determined by β2 adrenergic signaling from myeloid cell lineage (monocytes/macrophages and granulocytes).

Octacalcium phosphate precipitation on titanium alloys using electrochemical method for biomedical implants

by Kyeong-Tae Kim | Han-Cheol Choe | Student | Professor

Abstract ID: 10586
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Corrosion behavior, Octacalcium phosphate, Plasma electrolytic oxidation, Precipitation, Titanium alloys

In this study, octacalcium phosphate(OCP) precipitation on plasma electrolytic oxidation(PEO) films formed on titanium alloys for biomedical implant has been investigated using a variety of techniques. OCP exhibits thermodynamic instability and inherent synthesis issues. However, it possesses compositional affinity similar to native bone and tends to induce favorable cell adhesion characteristics. Functionally, it serves as a bioactive bone cement, promoting the maturation of new bone tissues due to its high reactivity and creating a biocompatible environment that optimally fosters the growth of the new bone. The OCP precipitation treatment was carried out on the PEO-treated Ti-6Al-4V alloy in solution of dicalcium phosphate dihydrate (DCPD) nanoparticles, which were then used to coat the surface after adjusting the pH using electrochemical methods. The surface morphology and structure underwent analysis through field emission scanning electron microscopy(FESEM), energy-dispersive X-ray spectroscopy(EDS), X-ray diffraction(XRD), and Fourier transform infrared spectroscopy(FT-IR). Zeta potential was utilized to investigate adsorption. To assess the corrosion resistance of the coatings, electrochemical corrosion tests, including potentiodynamic polarization (PDP) and alternating current (AC) impedance measurements, were conducted. OCP precipitation improved the surface characteristics. The OCP precipitation treatment on surface offered a means to enhance substrate properties, potentially promoting bone formation and aiding in implantology. Examining the synergy between PEO treatment and OCP coating for enhancing the surface properties of titanium in bio implants, the findings suggest improved biocompatibility and corrosion resistance, potentially boosting the long-term stability and performance of implants. (This research was supported by NRF: 2023R1A2C1005748; 2024-GJ-RD-0008; RS-2023-00223520, hcchoe@chosun.ac.kr).

Preparation and High Temperature Corrosion Behavior of Accident-tolerant Coatings on Nuclear Cladding Tubes

by Jin Xiaoyue | Luo Jun | Pang Pan | Ou Yixiang | Wang Haoqi | Zeng Xinmiao | Beijing Academy of Science and Technology | Beijing Academy of Science and Technology | Beijing Academy of Science and Technology | Beijing Academy of Science and Technology | Beijing Academy of Science and Technology | Beijing Academy of Science and Technology

Abstract ID: 10101
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: MAO□MEVVA□FCVAD□Zirconium-based alloys□Accident-tolerant Coatings

Zirconium-based alloys have been used as reactor structural materials including fuel claddings, guide tubes, and spacer grids in light water reactors (LWRs) owing to their low neutron capture cross-section, high melting point, good mechanical performance and corrosion resistance. Nevertheless, Zr alloys were subjected to the drastic steam oxidation accompanied with lots of hydrogen release under the loss-of-coolant accident (LOCA) condition, which could trigger severe hydrogen explosion accidents. The uniform and compact ZrO_2/Cr composite coatings on pure zirconium and Zr–1Nb alloy were fabricated by micro-arc oxidation (MAO), metal vapor vacuum arc (MEVVA) and filtered cathodic vacuum arc deposition (FCVAD) treatments. The high-temperature steam oxidation behavior of Zr substrate, MAO coating, Cr coating, ZrO_2/Cr composite coating were evaluated in water vapor environment at 900–1200 °C. The steam oxidation mechanisms of Zr substrate and ZrO_2/Cr composite coating samples were discussed. In addition, the initial corrosion processes of bare and ZrO_2/Cr-coated alloys in 300 °C/14 MPa lithium borate buffer solution were explored by an in-situ high temperature electrochemical analyzer.

Preparation of PPy/TiO2 Composite Coatings with Patterned Surface Potential and its Cellular Responses

by Yang Yi | Kui Cheng | School of Materials Science and Engineering, Zhejiang University | School of Materials Science and Engineering, Zhejiang University

Abstract ID: 10253
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Composite Coatings, Osteogenic Differentiation, Patterned Potential, Photoelectricity

The size and geometric morphology of surface structures, as well as the surface potential, are crucial factors determining the fate of cells. In studies, the surface potential of materials is often simplified as a uniform macroscopic quantity, while in reality, it is related to surface curvature, which means that the distribution of surface potential in microstructures is non-uniform. In this research, polypyrrole @ titanium dioxide nanoparticles (PPy/TiO_2) were used as a cell culture surface to construct composite coatings with subcellular scale surface microdomain potentials. By applying an external field of illumination, a potential difference was established to explore the law and mechanism of surface microdomain potential on the osteogenic differentiation of stem cells.

TiO_2 nanoparticles were prepared on film through the phase separation-induced self-assembly method. Then, the novel PPy/TiO_2 composites were synthesized by polymerization of pyrrole with TiO_2 nanoparticle as a photosensitizer. The photo response of the composites was shifted into visible light spectrum, which could be interpreted in terms of the interaction between PPy and TiO_2. The distribution of patterned surface potential was determined by Kelvin probe force microscopy. Cellular experiments showed that the material exhibited good biocompatibility. Moreover, the patterned surface potential and changes in the distribution of microdomains effectively regulated the osteogenic differentiation of stem cells. Selecting appropriate patterned potentials could endow the material with a good ability to promote osteogenic differentiation. This may be attributed to the differences in physiological environments formed by different microdomain potentials in the extracellular microenvironment, modulating transmembrane potential, and thereby regulating cell growth, differentiation, and other functions, resulting in differential expression of relevant osteogenic genes.

Preparation of surface microstructure on polyimide films based on ion beam technology

by Pang Pan | Beijing Academy of Science and Technology

Abstract ID: 10596
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: etching morphology, ion implantation, periodic structures

To obtain polyimide films with periodic surface structures, ion beam techniques, such as ion implantation and filtered cathode vacuum arc, are used to etch a patterned copper clad laminate. The three dimensional structure can be obtained by selecting different treatment atmospheres and ion energies. In order to obtain the optimal performance, the polyimide film with different parameters of three-dimensional periodic structure were prepared. The surface morphology of the sample was measured by atomic force microscopy and scanning electron microscope to reveal the relationship between ion energy and etching morphology. The etching mechanism is briefly analyzed. Finally, the copper clad plate with three-dimensional periodic structure were prepared.

PVTF-based Janus membrane accelerates bone regeneration through synergistic immunomodulation and osteogenesis enhancement

by Haoqing Liu | Kui Cheng | the School of Materials Science and Engineering, Zhejiang University, Hangzhou, China | the School of Materials Science and Engineering, Zhejiang University, Hangzhou, China

Abstract ID: 10263
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: GBR, immunomodulation, osteogenesis, osteoimmunology

For bone defects that exceed critical dimensions or in difficult healing environments, it is extremely difficult to repair despite the healing ability of the bone. Among the effective methods of treating bone defects, guided bone regeneration (GBR) technology has been widely studied and applied because of its wide range of applications and low immunogenicity compared with autografts and allografts. The bones themselves are piezoelectric, and the charges/potentials produced in response to mechanical activity can augment bone metabolism and growth. Piezoelectric materials can stimulate the physiological electrical microenvironment that is important in regulating metabolic activities such as growth, structural remodeling, and fracture healing. Many researchers have employed poly(vinylidene fluoride-trifluoroethylene) (PVTF) to construct microenvironments with different surface potentials to explore its regulatory effects on cells. However, PVTF has poor hydrophilicity, which is not conducive to the adsorption and adhesion of proteins and cells on it in the humoral environment. Therefore, enhancing the adhesion and proliferation of cells on PVTFs while preserving their electrical signals would be one of the effective strategies to enhance the effects of GBR. In this study, JANUS membranes were obtained by solution casting method and contact polarization, while ethanolamine heat treatment was used on one side to enhance the affinity between cells and materials. In addition, the adhesion, proliferation, cellular osteogenesis and immune modulation of NIH-3T3, BMSCs and BMDMs on different surfaces were explored. The results showed that the JANUS membranes exhibited good biocompatibility, osteogenic activity and immunomodulation in vitro, which not only promoted the adhesion, proliferation, spreading and osteogenesis of BMSCs, but also efficiently induced M2 macrophage polarization and inhibited fibrous tissue invasion. Overall, the results provide an alternative approach to conveniently fabricate Janus membranes that are both electrically signaling and cell affinity to synergistically regulate cellular immune and osteogenic functions to enhance bone regeneration.

Recent Advances and Strategies for High-Performance Coatings Deposited by Deep oscillation Magnetron Sputtering

by Yixiang Ou | 1 Radiation Technology Institute, Beijing Academy of Science and Technology, Beijing 100875, China 2 Advanced Energy Material and Intelligent Equipment Joint Laboratory, Beijing Academy of Science and Technology, Beijing 100875, China

Abstract ID: 10078
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: High-performance coatings□Deep oscillation magnetron sputtering□Flexible hard coatings, Superhard yet tough coatings

Coatings with micro- or nano-scaled structure are always fabricated by various techniques to fulfill the requirements of unique performances according to special working conditions. The differences in preparation techniques always result in large differences in their properties, even for the same coating materials. High-performance coatings are solely up to surface integrity, morphology, microstructure, stress state, interfacial structure, cohesion and adhesion that are all strongly affected by preparation processes. Therefore, how to take advantage of the numerous deposition techniques to design a right preparation process to produce coatings of high performance to meet the demands is the real question. Deep oscillation magnetron sputtering (DOMS) is a novel high-power impulse magnetron sputtering, which has become a hotspot in tribological hard coatings around world. Hence, we summarized designs, preparation and application of typical high-performance coatings, such as flexible hard coatings, superhard yet tough coatings deposited by DOMS.

Study on Atmospheric Plasma treatment for Electrospun Polyethylene Glycol Containing Lanthanum Chloride Antibacterial Fiber Membrane

by Yuqi Huang | Shu-Chuan Liao | Department of Chemical and Materials Engineering, Tamkang University, New Taipei city, Taiwan | Department of Chemical and Materials Engineering, Tamkang University, New Taipei city, Taiwan

Abstract ID: 10364
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: , Electrospinning, Lanthanum Chloride Anhydrous, Polyethylene glycol, antibacterial, cold plasma treatment

Electrospinning is a process that uses electric charges to extract fibers from liquids at the nanometer or micrometer scale. Polyethylene glycol(PEG) is a biocompatible and non-toxic material that serves as a base for biomedical materials. However, it has limited antibacterial properties. To improve this, a study was conducted using PEG and Lanthanum Chloride Anhydrous ($LaCl_3$) as the spinning solution. The electrospinning technique was used to create nanofiber membranes, which were then treated with cold plasma to modify their surface. The study investigated the effect of different $LaCl_3$ ratio solutions on the antibacterial properties of the- membranes. The nanofiber membrane were characterized by SEM and EDS, mechanically by tensile testing, and surface chemical structure by FTIR. The antibacterial properties were evaluated by testing its ability to inhibit the attachment of Escherichia coli. Surface wettability was also assessed through water uptake and contact angles measurements. This study demonstrates the positive effect of cold plasma treatment on nanofibers' mechanical, biological, or chemical properties.

Tribocorrosion response of hard yet tough TiZrCN nanocomposite coatings in simulated body fluids

by Haoqi Wang | Beijing Academy of Science and Technology

Abstract ID: 10138
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Deep Oscillation Magnetron Sputtering, TiZrCN coatings, Tribocorrosion response, hard yet tough

High-performance ceramic surface protective coatings have emerged as a highly promising solution in the field of medical implants due to their ability to effectively inhibit the release of mechanical wear debris and toxic metal ions. In this work, TiZrCN nanocomposite coatings were deposited on medical-grade polished titanium substrates by Deep Oscillation Magnetron Sputtering. The corrosion and tribocorrosion behaviors of nanocomposite structure TiZrCN coatings in simulated body fluids, and their responses under local loads and crack formation mechanisms were investigated. The results indicate that TiZrCN coatings with high toughness, hardness, and adhesion inhibit the initiation and propagation of microcracks during friction and corrosion processes, and exhibit excellent friction and wear performance, therefore, it is expected to become a strong candidate for surface protective coatings on next-generation medical implants.

Wollastonite-Forsterite Composite Coatings Containing Functional Elements on the Plasma Electrolytic Oxidized Ti-6Al-4V Alloy via Spin Coating

by soyun Joo | jong kook Lee | han cheol Choe | student | professor | corresponding author

Abstract ID: 10585
: ThinFilms2024
Symposium: 2. Biomedical and Healthcare (BHC)
Keywords: Forsterite, Funtional elements, Plasma electrolytic oxidation, Spin coating, Ti-6Al-4V, Wollastonite

The composite coating consisted of wollastonite ($CaSiO_3$), which is recognized for its capacity to induce apatite formation on implant surfaces, essential for enhancing osseointegration. However, due to concerns about the potential dissolution of calcium from the wollastonite coating over time, forsterite (Mg_2SiO_4) was incorporated into the composite. This addition aimed to minimize calcium dissolution and provide a protective barrier for the underlying apatite layer. Forsterite is a key material in the magnesia-silica system for biomaterials. It is composed of magnesium, silicon, and oxygen, and it offers excellent mechanical properties, chemical stability, and superior fracture strength compared to the minimum threshold for cortical bone. Additionally, it releases silicon and magnesium ions, which help in bone growth and regeneration. Therefore, the use of a Ca-Mg composite layer is intended to retain the advantageous properties of apatite, such as enhancing bone tissue integration.Ti-6Al-4V alloy, a common material for biomedical implants, underwent plasma electrolytic oxidation (PEO) to improve its surface functionalization. Subsequently, a composite coating was applied using the sol-gel method. This sol-gel technique enabled the uniform and controlled deposition of a wollastonite-forsterite composite coating on the PEO-treated Ti-6Al-4V alloy.

For this study, synthesized composites containing functional elements such as Mn, Zn, and Sr, etc was manufactured by the sol-gel method. Then this composite was coated on the PEO-treated Ti-6Al-4V alloys by spin coating. After coating, surface properties were analyzed by using FE-SEM, AFM, and corrosion test. Also, *in vitro* test was performed for biocompatibility. In conclusion, synthesized composites can improve the functional surface characteristics and biocompatibility. (Supported by National Research Foundation of Korea: 2023R1A2C1005748; RS-2023-00222390; hcchoe@chosun.ac.kr).