Surface Engineering of Biomaterials, Devices and Regenerative Materials: Health, Food, and Agriculture Applications
Room Golden State Ballroom - Session MD-ThP

Surface Engineering of Biomaterials, Devices and Regenerative Materials: Health Food, and Agriculture Applications Poster Session

MD-ThP-1 Eco-Friendly Synthesis of Graphene Intercalation Material for Highly Sensitive Maldi-Ms Bioanalysis, *Yao-Tsung Hsu,* Graduate Institute of Medical Sciences, College of Medicine, Taipei Medical University, Taiwan*; Shih-Min Wang,* National Atomic Research Institute, Taiwan*; **Fu-Der Mai [fordmai@tmu.edu.tw]**,* Department of Biochemistry and Molecular Cell Biology, School of Medicine, College of Medicine, Taipei Medical University, Taiwan

Introduction: Developing highly sensitive and environmentally benign materials for biomolecular analysis remains a critical challenge. Matrix-Assisted Laser Desorption/Ionization-Mass Spectrometry (MALDI-MS) is a powerful tool in proteomics, but its sensitivity is often limited by the co-crystallization matrix. We propose a novel, eco-friendly synthesized intercalation material designed to function as an "amphiphile attractor" to significantly boost analytical performance.Methods: Our methodology begins with the sonication-induced scission of few-layer precursory graphene, leading to the asymmetric cleavage and production of nanoscale Asymmetrically Cleaved Graphene (ACG), with an average dimension of 41.58 nm. The ACG exhibits high surface energy, making it intrinsically "amphiphile-attractive." Subsequently, ACG is self-assembled and wrapped by amphiphiles into a hemimicelle structure, allowing it to intercalate into bulk graphite to form the final Asymmetrically Cleaved Graphene Intercalated Material (ACGIM).Results and Discussion: The unique structure of ACGIM is highly promising for bioanalysis. The attracted amphiphiles within the ACGIM effectively stabilize biomolecules, which is crucial for signal integrity. To validate its analytical potential, we conducted a signal enhancement experiment using ACGIM as a novel matrix substitute for peptide detection via MALDI-MS. The results demonstrated a remarkable 22-fold enhancement in the detection signal for the target peptide compared to conventional methods.Conclusion: The ACGIM represents a new class of amphiphile-attractive intercalation materials synthesized under green conditions. Its superior ability to stabilize biomolecules and significantly enhance signal intensity in MALDI-MS offers a robust platform for highly sensitive bioanalysis, particularly in peptide and protein research. Further exploration into its application for diverse biomolecule types is warranted.

MD-ThP-2 Study of the Antimicrobial and Osteoinductive Properties of Polymeric Nanocomposite Membranes, ***Lucia Sofia Flores-Hidalgo* [floreshidalgol@pceim.unam.mx]**, Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México*; Phaedra S. Silva-Bermúdez,* Unidad de Ingeniería de Tejidos, Terapia Celular y Medicina Regenerativa; Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra, Mexico*; Gina Prado-Prone,* Laboratorio de Biointerfases, DEPeI, Facultad de Odontología, Universidad Nacional Autonoma de Mexico, Mexico*; Monserrat Ramirez-Arellano,* Facultad de Medicina, Universidad Nacional Autonoma de Mexico, Mexico*; Sandra. E Rodil,* Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México

Nanofibers have garnered considerable attention in recent years due to their wide-ranging applicability in various fields, including tissue engineering, biotechnology, medicine, sensing, and bioremediation. Among the different fabrication methods for composite membranes, electrospinning stands out for its ability to utilize a wide range of polymers and copolymers. Several configurations of the electrospinning process exist; among them, co-electrospinning is noteworthy, as it allows the simultaneous spinning of two independent polymer solutions while preserving their individual properties.

Polycaprolactone (PCL) and gelatin are two polymers widely studied for biomedical applications due to their good biocompatibility and biodegradability. In parallel, nanoparticles of various metal oxides, such as zinc oxide (ZnO) and magnesium oxide (MgO), have been investigated for their antibacterial and osteoinductive properties, respectively.

For this reason, the present work reports the porous microfibrous structure of PCL/gelatin nanocomposite membranes obtained via electrospinning by combining fibers containing ZnO nanoparticles and fibers containing MgO nanoparticles. These membranes were characterized morphologically and compositionally using SEM, FTIR, TGA, EDS, DSC, and ICP analyses. Finally, biological assays were performed to evaluate their antibacterial efficacy and their potential to promote an osteoinductive environment, assessing their possible use as an adjuvant in the treatment of open fractures.

MD-ThP-3 Understanding the Influence of Sn and Nb on Morphology, Sustainable Synthesis of Calcium Phosphate 1d Nanostructures via Electrospinning for Advanced Functional Applications, *Yao Mawuena Tsekpo, Weronika Smok,* Faculty of Mechanical Engineering, Silesian University of Technology, Poland*; Adrian Adrian Radon,* Łukasiewicz Research Network – Institute of Non-Ferrous Metals, Poland*; Pawel Jarka, **Tomasz Tanski [tomasz.tanski@polsl.pl]**,* Faculty of Mechanical Engineering, Silesian University of Technology, Poland

Calcium phosphate compounds are a sustainable material with applications in biomedicine and environmental remediation. The influence of dopants on the morphology of one-dimensional (1D) structures prepared by the electrospinning technique with biogenic calcium as a starting material remains understudied. This work presents a novel method for synthesising calcium phosphate nanowires doped with Sn and Nb using Galatea paradoxa clamshells as a calcium source. The process integrates electrospinning and sol-gel techniques to achieve 1D nano calcium pyrophosphate and aims to elucidate the influence of temperature on the process. Thermogravimetric analysis (TGA), Scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FTIR) were employed to characterise the nanostructures. Calcination at 600 ºC and 700 ºC reveals the formation of wire-like structures at the nanoscale with diameters ranging from 68 – 403 nm. The Sn-doped wires were observed to be more thermally stable at higher temperatures (700 ºC) whilst having narrower wire diameters as compared to the Nb-doped wires. XRD analysis confirmed the presence of Sn and Nb, corroborating the presence of their oxide and aligning with the Fast Fourier Transform (FFT) diffraction patterns obtained in TEM. These findings indicate the successful formation of 1D nanostructures of calcium phosphate nanowire doped with Sn and Nb. The observed structure and morphology of the prepared nanostructure exhibit properties suitable for application in bone regeneration and biomedicine, adsorption of harmful heavy metals, and as a sustainable photocatalyst.

MD-ThP-4 Advancing Surface Engineering of Additively Manufactured Dental Implants by HiPIMS β-Ti Coatings, ***Juan Carlos Sanchez-Lopez* [jcslopez@icmse.csic.es]**, Instituto de Ciencia de Materiales de Sevilla (CSIC-US), Spain*; Amanda Robau-Porrua,* Universidad de Concepción-Chile*; Marleny Rodríguez-Albelo,* Universidad de Sevilla, Spain*; Celia Garcia-Hernandez, Cristina Garcia-Cabezon,* Universidad de Valladolid, Spain*; Jesús Eduardo Gonzalez-Ruiz,* Universidad de la Habana, Cuba*; Yadir Torres,* Universidad de Sevilla, Spain

Improving the mechanical compatibility and corrosion resistance of metallic implants is essential for long-term clinical success. Titanium and its alloys are widely used for dental and orthopedic devices, yet surface reactivity and elastic modulus mismatch with bone can limit their performance. Surface modification by magnetron sputtering offers an effective strategy to tailor surface properties at the nanoscale while preserving bulk integrity.The β-phase Ti alloys show a significant reduction of the elastic modulus compared with bulk titanium, improving biomechanical compatibility and mitigating stress-shielding effects.

Building upon our previous studies on flat titanium substrates, the present work represents a significant step forward by applying high-power impulse magnetron sputtering (HiPIMS) coatings to real 3D titanium implant geometries. This transition allows us to assess the feasibility of conformal deposition on complex surfaces while maintaining the advantageous features of HiPIMS. Ti-35Nb-7Zr-5Ta (wt. %) β-type coatings were deposited onto dental implants fabricated by Laser Bed Fusion (LBF), producing dense, adherent layers with controlled nanoroughness and uniform coverage, even within threaded regions.

Microstructural and chemical analyses (SEM, XRD, XPS) confirmed homogeneous β-phase formation and the presence of a protective TiO_2 surface layer. Nanoindentation revealed a reduction in elastic modulus of up to 30% compared with uncoated titanium, mitigating stress-shielding effects. Electrochemical tests in simulated physiological media demonstrated enhanced corrosion resistance and surface stability.

These results highlight the versatility of HiPIMS as a scalable tool for the conformal coating of complex 3D implants, enabling the development of next-generation dental and orthopedic biomaterials with optimized mechanical and corrosion performance.

MD-ThP-5 Electrochemical Characterization of Copper-Coated Commercial Ti6Al4V Alloy for Advanced Biomedical Applications*, Bryan Angel Zárate Verduzco [1629251c@umich.mx],* Universidad Michoacana de San Nicolás de Hidalgo, Mexico*; Victor Manuel Solorio García, Miguel Ivan Dávila Perez,* Tecnologico Nacional de México/ Instituto Tecnológico de Morelia, Mexico*; Roberto Guerra González,* Universidad Michoacana de San Nicolás de Hidalgo, Mexico*; Héctor Javier Vergara Hernández,* Tecnológico Nacional de México/ Instituto Tecnológico de Morelia, Mexico*; Julio César Villalobos Brito,* Tecnologico Nacional de México/ Instituto Tecnológico de Morelia, Mexico

Electrodeposited copper (Cu) coatings on titanium alloys are promising candidates for multifunctional biomaterials combining antibacterial and conductive properties. This study evaluates the electrochemical performance and corrosion resistance of Cu coatings applied to commercial Ti6Al4V. Open-circuit potential (OCP), linear polarization resistance (Rp), electrochemical impedance spectroscopy (EIS), and potentiodynamic polarization tests were performed in Hank's solution at 37 °C, with pH measurements during the tests. Results showed that Cu deposition modifies the passive behavior of Ti6Al4V, shifting the corrosion potential toward more active values while maintaining acceptable polarization resistance. Among the tested conditions, deposition exhibited the lowest corrosion rate compared to the base material. Equivalent circuit modeling of EIS data revealed two time constants associated with the outer Cu layer and the Ti oxide interface, evidencing a dual protective mechanism. The combined analysis indicates that optimized deposition time can balance ion-release kinetics and surface passivation, contributing to long-term functional stability. These insights lay the groundwork for predictive corrosion models and the rational design of antibacterial, corrosion-resistant coatings for next-generation biomedical implants.

MD-ThP-6 TiO_x Nanocoating as Antimicrobial for Personal Protective Equipment*, Lorena Reyes-Carmona [lorena.unam753@gmail.com], Sandra Rodil,* UNAM, Mexico*; Omar Sepúlveda-Robles,* IMSS, Mexico*; Gina Prado-Prone, Argelia Almaguer-Flores,* UNAM, Mexico

Introduction: Pathogenic bacteria and viruses could be transmitted by aerosols formed from saliva droplets. These bioaerosols are becoming the main airborne transmission source for respiratory microorganisms. It has been reported that health professionals are highly exposed to bioaerosols generated during medical or dental procedures since rotary instruments are used, which produce pathogenic bioaerosols. The development of nanomaterials with antimicrobial activity to cover personal protective equipment (PPE), such as facemasks, could be an option to avoid the transmission of these pathogens.

Objective: The aim of this study was to evaluate the antibacterial and antiviral capacities of titanium oxide nanocoating (TiO_x) deposited on polypropylene (PP) fabrics used to produce medical and dental protective equipment.

M**ethods:** TiOx nanocoating was deposited on PP fabric by magnetron sputtering. They were characterized using optical microscopy, XPS, WCA, optical profilometry, and ICP-MS. For antimicrobial evaluation, pathogenic bacteria and surrogates virus (RNA and DNA bacteriophages) were used. Two methodologies were used: short (2 min) and long (24 h) term interaction of nanocoatings with bacterial and viral aerosols.

Results: ZnO nanocoating was homogeneously deposited on the PP. The antimicrobial results showed a reduction of the bacteria between 18-95 %, depending of the bacterial strain tested. With respect to viral assays with RNA bacteriophages, a total reduction of the viral replication was achieved after 24 h. However, the DNA phage was not completely inactivated.

Conclusions: TiO_x nanocoating showed antimicrobial potential against bacteria and surrogate viruses. This nanocoating has the potential to be used to cover medical PPE, to reduce and prevent the transmission of pathogens in medical and dental environments.

Keywords: Nanocoating, titanium oxide, antibacterial.

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MD-ThP-7 "Adsorption of Heavy Metals in Aqueous Solutions by Polymeric Nanofibers"*, Kevin Javier Vazquez Mendoza [1907917k@umich.mx],* Universidad Michoacana de San Nicolás de Hidalgo, Mexico*; Luis Jesus Villareal Gomez,* Universidad Autónoma de Baja California, Mexico*; Roberto Guerra-Gonzalez,* Universidad Michoacana de San Nicolás de Hidalgo, Mexico

Heavy metal contamination of water resources constitutes a significant and persistent threat to human health and ecosystem integrity on a global scale. In Mexico, the synergy between geogenic sources and intensified anthropogenic activity (mining, industrial, and agricultural) has led to the contamination of strategically important water bodies, adversely affecting the quality of life in various regions, with the state of Michoacán being a particularly relevant case study. Conventional wastewater treatment technologies, such as chemical precipitation or reverse osmosis, often exhibit critical limitations in terms of efficiency at low concentrations, high operating costs, and the generation of toxic byproducts. Given this situation, nanotechnology is emerging with disruptive solutions. Specifically, nanomaterials, and particularly polymeric nanofibers obtained through the versatile electrospinning technique, have been postulated as a high-potential alternative. Their distinctive attributes, including exceptional specific surface area, high interconnected porosity, and remarkable ease of surface chemical functionalization, position them as high-capacity adsorbents.This research comprehensively explores the potential of nanofibers, with a particular focus on those formulated from biopolymers such as chitosan and biodegradable polyesters such as polycaprolactone (PCL), for the adsorption of heavy metal cations (e.g., lead, cadmium) in aqueous systems. An in-depth review of the principles governing water pollution, heavy metal speciation and toxicity, and existing treatment technologies is provided, with a critical analysis of their foundations and limitations. Subsequently, the fundamentals of nanomaterials and nanofibers are addressed, detailing their unique properties. The electrospinning process is extensively explored, analyzing the effect of solution, process, and environmental parameters on the morphology and properties of the resulting fibers. Finally, the adsorption mechanisms are analyzed, and the state of the art regarding the use of electrospun nanofibers for heavy metal removal is reviewed, along with the materials and functionalizations employed, and the key factors governing their efficiency and regenerative capacity.

MD-ThP-8 Comparative Analyses of Conventional Electrical Discharge Machining (EDM) and Multiple Powder-Mixed EDM of Biomaterials*, Madhusmita Mallick [mmallick@iitbbs.ac.in],* IIT BHUBANESWAR, India

Powder-mixed EDM is widely implemented to improve the material removal rate and surface quality of metallic substrates by the addition of selective powders like graphene and HAP owing to their better electrical conductivity and biocompatibility nature respectively. This study highlights powder-mixed electrical discharge machining (PMEDM) of biomaterials such as commercially pure titanium and Nitinol using graphene and hydroxyapatite (HAP) powders which is used as additives in the EDM oil (dielectric medium) i n conventional EDM process. Taguchi L9 experiments were conducted for conventional EDM and Gr/HAP powder-mixed EDM processes with input parameters like pulse on (microsecs), pulse off, peak current (amp) and powder concentration (g/L).Comparative analyses were performed to evaluate the effects of powder addition on the microstructure, adhesion, and performance of the modified surfaces. The results showed that powder-mixed EDM significantly improved MRR and surface quality of coated samples compared to conventional EDM. Multi-objective optimization of MRR, SR and TWR for both the biomaterials were done using Grey Relational Analysis (GRA) method. Additionally, corrosion tests were performed to evaluate protection efficiency of coated samples by using Electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization techniques. The results depicted higher corrosion resistance property of combined graphene and HAP powders conducted under simulated body fluid conditions. These findings suggest that integrating powder-mixed EDM with biocompatible nanomaterials presents a promising approach for biomedical applications.

Keywords: Powder-mixed EDM, Graphene and HAP powder, corrosion-resistance, Taguchi L9 approach, ANOVA, GRA

MD-ThP-9 Investigating the Corrosion Behavior of Sol Gel and PEO Coatings on Magnesium for Biomedical Applications*, Vinod Prabhakar* ***[vinodp2@uic.edu]****, Avirup Sinha, Sujoy Ghosh,* University of Illinois at Chicago, USA*; Hamdy Ibrahim,* Kennesaw State University, USA*; Mathew T. Mathew,* University of Illinois College of Medicine at Rockford and Rush University Medical Center, USA

Magnesium (Mg) alloys have been applied to orthopedics as its elastic modulus resembles bone, and its stress-strain behavior resembles ductile metals. Mg alloys exhibit high corrosion rates including high degradation and H_2 release. Existing coatings, such as titanium, sol-gel, and plasma electrolytic oxidation (PEO) have improved corrosion properties of Mg alloys. This study evaluates corrosion in bovine calf serum (BCS), a fluid that simulates lubricating human synovial joints. The goal of this study was to test the corrosion behavior of magnesium alloys with sol-gel and PEO coatings in BCS, and the hypothesis was that under BCS, the different coatings will increase the corrosion resistance of the Mg alloy. The experiments were conducted under a three-electrode setup, with the SCE reference electrode, graphite counter electrode, and Mg working electrode. Microstructures were analyzed through scanning electron microscopy (SEM) and profilometry to confirm corrosion sites, oxide damage, wear, and surface roughness. Corrosion current decreased, corrosion potential increased and the system's resistance and capacitance increased and decreased as the coating increased. These trends were expected as the coated alloys corrode slower and have less tendency for corrosion. Overall, this study effectively simulated Mg alloy corrosion in BCS.

MD-ThP-10 Mechanisms of Fretting Corrosion in Titanium-based Biomedical Modular Implant Interfaces*, Avirup Sinha* ***[asinha38@uic.edu]****,* University of Illinois - Chicago, USA

Fretting corrosion is observed at modular junctions under load, where micro-motions lead to material loss and release of metallic ions or debris. Depending on applied load and displacement amplitude, fretting progresses through partial slip, mixed, and gross slip regime. In this study, fretting corrosion behavior was investigated under two contact configurations: metal on metal (Ti-6Al-4V on Ti-6Al-4V) and metal on ceramic (Ti-6Al-4V on ZrO2) in Bovin Calf Serum (BCS). BCS used in the experiment reflect two conditions: normal and infectious. Experiments were performed using 83 N normal load with a displacement amplitude of 5 µm at 1 Hz. Electrochemical protocols include sequential measurements of open circuit potential (OCP), potentiostatic (PS), and electrochemical impedance spectroscopy (EIS) which are synchronized with fretting motion. The test condition includes 10.9 mm diameter mirror polished disk and a 3 mm diameter pin with 20 ml of electrolyte used for each trial.This approach allows systematic evaluation of how contact pair and electrolyte chemistry influences the synergistic effects of wear and corrosion. The results are expected to advance the understanding of fretting corrosion in modular implants and support the design of materials and interfaces with improved in-vivo durability.

MD-ThP-11 Antimicrobial Potential of Silver-Copper Nanocoatings Deposited on Medical and Dental Polymeric Materials*, Argelia Almaguer-Flores* ***[aalmaguer@comunidad.unam.mx]****, Lorena Reyes-Carmona, David E. Martínez-Lara, Gina Prado-Prone, Sandra E. Rodil,* UNAM, Mexico

Introduction: During medical and dental procedures, infection prevention is vital because patients are often more vulnerable, and an infection could be life-threatening. Additionally, maintaining a microbial-free clinical environment—including instruments and surfaces—is essential to prevent contamination by microorganisms such as bacteria, fungi, and viruses that could be transmitted to patients.

Objective: To evaluate the antibacterial potential of a silver-copper nanocoating (SakCu®) deposited on medical-grade polyurethane (flat substrates and medical hoses) to reduce the adhesion of opportunistic pathogens associated with medical and dental devices.

Methods: The silver-copper nanocoating was deposited by magnetron sputtering in an inert argon (Ar) atmosphere, using a DC power source at 200 W. The characterization included scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-ray energy dispersive spectroscopy (EDS). The antibacterial assays included analysis of the effect of the SakCu® nanocoating on Gram-positive and Gram-negative bacterial strains, including *Escherichia coli* (ATCC 33780), *Pseudomonas aeruginosa* (ATCC 43536),*Staphylococcus aureus* (ATCC 25923), and *Staphylococcus epidermidis* (ATCC 14990).

Results: The nanocoating thicknesses obtained were 15, 30, and 50 nm. Surface morphology, analyzed by scanning electron microscopy (SEM), revealed a homogeneous coating in all cases. Transmission electron microscopy (TEM), elemental mapping, and electron diffraction (EDS) analyses confirmed an average composition of 42% Ag and 58% Cu, uniformly distributed, indicating the formation of an alloy. The antibacterial results showed a reduction in bacterial viability of more than 90% across all species tested.

Conclusions: The results showed the antibacterial potential of the silver-copper nanocoating (SakCu®) to prevent the adhesion of important opportunistic pathogens to medical-grade polyurethane surfaces on devices such as dialysis fluid bags and medical and dental hoses.

MD-ThP-12 Effects of the Temperature and Target Power on Microstructure and Electrochemical Properties of Fe-Mn-C-Zn Coatings via Magnetron Sputtering Co-Deposition*, Xinna Zhu* ***[289549@studenti.unimore.it]****,* Department of Engineering "Enzo Ferrari" University of Modena and Reggio Emilia, Modena, Italy*; Carlo Paternoster,* Laboratory for Biomaterials and Bioengineering, (CRC-Tier I), Dept Min-Met-Materials Eng., & Regenerative Medicine, CHU de Quebec, Laval University, Québec, QC, Canada*; Andrea Gatto,* Department of Engineering "Enzo Ferrari" University of Modena and Reggio Emilia, Modena, Italy*; Carlos Henrique Michelin Beraldo,* Laboratory for Biomaterials and Bioengineering, (CRC-Tier I), Dept Min-Met-Materials Eng., & Regenerative Medicine, CHU de Quebec, Laval University, Québec, QC, Canada*; Silvio Defanti,* Department of Engineering "Enzo Ferrari" University of Modena and Reggio Emilia, Modena, Italy*; Paolo Mengucci, Gianni Barucca,* Department SIMAU, Università Politecnica delle Marche, Ancona, Italy*; Helton José Wigger,* Laboratory for Biomaterials and Bioengineering (LBB-BPK), Associação de Ensino, Pesquisa e Extensão BIOPARK, Toledo, Brazil*; Andranik Sarkissian,* Plasmionique Inc., Varennes, QC, Canada*; Diego Mantovani,* Laboratory for Biomaterials and Bioengineering, (CRC-Tier I), Dept Min-Met-Materials Eng., & Regenerative Medicine, CHU de Quebec, Laval University, Québec, QC, Canada

Iron–manganese (Fe–Mn) alloys recently gained attention as promising materials for biodegradable metallic implants due to their excellent mechanical properties, comparable to stainless steel. However, their clinical translation is limited by two key issues: a high risk of post-surgical bacterial infections and a slow degradation rate. *Staphylococcus* species are among the main causes of implant-associated infections, forming resilient biofilms highly resistant to antibiotics and disinfectants. To overcome these limitations, this study develops Fe–Mn–Zn composite coatings with improved antibacterial and corrosion properties. Zinc was selected for its antibacterial and electrochemical properties: the higher electronegativity compared to iron (–1.2 vs –0.89 V) and lower solubility in a Fe-Mn-C matrix is expected to promote galvanic effects and controlled ion release.

Coatings were produced by dual magnetron sputtering using commercial zinc and Hadfield steel targets. The Fe–Mn target was kept at 300W, while the zinc target varied between 0–150 W to modulate composition. Depositions were carried out on silicon wafers at room temperature and 150 °C. The coatings were characterized by scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), transmission electron microscopy (TEM), contact angle measurements, potentiodynamic polarization (PDP), electrochemical impedance spectroscopy (EIS), scratch testing, and nanoindentation.

Zinc incorporation produced coatings with low surface roughness (1–10 nm) and no visible defects, maintaining a homogeneous surface at all deposition powers, with a columnar structure and intercolumnar spaces observed. Coating thickness ranged from ~500 to 700 nm. EDS showed zinc content increasing with Zn target power, reaching about 35 wt%, while iron and manganese decreased proportionally. XPS revealed strong zinc enrichment at the surface compared to bulk concentration. Mechanical testing indicated a slight reduction in hardness with increasing zinc, though values remained comparable to stainless steel and titanium alloys made by similar techniques.

Overall, dual magnetron sputtering enabled fabrication of high-purity Fe–Mn–Zn coatings with uniform morphology and modulable composition. Temperature was identified as a key factor influencing microstructure and elemental distribution. Further studies are needed to validate antibacterial properties and elucidate their effect on different classes of bacteria, responsible for infections and pathologies in biomedical applications of degradable materials.

MD-ThP-13 Effect of Fabrication Route on Adhesion and Stability of Copper Electrodeposits on Ti6Al4V Substrates*, Victor Manuel Solorio Garcia [vmsgvictor@gmail.com],* Tecnológico Nacional de México/ Instituto Tecnoógico de Morelia, Mexico*; Bryan Angel Zárate Verduzco,* Universidad Michoacána de San Nicolas de Hidalgo, Mexico*; Miguel Ivan Davila Pérez,* Tecnológico Nacional de México/ Instituto Tecnoógico de Morelia, Mexico*; Luis Rafael Olmos Navarrete,* Universidad Michoacana de San Nicolas de Hidalgo, Mexico*; Octavio Vázquez Gómez, Luis Emmannuel Reyes Gordillo,* Tecnológico Nacional de México/ Instituto Tecnoógico de Morelia, Mexico

The interfacial stability of metallic coatings strongly influences the functional lifetime of biomedical implants. This work investigates the effect of fabrication route on the adhesion and mechanical stability of electrodeposited copper (Cu) coatings on Ti6Al4V substrates produced by machining and powder metallurgy. Coatings were deposited under identical current and electrolyte conditions, and microhardness testing, DRX, and SEM/EDS microstructural analysis were performed. The Cu films on sintered Ti6Al4V exhibited significantly higher adhesion than those on machined samples, which correlated with increased roughness and open porosity inherent to the powder-metallurgy surface. Elemental mapping revealed partial diffusion of Cu into the Ti matrix, enhancing metallurgical bonding at the interface. These findings demonstrate that microstructural tailoring via the fabrication route can improve coating–substrate integrity and long-term performance in physiological conditions. The results provide a framework for integrating electrodeposition with energy-efficient manufacturing routes for functional coatings, bridging laboratory research with industrial implementation in biomedical device production.

MD-ThP-14 Improvement of Corrosion-Resistance Behavior of Electrophoretic Deposited Graphene-Hap Composite Coatings on Textured Biomedical Implant Surfaces.*, Smita Hasini Pradhan [a25me09006@iitbbs.ac.in],* IIT Bhubaneswar, India

Nickel-titanium alloys and commerciallly pure titanium are widely used as metallic bioimplants owing its unique combination of properties despite its inherent issue of poor corrosion resistance property. This study focusses on improving the corrosion resistance behavior of biomaterials (Nitinol and commerciallly pure titanium) by employing a 2-step processes including Femtosecond laser surface texturing (LST) and Electrophoretic deposition method (EPD). LST promotes refinement of surface grain size by the formation of TiO_2 phase within the EPD coated samples which renders mechanical interlocking points for better coating adhesion. To further enhance the corrosion resistance and biocompatibility nature of biomaterials, graphene and HAP composite coatings were prepared by EPD method onto the biomaterials. The metallic substrates were modified using the femtosecond laser texturing in order to generate micro-textures in the form of grid-like and circular patterns, followed by EPD coating on both bare and textured surfaces. The surface morphologies, microstructure and phase purity analyses were carried out using SEM, EDS, Raman spectroscopy and XRD techniques to confirm the actual composition and quality of the obtained coatings. Scratch test analyses were performed to determine the adhesion strength of the EPD-coated Gr/HAP coatings on laser-textured and bare substrate samples. The corrosion tests were conducted in simulated body fluid solution (SBF) to determine the protection efficiency of the coated samples using EIS and potentiodynamic polarization studies. The result of corrosion tests highlighted superior corrosion resistance property of laser textured coated samples as compared to bare and EPD coated samples due to the excellent corrosion resistance property of graphene nanosheets and higher adhesion property of Gr/HAP coating on the metallic substrates. This synergistic effect of both laser texturing and Gr/HAP composite EPD coatings could be a potential candidate for biomedical applications.

MD-ThP-17 On the Adhesion of a-C:H Coatings Deposited by PECVD on PDMS for Biomedical Applications*, Lidi Astrid Yáñez-Hernández [lidi.yanez-hernandez.1@ulaval.ca], Linda Victoria Bonilla-Gameros, Pascale Chevallier,* Université Laval, Canada*; Laurent Houssiau,* University of Namur, Belgium*; Andranik Sarkissian,* Plasmionique Inc., Canada*; Diego Mantovani,* Université Laval, Canada

Polydimethylsiloxane (PDMS) is widely used in biomedical devices. Despite its favorable properties, such as hemocompatibility, elasticity, and stability, it remains prone to bacterial colonization, which can lead to severe infections and device failure. Hydrogenated amorphous carbon (a-C:H) coatings have emerged as a versatile route to enhance biomaterial surfaces, and can serve as platforms for the controlled release of antibacterial agents. However, adhesion of a-C:H coatings to soft polymers such as PDMS remains a critical bottleneck for clinical success. This study investigates how substrate bias and hydrogen incorporation during plasma-enhanced chemical vapor deposition (PECVD) affect adhesion, morphology, and interface integrity of a-C:H coatings on PDMS. Coatings deposited without bias were termed polymer-like carbon (PLC), and those deposited at −300 V as diamond-like carbon (DLC). The incorporation of hydrogen during deposition produced the hydrogenated counterparts, PLCH and DLCH. Time-of-flight secondary ion mass spectrometry (ToF-SIMS) depth profiling revealed greater coating thickness and sharper interfaces for non-biased coatings. In contrast, biased coatings showed thinner films with evidence of intermixing with substrate components. Regarding hydrogen incorporation, a decrease in coating thickness and surface roughness was observed, as well as a reduction in crack density after tensile deformation. Furthermore, immersion tests under pseudo-physiological conditions demonstrated that the PLCH remained stable for 21 days, with only localized cracks and no significant delamination under static and dynamic conditions. These results suggest that this coating can withstand physiological stresses while maintaining mechanical integrity. Therefore, among the variants studied, PLCH (non-biased + H_2) emerges as the most promising coating for flexible PDMS biomedical devices, offering an optimal balance of thickness, adhesion, flexibility, and chemical durability.

Keywords: Polydimethylsiloxane, Hydrogenated amorphous carbon, coatings, diamond-like carbon, polymer-like carbon, plasma-enhanced chemical vapor deposition, adhesion.

MD-ThP-18 An Asymmetric Capillary-Driven Microtiter Platform Enabling Centrifuge-Free Point-of-Care Diagnostics*, KangKug Lee [klee3@wilberforce.edu], Yasmine Jones, Anastesia Smith,* Wilberforce University, USA

We present an innovative microtiter platform that leverages asymmetric capillary action to enable rapid plasma separation and colorimetric analysis from ultra-low volumes of whole blood. In contrast to conventional workflows that rely on large sample volumes (>10 mL) and centrifugation, our simplified approach requires <10 µL of whole blood and no instrumentation. The platform is polymer-based and features spray-coated superhydrophilic nanoporous surfaces combined with hydrophobic screw-shaped sidewalls. Plasma separation is initiated through simple manual shaking using two fingers, which provides sufficient centrifugal force to displace blood cells toward the hydrophobic sidewalls, while asymmetric capillary-driven lateral flow retains the plasma in the bottom nanoporous zone. This streamlined process substantially reduces sample volume, cost, and processing time, offering a portable and user-friendly solution for point-of-care (PoC) diagnostics.

MD-ThP-19 Influence of Microstructures on the Corrosion Behavior of Cobalt-Chromium Alloys Under Different Ortho Joint Conditions*, Mathew Mathew [mtmathew@uic.edu], Avirup Sinha, Sujoy Ghosh, Maansi Thapa, Remya Ramachandran, Nicki Ta,* University of Illinois at Chicago, USA

Cobalt-Chromium-Molybdenum (CoCrMo) alloys have been used in various biomedical applications, including hip and knee implants, making them highly essential in orthopedics. A major concern regarding these implants is their long-term corrosion resistance, as corrosion can have a negative impact on patient health. Corrosion resistance is impacted by a variety of factors, such as the alloy's microstructure and the environmental conditions that can affect the release of metal ions. In this study, two different microstructures of CoCrMo were tested including homogeneous and banded samples. Each microstructure was tested under three different conditions: normal, inflammatory, and infectious. To stimulate these environments, 30 g/L protein was used for normal conditions, 0.5 mM hydrogen peroxide for inflammation, and 15 µg/L LPS for infectious conditions. To test the long term effects of these conditions, 24 hour corrosion experiments were performed using a three-electrode electrochemical set up. The electrochemical testing protocol included the sequence of open circuit potential, potentiostatic run, electrochemical impedance spectroscopy, and cyclic polarization. For banded samples the experiments were run at a constant potential of -0.7V and for homogeneous samples, it was run at -0.68V. The banded structure exhibited higher current values than the homogeneous structure, indicating that CoCrMo alloys with a homogeneous microstructure have greater corrosion resistance. Furthermore, among normal, inflammatory, and infectious conditions, the inflammatory condition resulted in the greatest alloy loss (µg) for both banded and homogeneous structures. Specifically, the banded structure showed a loss of 37.53 µg, while the homogenous structure exhibited a loss of 5.69 µg, indicating inflammatory conditions have the least corrosion resistance.

MD-ThP-20 Effect of Current Density Variation on Cu-Incorporated Mao Coatings on Ti-30nb-5mo Alloy, *Giovana Collombaro Cardoso,* Universidade Estadual Paulista, UNESP, Bauru, Brazil*; Gustavo da Silva Diniz,* Universitdade Estadual Paulista, UNESP, Bauru, Brazil*; **Carlos Roberto Grandini [carlos.r.grandini@unesp.br]**,* Universidade Estadual Paulista, UNESP, Bauru, Brazil

Titanium and its alloys are widely used as biomaterials due to their excellent mechanical performance and corrosion resistance [1]. However, their inert surfaces limit biological interactions after implantation [2]. Surface modification by Micro-Arc Oxidation (MAO) is a versatile and cost-effective approach to produce porous TiO_2 coatings that can incorporate bioactive elements, enhancing osseointegration and antibacterial behavior [3]. This study investigates the effect of current density on the properties of MAO coatings formed on Ti-30Nb-5Mo alloy substrates. The process was carried out at 300 V for 3 minutes in an electrolyte containing calcium acetate, sodium glycerophosphate, and copper chloride, with current densities ranging from 1.0 to 2.5 A/cm^2. X-ray diffraction (XRD) revealed that higher current densities promoted the formation of rutile TiO_2 and increased surface roughness. Consequently, the water contact angle decreased, indicating improved hydrophilicity and potential for better cell adhesion. X-ray photoelectron spectroscopy (XPS) confirmed copper incorporation into the coatings, suggesting that the modified surfaces may provide antibacterial functionality. These results demonstrate that tuning the current density during MAO treatment is an effective strategy for tailoring the surface morphology, chemistry, and biological performance of Ti-based alloys for biomedical applications. (Financial Support: CNPq and FAPESP).

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