Surface Engineering of Biomaterials, Devices and Regenerative Materials: Health, Food, and Agriculture Applications
Room Town & Country A - 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,
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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,
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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.

Methods: 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-10 Investigating the Corrosion Behavior of Sol Gel and PEO Coatings on Magnesium for Biomedical Applications,
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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-11 Antimicrobial Potential of Silver-Copper Nanocoatings Deposited on Medical and Dental Polymeric Materials,
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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,* 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 [Diego.Mantovani@gmn.ulaval.ca]**,* 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-17 On the Adhesion of a-C:H Coatings Deposited by PECVD on PDMS for Biomedical Applications, *Lidi Astrid Yáñez-Hernández, Linda Victoria Bonilla-Gameros, **Pascale Chevallier [pascale.chevallier@crchudequebec.ulaval.ca]**,* 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-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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MD-ThP-21 Influence of Microstructure and Processing Voltage on the Formation and Properties of Coatings Obtained by Micro-Arc Oxidation (MAO) in Ti-25Ta-xNb Alloys*,* ***Fernanda de Freitas Quadros [ff.quadros@unesp.br]**,* Sao Paulo State University (UNESP), Brazil*; Katia Barbaro,* Istituto Zooprofilattico Sperimentale del Lazio e della Toscana, Italy*; Diego Rafael Nespeque Corrêa,* Sao Paulo State University (UNESP), Brazil*; Julietta V. Rau,* Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche, Italy*; Carlos Roberto Grandini,* Sao Paulo State University (UNESP), Brazil

The Micro-Arc Oxidation (MAO) technique has emerged as one of the most effective methods for improving the surface properties of metallic materials, particularly in titanium (Ti) alloys used for biomedical applications[1]. Although Ti exhibits good mechanical performance, high corrosion resistance, and excellent biocompatibility, issues such as corrosion, infection, and implant rejection may still occur[2]. Ti is an allotropic element, displaying a hexagonal close-packed (α) structure below 882 °C and a body-centered cubic (β) structure above this temperature[2]. The addition of β-stabilizing elements, such as tantalum (Ta) and niobium (Nb), lowers the β-transus temperature and can enhance the material's corrosion resistance and biocompatibility due to the intrinsic properties of Ta and Nb [3]. This study aimed to investigate the influence of microstructure, particularly through variations in Nb content, on coatings obtained by MAO in Ti-25Ta-xNb alloys (x = 10, 20, and 30 wt.% Nb) under different applied voltages (200, 250, and 300 V). X-ray diffraction (XRD) analyses revealed the predominance of Ti oxides in the anatase and rutile phases, with rutile being more pronounced in samples processed at higher voltages [3]. Scanning electron micrographs showed that both the alloy microstructure and the applied voltage significantly influenced coating formation and morphology, with variations in pore size, shape, and interconnectivity [3]. Rockwell C microhardness tests demonstrated good film adhesion to the substrate under all conditions analyzed [3]. In biological assays, Ti-25Ta-xNb substrates (200–300 V) exhibited non-cytotoxic behavior toward stem cells and effective antibacterial activity against Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Enterococcus faecalis, with the Ti-25Ta-30Nb alloy treated at 300 V showing the most promising performance. These findings indicate that surface modification via MAO, combined with controlled Nb addition, produces coatings with excellent adhesion, biocompatibility, and antimicrobial properties. The authors acknowledge the financial support from the funding agencies FAPESP, CAPES, and CNPq.

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MD-ThP-22 Using X-Ray Photoelectron Spectroscopy to Probe Lateral and Depth Distribution of Copper Based Photocatalytic Biocidal Film*,* ***David Surman [dsurman@kratos.com]**,* Kratos Analytical Inc, USA*; Jonathan Counsell,* Kratos Analytical Limited, UK*; Heather Yates,* University of Salford, UK

Copper based antimicrobial coatings are of increasing interest for reducing surface mediated transmission of pathogens, particularly in healthcare environments. In this study, X-ray photoelectron spectroscopy (XPS) was used to characterise the surface chemistry, lateral homogeneity, and depth distribution of copper within a copper oxide-titania composite thin film. The film was deposited on glass by open environment chemical vapour deposition (CVD), mimicking an industrial online process.

Large area XPS survey spectra confirmed the presence of copper at the outermost surface despite sequential deposition of titania over the copper oxide layer. This suggests either a non-continuous copper layer or a copper layer thinner than the ca. 10 nm sampling depth of XPS. Lateral compositional variation was assessed using XPS group array analysis over several millimetres, revealing a non-uniform surface distribution of copper across the sample.

High resolution Cu 2p spectra acquired from copper rich regions showed characteristic shake–up satellite features consistent with Cu(II), with no evidence of X–ray induced reduction during extended analysis. Destructive sputter depth profiling using Ar^+ ions revealed a high initial copper concentration at the surface (*ca.* 35 at.%), decreasing through the titania layer to *ca.*5 at.% and falling to background levels at the titania-silica interface. No copper diffusion into the glass substrate was observed.

These results demonstrate the capability of XPS to resolve both lateral and depth dependent copper distributions in complex antimicrobial coatings. They also provide critical insight into surface chemistry and elemental migration relevant to biocidal performance and coating optimisation.

MD-ThP-23 Surface-Engineered Graphene/PDMS Coatings Reduce Multispecies Uropathogenic Biofilms Under Urine-like Conditions*,* ***Francisca Sousa-Cardoso [francisca.sousa.cardoso@outlook.pt]**, Rita Teixeira-Santos, Luciana C. Gomes, Rita Vieira,* University of Porto, Portugal*; Brian A. Korgel,* University of Texas at Austin, USA*; Olívia S. G. P. Soares, Filipe J. Mergulhão,* University of Porto, Portugal

Silicone elastomers such as polydimethylsiloxane (PDMS) are widely used in indwelling urological medical devices, yet their hydrophobic surfaces provide a favorable substrate for polymicrobial biofilm development under urine-like conditions. This work reports a thin, surface-engineered graphene/PDMS composite coating designed to reduce mixed uropathogenic biofilms through intrinsic, contact-active surface properties rather than soluble antimicrobials.

Graphene nanoplatelets were functionalized via melamine-assisted mechanochemical processing, followed by thermal treatment and incorporated at 1 wt.% into PDMS to obtain spin-coated films onto glass slides. Surface morphology and topography were assessed through Scanning Electron Microscopy (SEM), which showed a uniform elastomeric coating decorated with graphene-associated micro/nano-asperities and protrusions, and white-light optical profilometry (OP), which confirmed increased roughness and topographic complexity compared with unmodified PDMS. To confirm the surface chemistry of the functionalized graphene material used to fabricate the coating, additional characterization was performed by Scanning Transmission Electron Microscopy (STEM) imaging with Energy-Dispersive X-ray Spectroscopy (EDX) elemental mapping and X-ray Photoelectron Spectroscopy (XPS), which corroborated nitrogen incorporation at the graphene surface.

Antibiofilm performance was evaluated after 24 h in artificial urine medium using a 1:1:1 tri-species community of *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. Total biofilm cells were quantified by flow cytometry, and confocal laser scanning microscopy enabled 3D reconstruction of biofilm architecture and spatial organization within the mixed community. Relative to PDMS controls, the graphene/PDMS coating reduced total cells by ~41% in tri-species biofilms. Confocal reconstructions further indicated substantial architectural attenuation on the composite surface, with ~30% lower biovolume and ~70% lower thickness, and the most pronounced suppression associated with *S. aureus* within the mixed biofilm.

Overall, the engineered graphene/PDMS surface reduced tri-species biofilm cells and thickness compared to bare PDMS. This material and coating strategy can thus be promising for silicone indwelling medical devices, including catheters and ureteral stents.

MD-ThP-24 Flexible Negative Pyramid Microarrays Coated with Ag NanoParticles for Raman Enhancing Detection*,* ***Ting-Yu Liu [tyliu0322@gmail.com]**,* Ming Chi University of Technology, Taiwan

Light-capturing flexible PDMS substrates with negative pyramid microarrays are fabricated through a sequential replication process using silicon master stamps. These stamps, containing negative pyramid structures, are produced via photolithography followed by wet chemical etching. Silver (Ag) is then thermally deposited onto the flexible PDMS surface, forming densely packed nano-islands. These nano-islands generate localized surface plasmon resonance (LSPR), which produces strong surface-enhanced Raman scattering (SERS) "hot spots." In addition, the negative pyramid structures enhance the SERS signal by approximately four times due to multiple reflections of the incident laser within the microarrays. The PDMS-NP-Ag substrates demonstrate a detection limit below 10^{-8} M for rhodamine 6G (R6G) and malachite green, indicating high sensitivity. They also show excellent reproducibility, with a variation of only 7.6% across 20 randomly selected measurement points. Furthermore, the flexible nature of these substrates allows them to conform to irregular surfaces, such as apples, enabling practical applications in detecting pesticides and microorganisms. Overall, the substrates exhibit efficient and reproducible detection of environmental pollutants (e.g., R6G, malachite green, and paraquat) as well as bacteria (E. coli) at ultra-low concentrations.

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