Surface Engineering of Biomaterials, Medical Devices and Regenerative Materials
Room Palm 1-2 - Session MD1-1-MoM

Development and Characterization of Bioactive Surfaces/Coatings I

Moderators: Dr. Mathew T. Mathew, University of Illinois College of Medicine at Rockford and Rush University Medical Center, USA, **Dr. Sandra E. Rodil**, Universidad Nacional Autónoma de México

10:00am **MD1-1-MoM-1 Hybrid Ceramic Coating with Enhanced Corrosion Resistance for Magnesium-Based Biodegradable Implants**, ***Abdelrahman Amin [xml111@mocs.utc.edu]***, *Diya Patel,* University of Tennessee at Chattanooga, USA; *Bryce Williams, Thomas McGehee, Alyssandra Navarro, Mostafa Elsaadany,* University of Arkansas, USA; *Hamdy Ibrahim,* University of Tennessee at Chattanooga, USA; *Merna Abdrabo,* The University of Tennessee at Chatanooga, USA

Biodegradable implants, recognized for their unique mechanical properties and compatibility with human bone, have become essential in various biomedical applications. Magnesium, a key material in such implants, is notable for its favorable biodegradability within the human body. However, one limitation of magnesium is its tendency to degrade too quickly, leading to a loss of mechanical integrity before bone healing is complete. This rapid degradation can undermine the implant's effectiveness, driving efforts to manage magnesium's high corrosion rate through various approaches. Among these, the development of protective coatings on magnesium alloys has shown significant promise. Such coatings provide a temporary protective layer, thereby slowing down the corrosion process and extending the implant's functionality. Hybrid coatings, particularly those combining Plasma Electrolytic Oxidation (PEO) with sol-gel techniques, have improved the ability to control and adjust corrosion rates while incorporating bioactive agents like hydroxyapatite (HA) nanoparticles. These nanoparticles contribute to enhanced bioactivity and osteoconductivity, further supporting bone healing. In this study, the primary objective is to explore how altering the key parameters of Sol-gel coating affects the corrosion resistance of a magnesium alloy substrate that has been pre-coated with a PEO layer. Specifically, the combined impact of varying HA concentration within the Sol-gel solution, dip time, and the number of layers deposited are examined. The findings of this work establish the relationship between the sol-gel coating process parameters and the corrosion properties of the developed hybrid coating leading to a better understanding of their effect on developing magnesium-based implants with superior properties.

10:20am **MD1-1-MoM-2 Functional Coatings by Low Vacuum Plasma for the Innovation in Regenerative and Reparative Medicine**, *Pascale Chevallier, Carlo Paternoster, Francesco Copes,* Laval University, Canada; *Andranik Sarkissian,* Plasmionique Inc., Canada; ***Diego Mantovani [diego.mantovani@gmn.ulaval.ca]***, Laval University, Canada **INVITED**

Over the last 50 years, biomaterials, prostheses and implants saved and prolonged the life of millions of humans around the globe. Today, nano-biotechnology, nanomaterials and surface modifications provide a new insight to the current problem of biomaterial complications, and even allows us to envisage strategies for the organ shortage. In this talk, creative strategies for modifying and engineering the surface and the interface of biomaterials, including metals, polymers from natural and synthetic sources, will be discussed. The unique potential of low-pressure low-temperature plasma surface modification will be detailed with the overall aim to envisage today how far innovation can bring tomorrow solutions for reparative and regenerative medicine. Applications for health will be emphasized, including biologically active-based, biomimetic, low-fouling, bactericidal, and antiviral coatings.

References

1. M. Shekargoftar, S. Ravanbakhsh, V. Sales de Oliveira, J. Buhagiar, N. Brodusch, S. Bessette, C. Paternoster, F. Witte, A. Sarkissian, R. Gauvin, D. Mantovani. Effects of Plasma Surface Modification of Mg-2Y-2Zn-1Mn for Biomedical Applications [https://www.sciencedirect.com/science/article/pii/S2589152924002825], *Materialia*, 102285, 2024.
2. S.H. Um, J. Lee, M. Chae, C. Paternoster, F. Copes, P. Chevallier, D.H. Lee, S.W. Hwang, Y.C. Kim, H.S. Han, K.S. Lee, D. Mantovani, H. Jeon. Biomedical Device Surface Treatment by Laser-Driven Hydroxyapatite Penetration-Synthesis Technique for Gapless PEEK-to-Bone Integration [https://onlinelibrary.wiley.com/doi/abs/10.1002/adhm.202401260] . *Adv Healthcare Mater*, 13, 26, 2401260, 2024.
3. M.E. Lombardo, V. Mariscotti, P. Chevallier, F. Copes, F. Boccafoschi, A. Sarkissian, D. Mantovani. Effects of cold plasma treatment on the biological performances of decellularized bovine pericardium extracellular matrix-based films for biomedical applications [https://www.explorationpub.com/Journals/ebmx/Article/10137]. *Exploration of BioMat-X*, 1, 2, 84-99, 2024.
4. L. Bonilla-Gameros, P. Chevallier, X. Delvaux, L.A. Yáñez-Hernández, L. Houssiau, X. Minne, V.P. Houde, A. Sarkissian, D. Mantovani. *Nanomaterials*, 14, 7, 609, 2024.
5. L. Marin de Andrade, C. Paternoster, P. Chevallier, S. Gambaro, P. Mengucci, D. Mantovani. Bioactive Materials, 11, 166, 2022.

11:00am **MD1-1-MoM-4 10-h2da Coating on Polyvinyl Chloride Catheter Biomaterials for Prevention of Candida-Associated Urinary Tract Infections**, ***Jermiah Tate [jdtate3@memphis.edu]***, *Joel Bumgardner, Tomoko Fujiwara, J. Amber Jennings,* University of Memphis, USA

Urinary catheters made of polyvinyl chloride (PVC) are susceptible to microbial biofilm formation. 10-hydroxy-2-decenoic acid (10-H2DA) is a dispersal signaling molecule known to inhibit biofilm and planktonic growth of microorganisms. This study hypothesized that coating PVC with 10-H2DA would inhibit planktonic and biofilm-associated Candida albicans. Interactions of the PVC and 10-H2DA molecules were analyzed using Video Contact Angle (VCA), Fourier Transform Infrared (FTIR), and High-Performance Liquid Chromatography (HPLC).Successful coating of PVC with 10-H2DA was demonstrated through a lowered contact angle. The control group displayed an average contact angle of 107° with a p value <0.0001 of significance compared to the following groups:10mg/ml (65.8°), 15mg/ml (80.7°), and 20 mg/ml (55.8°). FTIR peaks appeared in regions indicative of the 10-H2DA on the surface of PVC. Elution data displays a burst release of 50% 10-H2DA within 3-6-hours. After 48 hours of incubation, over 60% of planktonic C. albicans growth was inhibited (p<0.0001) in the environment of PVC coated with 10-H2DA compared to uncoated PVC. There were no significant reductions of biofilm. Immersing PVC in 10-H2DA showed short-term surface activity, attributed to the short timeframe of release of 10-H2DA. Further investigations will explore anti-biofilm properties of 10-H2DA on the PVC surface against other common microorganisms responsible for biofilm development on urinary catheters and chemical conjugation for longer term release.

11:20am **MD1-1-MoM-5 Hydrogen-Treated Orthopedic Implants : A Novel Approach to Enhance Biocompatibility and Mitigate Inflammation**, ***Ren-Jei Chung [rjchung@mail.ntut.edu.tw]***, National Taipei University of Technology, Taiwan **INVITED**

The surface modification of cobalt-chromium-molybdenum (CoCrMo) alloy to create hydrogenated CoCrMo (H-CoCrMo) surfaces has shown promise as an anti-inflammatory orthopedic implant. Utilizing the electrochemical cathodic hydrogen-charging method, the CoCrMo alloy surface was hydrogenated, resulting in improved biocompatibility, reduced free radicals, and an anti-inflammatory response. *In vitro* studies demonstrated enhanced hydrophilicity and the deposition of hydroxyapatite. The cell study result revealed a suppression of osteosarcoma cell activity. Finally, the *in vivo* test suggested a promotion of new bone formation and a reduced inflammatory response. The diffusion of hydrogen to a depth of approximately 106 ± 27 nm on the surface facilitated these effects. The findings suggest that electrochemical hydrogen charging can effectively modify CoCrMo surfaces, offering a potential solution for improving orthopedic implant outcomes through anti-inflammatory mechanisms.

Author Index

Bold page numbers indicate presenter