Surface Engineering of Biomaterials, Medical Devices and Regenerative Materials
Room Golden State Ballroom - Session MD-ThP

Surface Engineering of Biomaterials, Medical Devices and Regenerative Materials Poster Session

MD-ThP-1 Electrochemical and Antimicrobial Coating: Increasing the Ionic Charge on Titanium Surfaces as a Preventive Strategy for Titanium Implants*, **João Pedro dos Santos Silva [jpedrooss85@gmail.com]**,* École des mines de Saint-Étienne, France*; Daniela Buenos Ayres de Castro, Mariana Mireski, Catia Sufia Alves Freire de Andrade, Maria Helena Rossy Borges,* Universidade Estadual de Campinas, Brazil*; Jean Geringer,* École des mines de Saint-Étienne, France*; Valentim Adelino Ricardo Barão,* Universidade Estadual de Campinas, Brazil

Peri-implant conditions and the electrochemical degradation of titanium (Ti) are critical factors in the failure of biomedical implant treatments. Developing functional surfaces to address these challenges is essential. Cationic coatings have proven to be an effective strategy for reducing biofilm formation and enhancing corrosion resistance. This treatment focuses on increasing the surface charge of implants and provides antimicrobial properties without the use of pharmaceutical agents, making the approach safer, more cost-effective, and sustainable. Thus, this coating was developed in two stages: (1) functionalization with hydroxyl groups (-OH) using plasma electrolytic oxidation (PEO), incorporating bioactive elements and enhancing surface functionalization; (2) silanization with tetraethylorthosilicate (TEOS) or 3-glycidyloxypropyltrimethoxysilane (GPTMS), which bind to alkaline surfaces and promote proton release through chemical reactions. Four groups (untreated Ti, PEO, PEO + TEOS, and PEO + GPTMS) were evaluated for surface characterization, electrochemical performance, and antimicrobial activity. Micrographs showed distinct morphologies in the silanized groups, with the alkalinization step generating pores that enhanced topography and roughness. The superhydrophilic affinity created by alkalinization evolved into hydrophobic (TEOS) and superhydrophobic (GPTMS) characteristics after silanization. The presence of amine groups, detected by X-ray photoelectron spectroscopy (XPS), indicated an increase in surface charge, confirmed by zeta potential measurements. Positively charged surfaces demonstrated superior electrochemical performance and greater antimicrobial potential against Streptococcus mitis biofilm formation (24 h). In conclusion, cationic coatings show promise for implantable devices, offering improved resistance in adverse environments and antimicrobial properties.

MD-ThP-2 Flexible, Enzyme-Free, and Ultra-Sensitive Cholesterol Sensor Based on In-Situ Etched $Ti_3C_2T_x$ MXene Nanosheets*, **Sanjeev Kumar [sanjeev.kumar@rgu.ac.in]**, Jyoti Jaiswal, Rajesh Chakrabraty, Kulsuma Begum, Bitupan Prasad,* Rajiv Gandhi University, India

This work presents an enzyme-free cholesterol sensor based on $Ti_3C_2T_x$ MXene nanosheets, offering a highly sensitive detection platform. The $Ti_3C_2T_x$ MXene nanosheets were synthesized via in-situ LiF/HCl etching, and the sensing electrode was prepared by drop-casting a colloidal solution of the as-synthesized MXene onto a paper substrate. To investigate the quality and properties of the synthesized $Ti_3C_2T_x$ MXene nanosheets, microstructural and compositional studies were conducted utilizing FESEM, XRD, Raman spectroscopy, XPS, and EDS. These characterizations confirmed the successful synthesis of the $Ti_3C_2T_x$ MXene nanosheets. Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were performed to analyse the electrochemical behaviour of the $Ti_3C_2T_x$ MXene-based electrode. The responses of the fabricated electrode to different cholesterol concentrations were recorded using CV in phosphate buffer solution, exhibiting robust linear response ($R^2 \sim 0.99$) in the range from 1 to 250 nM. The MXene-based electrode exhibited good sensitivity (0.75377 ± 0.01107 mF nM^{-1}), a low detection limit (0.07 nM), high selectivity, practical reproducibility, and excellent cyclic stability, suggesting its potential for real-time cholesterol monitoring in biomedical and healthcare applications.

MD-ThP-3 Effect of the Thickness of Fibrous Cap and Compositions on the Rupture Behaviour of the Atherosclerosis Plaques*, **Jiling Feng [j.feng@mmu.ac.uk]**, Mohamed Abdulsalam,* Manchester Metropolitan University, U.K.

Atherosclerotic plaque rupture is the leading cause of the cardiovascular diseases (CVD) such as coronary arteries disease, stroke and heart attack. Early detection of the plaques which are prone to the rupture, also known as vulnerable plaque, can provide important clinical information to prevent the fatal cardiovascular event. The vulnerable plaques are commonly characterized as the large lipid core and thin fibrous caps with the thickness less than 65 µm. However, evidence showed that plaques with fibrous caps > 65 µm are also susceptible to plaque rupture or erosion and can cause acute myocardial infarction and sudden death [1]. The effect of the critical thickness of fibrous cap and compositions of the plaques on the rupture behaviour of the arterial plaques has not been fully investigated. In this study, the artificial plaques with a variety of the compositions (lipid core, calcium and collagen) and with a range of thickness of fibrous cap were fabricated. The mechanical properties of the plaques were tested by using the unconfined compression testing. Meanwhile, the deformation of the arterial plaques samples and rupture behaviours were also recorded by using the high-resolution of camera. The initiation and propagation of the rupture of fibrous cap were analysed using digital image correlation (DIC) software. The experimental results indicated that the thicker the fibrous cap, the stiffer the arterial plaque. This phenomenon was observed in the plaques with large lipid core and calcified plaques. The Young's module for the plaques with large lipid core (Figure 1a) ranges from 0.0235 to 3.7174 MPa which are compatible with the value of plaques in the human carotid arteries which were observed in the clinical findings. The plaques with higher percentage of collagen possess the the greater Young's modules (Figure 1b).

Reference

[1] Liu, X., He, W., Hong, X. *et al.* New insights into fibrous cap thickness of vulnerable plaques assessed by optical coherence tomography. *BMC Cardiovasc Disord* **22**, 484 (2022).

MD-ThP-4 Effects of Electrical Stimulation with Iridium Oxide Plasma Protein Hybrid Film on Nerve Cells*, **Po-Chun Chen [cpc@mail.ntut.edu.tw]**,* National Taipei University of Technology, Taiwan

Iridium oxide (IrOx) is a well-known material for neural stimulation, but its rigidity and lack of bioactivity limit its biomedical application. To address this, an IrOx film incorporating plasma proteins (IrOx-PP) was developed to enhance biocompatibility and promote neuronal growth. The addition of plasma proteins created bioactive sites that improved cell adhesion and differentiation while maintaining the electrochemical properties needed for neural stimulation. The IrOx-PP hybrid films showed significantly higher cell viability and metabolic activity, with electrical stimulation further enhancing cell growth and bioactivity. Neurite length increased significantly under electrical stimulation, with the IrOx-PP hybrid films showing the greatest enhancement. In addition, cells on IrOx-PP hybridfilms expressed higher levels of the neuronal markers, indicating their superior potential for promoting neuronal differentiation and neurite outgrowth compared to pure IrOx films. This result demonstrated that the IrOx-PP hybrid film can potentially serve as a platform for advanced neural interfaces, providing improved tissue integration.

Author Index

Bold page numbers indicate presenter