Surface Engineering of Biomaterials, Devices and Regenerative Materials: Health, Food, and Agriculture Applications
Room Town & Country B - Session MD1-2-TuM

Coatings and Surfaces for Medical Devices: Mechanical, Corrosion, Tribocorrosion, and Surface Processing II

Moderators: Po-Chun Chen, National Taipei University of Technology, Taiwan , **Jean Geringer**, Ecole Nationale Superieure des Mines, France

8:00am **MD1-2-TuM-1 Metallic-Capped Nanoslit Structure Integrating with Microfluidic Devices for Biosensing Applications.**, ***Yu-Jui (Ray) Fan [rayfan@nycu.edu.tw]***, National Yang Ming Chiao Tung University (NYCU), Taiwan **INVITED**

A localized surface plasmon Resonance (LSPR) is the result of the confinement of a surface plasmon in a nanoparticle/nanostructure of size comparable to or smaller than the wavelength of light used to excite the plasmon. The plasmon resonant frequency is highly sensitive to the refractive index of the environment; a change in refractive index results in a shift in the resonant frequency. As the resonant frequency is easy to measure, it can be used as an immunosensor. We will introduce the metallic-capped nanostructures as LSPR biosensors integrating with microfluidic devices. In this talk, I will show two examples: (1) an LSPR sensor integrating with microfluidic-based polymerase chain reaction (PCR) for DNA detection, and (2) an LSPR sensor integrating with a microfluidic-based preconcentrator for antigen detection.

8:40am **MD1-2-TuM-3 Plasma-Activated Chitosan-Hydrogel Coating Incorporating Natural Immunomodulatory Protein (GMI) for Enhanced Tissue Regeneration and Oral Cancer Inhibition**, *Yu-Rou Lin, Meng Yun Wu, Sheng-Yen Lin,* ***Ying-Sui Sun [yingsuisun@tmu.edu.tw]***, Taipei Medical University, Taiwan **INVITED**

Dental implant regeneration aims not only to restore alveolar bone integrity but also to re-establish the physiological functions of periodontal tissues and sensory feedback lost in conventional osseointegration. Conventional titanium implants, while mechanically stable, often lack the biological complexity of natural teeth. Therefore, regenerative implant strategies that promote bone formation, soft tissue integration, and nerve recovery are increasingly essential for long-term functional success. Meanwhile, oral cancer remains the sixth most prevalent malignancy globally, particularly in Southeast Asia. Betel nut chewing, smoking, and alcohol consumption are major etiological factors contributing to late-stage diagnosis, high recurrence, and impaired oral functions. Hence, developing biomaterials that simultaneously enhance tissue regeneration and suppress cancer progression represents a critical frontier in oral biomedical materials research. In this study, a plasma-activated chitosan-hydrogel coating incorporating a natural immunomodulatory protein, Ganoderma lucidum microspore immunomodulatory protein (GMI), was developed as a dual-functional platform for tissue regeneration and oral cancer inhibition. Plasma activation was employed to enhance the surface energy and introduce hydrophilic reactive groups (–OH, –COOH, $–NH_2$) on the chitosan hydrogel, improving protein immobilization efficiency and biointerface activity. GMI, known for modulating MAPK-related immune signaling, exhibits anti-inflammatory, antiviral, and anticancer properties while promoting tissue repair. The plasma-activated hydrogel surface was characterized using FESEM and immunofluorescence microscopy, confirming an extracellular matrix (ECM)-like morphology favorable for cell attachment. Biological performance was evaluated using dental pulp stem cells (DPSCs) and oral cancer cell lines. The AlamarBlue assay demonstrated that the plasma-activated GMI–hydrogel coating significantly enhanced DPSC viability and proliferation compared to untreated controls. Wound healing and migration assays revealed accelerated cell migration and coverage on the plasma-treated surfaces. Western blot analysis further confirmed the upregulation of MAPK-associated proteins involved in regenerative signaling. In parallel, the GMI-loaded coatings induced apoptosis in oral cancer cells, inhibiting their adhesion, spreading, and colony formation. These results collectively demonstrate that the synergistic combination of plasma surface engineering and GMI bioactivity enables precise modulation of cellular behavior toward regeneration while suppressing malignant cell functions.

9:20am **MD1-2-TuM-5 Low Temperature Plasma Assisted Strategies to Surface Engineering of Biomaterial**, *Claude Côté, Noureddine Oudini, Alexa Bagdasarian,* PLASMIONIQUE Inc., Canada*; Kambiz Chizari,* PLSMIONIQUE Inc, Canada*; Eduardo Loreto,* PLASMIONIQUE Inc, Canada*; Anita Sarkissian, Ryan Porter,* ***Andranik Sarkissian [sarkissian@plasmionique.com]***, PLASMIONIQUE Inc., Canada **INVITED**

The unique characteristics of materials at the nanoscale make them some of the most promising molecular building blocks in nanotechnology. Nanostructured materials have attracted significant attention across various industrial fields due to their exceptional mechanical, chemical, electrical, and optical properties, which enable a wide range of potential applications. However, each specific application demands precisely engineered structures tailored to its unique requirements. Consequently, the development of specialized strategies for selective processes - such as etching, deposition, functionalization, ion implantation, and synthesis - with excellent control is essential.

Biomaterials present additional challenges, as they must simultaneously satisfy multiple, and often competing, requirements, including biocompatibility, hemocompatibility, cytotoxicity, biodegradability, and mechanical and chemical stability.

Plasma- and vacuum-based technologies offer several distinctive advantages, particularly their ability to enable surface engineering with single-monolayer precision.

In this presentation, we will discuss a range of plasma-assisted surface modification strategies, illustrated with examples of their application to the surface engineering of biomaterials, including biodegradable materials.

10:00am **MD1-2-TuM-7 Superhydrophilic Metallic Coating: PVD Fabrication and Applications**, *Sea-Fue Wang,* National Taipei University of Technology, Taiwan*;* ***Jinn P. Chu [jpchu@mail.ntust.edu.tw]***, National Taiwan University of Science and Technology, Taiwan

Superhydrophilic coatings represent a powerful class of biomimetic technologies that address diverse real-world challenges—from maintaining building cleanliness and optical clarity to enhancing safety in medical settings and efficiency in industrial processes. In this presentation, I will report a novel superhydrophilic coating based on a sputter-deposited 316 stainless steel layer. The coated surface exhibits a water contact angle of approximately 10 degrees. Furthermore, this coating demonstrates notable antifouling and underwater superoleophobic properties, making it highly advantageous for application in separation membranes designed for oil/water emulsions. In addition to its antifouling and separation capabilities, this coating has proven highly effective at enhancing electrochemical responses, making it an excellent functional layer for sensor electrodes. This presentation will provide specific application case studies to demonstrate its practical utility in this domain.

10:20am **MD1-2-TuM-8 Ti-Nb-Mo Alloy Coatings Sputter-Deposited on 316L for Biomedical Applications**, *Katherine Martinez-Orozco, Bruno Aquino,* Federal University of Sao Carlos, Brazil*; Raira Apolinario, Haroldo Pinto,* University of Sao Paulo, Brazil*; Conrado Afonso,* ***Pedro Nascente [nascente@ufscar.br]***, Federal University of Sao Carlos, Brazil **INVITED**

Medical grade AISI 316L stainless steel (SS) has been widely used as prosthetic material due to its adequate biomechanical and biocompatibility properties, however, the cytotoxicity caused by the release of Cr and Ni ions can have toxic effects and cause allergies in human tissues. β phase (body-centered cubic) Ti-based alloys present lower elastic moduli, better biocompatibility, lower density, and better wear and corrosion resistance in biological environments than the 316L SS, however, they are much more costly. An economical option would be to coat a SS implant with a β-Ti alloy thin film with adequate composition to enhance the material biocompatibility. Nb and Mo are non-toxic and non-allergenic biocompatible metals, and their addition to Ti helps to stabilize the β phase. Ti-Nb-Mo alloy ternary alloys present a low elastic modulus that could prevent the stress shielding effect that can cause bone loss. We report on Ti-Nb-Mo alloy coatings deposited on 316L substrates by direct current magnetron sputtering. The following atomic compositions were produced: Ti74Nb21Mo5, Ti74Nb19Mo7, Ti72Nb19Mo9, and Ti67Nb22Mo11; a Ti80Nb20 coating was used as reference. Only the β phase was identified by grazing incidence X-ray diffraction. Scanning electron microscopy images revealed the presence of agglomerates and porous; the grain sizes decreased with the increasing in Mo content. The residual stresses presented a combination of compressive and tensile stresses. An inverse Hall-Petch effect was observed with the hardness reduction with the decreasing in grain size. X-ray photoelectron spectroscopy (XPS) analysis revealed that the Ti-Nb-Mo coatings presented oxidized surface layers, which can be beneficial for biomedical applications.

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