Surface Engineering of Biomaterials, Medical Devices and Regenerative Materials
Room Palm 1-2 - Session MD2-WeM

Surface Response to Biological Environments, Biointerphases, and Regenerative Biomaterials

Moderators: Po-Chun Chen, National Taipei University of Technology, Taiwan , **Dr. Jean Geringer**, Ecole Nationale Superieure des Mines, France, **Dr. Hamdy Ibrahim**, University of Tennessee at Chattanooga, USA

8:00am **MD2-WeM-1 Modulating Cell Responses via Surface Engineering*, Huinan Liu [huinanliu@engr.ucr.edu],*** University of California, Riverside, USA **INVITED**

Engineered surfaces provide promising solutions to meet the clinical needs for medical implants and devices. Bioresorbable implants and devices are designed to degrade harmlessly in the body over time as new tissues grow, which eliminates the need for secondary surgeries and associated complications. Recent researches on biodegradable polymers and metals have demonstrated their potentials for clinical applications, but there are still major challenges yet to be addressed, e.g. (1) controlling their degradation rates and cellular responses to match tissue healing rates, and (2) modulating their bioactivities to promote healing functions of desirable cells while inhibiting bacterial infections. In this presentation, our recent progress on engineering bioresorbable alloys and surfaces to regulate the degradation rates and cell responses will be presented. The relationships between surface microstructure, degradation, and interactions with host cells and pathogenic microorganisms will be discussed.

8:40am **MD2-WeM-3 Nanomaterials and Thin Films: Revolutionizing Bio-Applications for Early Disease Detection*, Samir Iqbal [smiqbal@utrgv.edu],*** University of Texas at Rio Grand Valley, USA **INVITED**

Modern nanofabrication techniques have enabled the creation of innovative architectures to interface with living systems, opening new frontiers in biotechnology and medical diagnostics. These development involves nanostructured or nanotextured sensor interfaces made from diverse materials, which exhibit remarkable antibacterial properties, enhanced cell adhesion, and, in some cases, unique interactions with normal and diseased cells. These surfaces hold significant promise for advancing biomedical applications.

Simultaneously, advancements in electronic miniaturization have led to the reproducible fabrication of nanoscale devices capable of interfacing with biological molecules. Leveraging microfluidics and nanoscale features, these devices can detect and identify molecular biomarkers and diseased cells with unprecedented precision. Such systems enable rapid, label-free, and selective chemical analyses from minute sample volumes, offering transformative potential for early diagnostics. Early detection of diseased cells, particularly when present in small numbers, is critical for improving survival rates in conditions such as cancer.

Nanomanufactured frameworks allow the combinatorial measurement of viscoelastic, mechanical, electrical, and chemical properties to transduce molecular and cellular anomalies into meaningful diagnostic signals. This talk will explore the role of nanoscale thin film properties in disease detection, emphasizing the importance of early cancer diagnosis. A comprehensive overview of molecular detection, isolation, and sorting of diseased cells using nanotechnology and microfluidics will also be provided, highlighting the transformative potential of these approaches in modern medicine.

9:20am **MD2-WeM-5 Green Fabrication of Conductive Carbon Thin Film Patterns for Biosensors*, Ying-Chih Liao [liaoy@ntu.edu.tw],*** National Taiwan University, Taiwan **INVITED**

The demand for sustainable and cost-effective materials in biosensing is growing, especially for real-time and portable health monitoring. However, conventional electrode fabrication methods often require multiple processing steps and use non-renewable materials. This reliance raises environmental concerns and limits scalability. In this study, a green approach is developed to directly transform biodegradable bacterial cellulose (BC) into conductive carbon thin films using CO_2 laser-induced carbonization under ambient conditions for biosensor fabrication. Bacterial cellulose (BC) a biopolymer generated by specific bacteria, features a highly porous, nanoscale fibrous structure along with notable mechanical strength and biocompatibility. These properties make it a highly versatile material for biomedical applications. The laser-induced carbonization process leverages these unique structural features of BC, converting it into a conductive carbon matrix suitable for electrochemical applications. This one-step technique involves the precise application of a CO_2 laser, which locally heats the BC, breaking down organic components and rearranging carbon atoms to create conductive graphitic structures.

This approach integrates essential elements into the BC matrix, enhancing conductivity and sensor functionality without requiring complex post-treatments. The laser-induced carbonized BC electrode offers promising detection capabilities for glucose and lactate, enabling concurrent sensing in phosphate buffer solution (PBS) and demonstrating selectivity, reproducibility, and stability, verified through differential pulse voltammetry (DPV). This streamlined laser carbonization method facilitates electrode fabrication and yields electrodes capable of application in real sweat sample analysis.These characteristics highlight BC-based electrodes as highly promising candidates for portable, cost-effective on-site biosensors for monitoring key biomarkers in sweat, underscoring the potential of laser-induced carbonization in advancing sustainable, high-performance materials for health monitoring technologies.

11:00am **MD2-WeM-10 Functionalized Graphene for Sensor Applications*, Chi-Hsien Huang [chhuang@mail.mcut.edu.tw],*** Ming Chi University of Technology, Taiwan **INVITED**

Graphene (G), a one-atom-thick, two-dimensional material, exhibits great potential as a biosensor transducer due to its high sensitivity to foreign atoms or molecules. However, its inertness limits its application, making functionalized graphene is very crucial for biosensor applications. In this presentation, I will talk about an atomic layered composite of graphene oxide/graphene (GO/G) by functionalizing chemical vapor deposition (CVD)-grown bilayer graphene (BLG) using our developed low damage plasma treatment (LDPT). This process selectively oxidized only the top layer of BLG, leaving the bottom layer intact. The GO top layer provides active sites for stable covalent bonding with biorecognition elements, while the G bottom layer acts as a sensitive transducer. With this GO/G composite, we constructed a solution-gated field effect transistor (SGFET)-based biosensors for miRNA-21, a cancer biomarker and p-tau 217, a Alzheimer's disease biomarker. In addition, laser induced graphene attracts a lot of attention because the preparation is low-cost, easy pattern fast and environment friendly. However, the electrochemical performance of standalone LIG is limited. To address this, the study enhances LIG by synthesizing nickel-iron Prussian blue analogues through co-precipitation and calcination, forming porous NiFe-Oxide, which is subsequently deposited onto the LIG surface via a facile physical deposition method. The porous NiFe-Oxide@LIG electrode material demonstrates excellent electrochemical sensing capabilities due to its high conductivity, improved surface area, enhanced active sites, and superior electrocatalytic performance for detecting the antioxidant propyl gallate (PG).

Keywords: graphene, LIG, sensor, biomarker

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