Biomaterial Surfaces & Interfaces
Room Naupaka Salon 5 - Session BI2-MoE

Biomaterials/Interfaces - Sustainable Materials

Moderator: Gabriella Lindberg, University of Oregon

7:40pm **BI2-MoE-7 Advanced BioAFM for Temporal Analysis*, Amy Gelmi,*** RMIT University, Australia **INVITED**

Electrical stimulation, a physical stimulation which can be delivered via a conductive biomaterial interface, directs human mesenchymal stem cell (hMSC) differentiation towards different cell tissue types.[1] Electrical stimulation conditioning offers a promising approach in directing stem cell fate. Conductive biomaterials are commonly used to provide either a passively conductive substrate, or actively provide 'smart' electrical stimulation of stem cells for tissue engineering. However, the mechanisms in which cells transduce these electrical signals into specific phenotype differentiation are poorly understood, restricting the intelligent design of stimulation protocols for targeted differentiation.

How the stem cells transduce an electrical signal into a biological response is explored via different classes of conductive biomaterials. Immediate changes in the stem cells during and post-stimulation is characterised, using live cell bio-AFM for morphological and biomechanical changes, complemented with standard biological characterisation. The advanced bioAFM technique delivered unprecedented intracellular biomechanical information of live cells undergoing simultaneous electrical stimulation.

For the first time we have characterised the transient mechanical response of hMSC to electrical stimulation, and related that to controlling stem cell differentiation towards osteogenesis. The knowledge gained from this study helps to further the intelligent design of stimulation parameters for targeted differentiation outcomes when using a conductive biomaterial.

[1] Gelmi, A., Schutt, C. E., Stimuli-Responsive Biomaterials: Scaffolds for Stem Cell Control. Adv. Healthcare Mater. 2020, 10, 2001125.

8:20pm **BI2-MoE-9 Development of an Active Sustainable Polymer Based on Crosslinked Gelatin*, Monique Lacroix,*** INRS Armand Frappier Health Biotechnology, Canada

Gelatin is a potential sustainable polymer for packaging development. Due to its biological origin this polymer is highly biocompatible and biodegradable. However, films based on gelatin have poor mechanical properties, high water solubility and permeability. Crosslinking reaction can help to overcome these limitations. In this study, ionization as a non - toxic physical treatment has been used to induce gelatin crosslinking reaction in presence of riboflavine to improve the functional properties of this biopolymer. Riboflavine is a photosensitive compound who can promote crosslinking of proteins during ionization treatment. Concentrations from 0.3 to 1.2 % of riboflavine have been used and doses from 5 to 15 kGy have been applied. Results demonstrated that 0.75% of riboflavine and a dose of 5 kGy were the optimal conditions to improve positively the tensile strength, the water resistance and water barrier properties of the films. The infrared spectroscopy evaluation suggests the formation of a more compact protein structure. A mixture of essential oils and silver nanoparticles were then added in the crosslinked gelatin before film formation. The active film was used for a *in situ* test on fresh meat. Results showed that this active film can increase the shelf life of the fresh meat by more than 6 days. This study suggests that crosslinking of gelatin during ionization treatment in presence of riboflavine is an effective green technology for the development of sustainable bioactive packaging.

8:40pm **BI2-MoE-10 Sustainability Inspired Development of Next Generation Neural Interfacing and Neurostimulation Electrodes via Reactive Hierarchical Surface Restructuring***, Shahram Amini,* Pulse Technologies Inc.*; Sina Shahbazmohamadi, Hongbin Choi,* ***Alexander Blagojevic****, Matthew Maniscalco, Pouya Tavousi,* University of Connecticut

Over the last two decades, platinum group metals (PGMs) and their alloys have been the preferred materials for electrodes in long-term implantable neurostimulation and cardiac rhythm management devices due to their superior conductivity, mechanical and chemical stability, biocompatibility, corrosion resistance, radiopacity, and electrochemical performance. Despite these benefits, the manufacturing processes for PGMs are extremely costly, complex, and present potential health hazards. Additionally, the volatility in PGM prices, high supply risk, and their scarce concentration of approximately 0.01 ppm in the earth's upper crust, combined with limited mining geographical areas, highlight their classification as critical raw materials. Effective recovery or substitution of PGMs is thus of paramount importance. Since postmortem recovery from deceased patients and refining PGMs used in electrodes and microelectrode arrays is rare, challenging, and costly, the substitution of PGM-based electrodes with other biocompatible materials that can match or surpass their electrochemical performance is the only viable and sustainable solution. In this context, we demonstrate for the first time how the novel technique of “reactive hierarchical surface restructuring” can be applied to titanium—widely used in non-stimulation medical device and implant applications—to create biocompatible, low-cost, sustainable, and high-performing neurostimulation and cardiac rhythm management electrodes. Our study shows that titanium electrodes, which initially exhibit poor electrochemical performance, undergo significant compositional and topographical transformations through this technique, resulting in electrodes with outstanding electrochemical performance. This innovation offers a promising path to reducing and ultimately substituting PGMs in long-term implantable neurostimulation and cardiac rhythm management devices.

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