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 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.

8:00pm **BI2-MoE-8 Sustainability Inspired Development of Next Generation Neural Interfacing and Neurostimulation Electrodes via Reactive Hierarchical Surface Restructuring***, **Shahram Amini**,* Pulse Technologies Inc.*; S. Shahbazmohamadi, H. Choi, A. Blagojevic, M. Maniscalco, P. 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.

8:20pm **BI2-MoE-9 Dynamic Supramolecular Gels for 3D Cell Culture***, A. Chalard, H. Porritt,* University of Auckland, New Zealand*; A. Taberner,* The University of Auckland, New Zealand*; J. Fitremann,* CNRS, France*; **Jenny Malmstrom**,* University of Auckland, New Zealand

Cells sense and adapt to forces and physical constraints imposed by the extra cellular matrix. Such mechanotransduction plays a crucial role in cell function, differentiation and cancer. In our research group we are developing materials to achieve spatiotemporal control over mechanical properties. Stiffness patterning of hydrogel scaffolds, through the use of stiffness gradients for instance, allows the modelling and studying of cellular responses to fibrotic mechanisms. Gelatine methacryloyl (GelMA) has been used extensively in tissue engineering for its inherent biocompatibility and the ability to precisely tune its mechanical properties. We have developed a method to photopattern the mechanical properties of GelMA hydrogels with visible light and using physical photomasks and projection with a digital micromirror device. This method allows to create hydrogels with areas of different stiffnesses and hydrogels with precise stiffness gradients. The mechanical properties of the resulting hydrogels have been characterised using force indentation with atomic force microscopy, which demonstrated the efficiency to spatially pattern the elastic modulus of GelMA according to the photomask or the projected pattern. (1)

In addition to pattern mechanical properties, it is interesting to include a dynamic aspect to cell-laden biomaterials, since native ECM is constantly reshaped by cells. Composite hydrogels are developed to bring different combinations of structures and properties to a scaffold by using different types and sources of materials. We have combined GelMA with biocompatible supramolecular fibers made of a small self-assembling sugar-derived molecule (*N*-heptyl-D-galactonamide, GalC7). The GalC7 fibers were directly grown in the GelMA through a thermal process, and it was shown that the presence of the fibrous network increased the Young’s modulus of GelMA. Due to the non-covalent interactions that govern the self-assembly, these fibers were observed to dissolve over time, leading to a dynamic softening of the composite gels. Cardiac fibroblast cells were successfully encapsulated into composite gels for 7 days, showing excellent biocompatibility and fibroblasts extending in an elongated morphology, most likely in the channels left by the fibers after their degradation. These novel composite hydrogels present unique properties and could be used as tools to study biological processes such as fibrosis, vascularization and invasion. (2)

1) Chalard, Malmström, et al. Frontiers in Cell and Developmental Biology 2022, 10.

2) Chalard, Malmström, et al. BioMaterials Advances, 2024, accepted

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