Topical Symposia
Room California - Session TS1
Biointerfaces

Moderators: Jinju Chen, Newcastle University, Tianyu Zhang, Montana State University, USA

8:00am **TS1-1 The Investigation of Mechanisms about Bacteria-Hydrogels Interactions*, Nehir Kandemir*, *W Vollmer, N Jakubovics, J Chen,* Newcastle University, UK

The structure and function of eukaryotic cells, like mammalian cells, can be regulated by altering their micromechanical environment such as alteration of their microenvironment stiffness. However, little work has been done for prokaryotic cells, like bacteria, which may be affected by similar interactions. In addition to this, bacterial cells are exposed to large forces from osmotic pressure differences and their microenvironment, but quantitative measurements of their mechanical properties have been limited. In this study, the aim is to investigate how physical factors (e.g. mechanical properties of the microenvironment), and chemical factors (e.g. chemical composition) would affect bacteria-material interactions and the bacteria cell mechanics. For this purpose, different mechanical characterisation techniques were adopted to extract the mechanical properties of *Escherichia coli* (Gram negative) and *Staphylococcus epidermidis* (Gram positive) encapsulated in agarose hydrogels made with different media. In addition, finite element simulations and theoretical models were employed to reveal more physical insights. Our study has demonstrated that the structure and properties of the microenvironment considerably affect the extraction of mechanical properties of the encapsulated cells. Such findings will help the further understanding of bacterial cell-materials interactions, which would have great potential impact in various healthcare industries.

8:20am **TS1-2 How Nanostructure on Ti Alloy Surface would Affect Bacterial Adhesion and Biofilm Formation?*, Yunyi Cao,*** Newcastle University, UK*; B Su,* University of Bristol, UK*; S Chinnaraj, N Jakubovics, J Chen,* Newcastle University, UK

Titanium and its alloys have been widely used in biomedical devices and surgical implants due to their excellent mechanical properties and good biocompatibilities. One of big issues for these Ti-based medical devices is bacteria induced infection and inflammation because biomaterial implant surface is also favorable for bacterial adhesion and biofilm formation. This would result in device retrieval and additional surgery, which will significantly affect the patients and increase the financial burden of national health services. To eliminate bacterial adhesion and biofilm formation, different nanostructures such as nanotexture and nanospikes were created on the titanium alloy implant surfaces. In order to understand how these nanostructures would affect bacterial adhesion and biofilm formation, a typical clinical relevant bacteria *Staphylococcus epidermidis* was cultured on these two nanostructured surfaces and the polished titanium surface (control sample). Both the initial bacterial adhesion and the biofilms grown on these surfaces for 3 days were analyzed. We found that both nanotexture and nanospikes enable to kill the bacteria and significantly inhibit biofilm formation compared to the control sample. Such an effect is even more significant for nanospike surfaces. This is possibly due to the high aspect ratio of the nanospike structures. To further reveal the mechanisms of this, some preliminary computational simulations based on interaction energy between bacteria and material surfaces were adopted.

8:40am **TS1-3 First Contact: Surface Sensing, Motility Appendages, and Hydrodynamics in Bacterial Interactions with Surfaces*, Gerard Wong,*** California NanoSystems Institute, UCLA, USA **INVITED**

Bacterial biofilms are integrated communities of cells that adhere to surfaces and are fundamental to the ecology and biology of bacteria. The accommodation of a free-swimming cell to a solid surface is more complex than simply modulation of cell adhesion. We investigate the interplay between motility appendages, molecular motors, hydrodynamics, and exopolysaccharide production near the surface environment using state of the art tools from different fields that are not usually combined, including theoretical physics, community tracking with single cell resolution, genetics, and microbiology. Themes such as *surface sensing*, multi-generational signaling via secondary messengers, subsequent downstream motility consequences, and the subsequent *onset of microcolony organization* via interactions between appendages and exopolysaccharides will be discussed.

9:20am **TS1-5 How Surface Physical Properties of Polymer Carrier Materials would Affect Wastewater Biofilm Formation?*, Sam Charlton*, *M Brown, R Davenport, J Chen,* Newcastle University, UK

Biofilms are ubiquitous naturally occurring biological populations encased within an extracellular polymeric substance (EPS) matrix which adhere to substrates within aqueous environments. It was reported that various surface properties and features (e.g. roughness, surface energy, topography, surface chemistry and surface charge) would affect biofilm formation. However, most of these studies are focused on single species biofilms with lack of studies on wildtype multispecies biofilms. Therefore, in this study we investigated how the physical properties of various polymer materials (such as HDPE and PVC) would affect wildtype wastewater biofilm formation. It demonstrated that surface roughness, surface topography and hydrophobicity would affect biofilm growth rate, biofilm microstructure and bacteria community as well as biofilm mechanics. Such finding is important for understanding the interactions between mixed species and material surfaces. It will also potentially have significant impact on nitrification efficiency for wastewater treatment industries.

9:40am **TS1-6 Evaluating the Electrochemical Corrosion and Immune Cell Activation Behaviour of Nano-crystalline Thin Films of Chromium Nitride Prepared by Reactive Magnetron Sputtering*, SaeedUr Rahman*, *A Ogwu, A Crilly,* University of the West of Scotland, UK

We investigated the potential of nano-crystalline chromium nitride thin film implant coatings to reduce the corrosion process and minimise the immune cell response in-vivo faced by patients with osteoarthritis. The films are prepared by reactive magnetron sputtering and characterised for grain growth by scanning electron microscopy. The chemical structure of the prepared films are characterised by X-ray photoelectron spectroscopy and Raman spectroscopy. The nano crystalline structure of the coatings which contributes to their phagocyte activation was probed by x-ray diffraction and radial distribution function analysis. We investigated the presence of surface chemical constituent entities on the coatings with XDLVO surface energy analysis and Kelvin probe contact potential difference/ work function measurements to establish the presence of hydrophobic surface chemical entities on the prepared films. The corrosion susceptibility of the films was investigated in saline solution. Our initial investigation includes open circuit potential measurements (OCP) over several hours, Tafel plots and Potentiodynamic polarization. The coatings show good corrosion resistance against pitting corrosion but could be improved further through a microstructural growth mode switch to eliminate potential pin-holes due to a columnar growth mode. The columnar Volmer-Weber growth mode observed by scanning electron microscopy is suspected to underlie the corrosion behaviour of the coating. The initial in vitro immune cell activation was investigated using peripheral blood mononuclear cells (PBMC) cultured on coated and uncoated control surfaces. Supernatants were collected at various time points and simulation conditions. There was a statistical significance ($P<0.01$) in the secretion of the inflammatory cytokine, interleukin 6 (IL-6), between the chromium nitride coated and the uncoated control surface. The results of our current in-vitro investigation based on corrosion and cellular response tests confirm the potential promise for the application of chromium nitride coatings prepared by reactive magnetron sputtering in orthopaedic implant applications.

10:00am **TS1-7 The Graphene Oxide Biopolymers (Polystyrene Sulfonate, PSS and Heparin), and PEDOT were Electrochemically Polymerized in the SUS316L Stainless Steel*, HuiMing Tsou*, *T Liu,* Ming Chi University of Technology, Taiwan

In this study, the graphene oxide (GO), biopolymers (polystyrene sulfonate, PSS and heparin), and PEDOT were electrochemically polymerized in the SUS316L stainless steel, which could produce an anti-fouling surface to avoid the restenosis of the blood vessels. The negative charge of GO, PSS and heparin would exclude the negative charge of protein and platelets to achieve the purpose of anti-fouling and anti-clotting. Furthermore, we also add the surfactant (SDS) in the electrochemically polymerization process. The result shows that the surface energy would decrease with the SDS addition to form the hydrophobic surface. The lower surface energy surface would enhance the ability of anti-fouling and anti-clotting. In conclusion, we have developed an excellent anti-fouling surface by using GO, PSS, heparin and SDS, which could be applied in the eluting stent. The hemocompatibility, biocompatibility, and drug controlled release would be studied detail in the future.

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