# iTERM Lunchtime Seminar Series

## Institute for Tissue Engineering and Regenerative Medicine

**TITLE**

***"The development of novel protein-functionalised plasma polymer biointerfaces for orthopaedic applications"***


*Dr. Callum. A.C. Stewart , Postdoctoral researcher, Ming Wai Lau Centre for Reparative Medicine , Karolinska Institutet*


Callum A.C. Stewart received his Doctorate in Philosophy (Science – Applied Physics) from the University of Sydney in 2019, and is currently employed at the Karolinska Institutet. His thesis was performed in the Applied and Plasma Physics group under the supervision Prof. M.M.M. Bilek and Dr B. Akhavan, with additional supervision from Dr Steven G Wise from the Heart Research Institute. His project involved the development of novel multifunctional biointerfaces for orthopaedic implants, utilising radical-functionalised plasma polymer films (rPPFs) and functionalisation with multiple proteins to enhance osseointegration between the implant surface and bone tissue. His review paper "A review of biomimetic surface functionalization for bone integrating orthopedic implants: Mechanisms, current approaches, and future directions" was recently published in Progress in Materials Science. His previous undergraduate and Masters projects at the University of Wollongong focussed on the use of novel high-atomic number (Z) nanoceramics for cancer radiation therapy, under the supervision of Dr Moeava Tehei and Dr Konstantin Konstantinov.

**ABSTRACT**


Titanium alloys are the standard material for load bearing orthopaedic devices because of their biological compatibility and mechanical properties. The biological compatibility comes from the inert Ti-oxide surface layer and can result in post-operative complications such as bacterial-film formation and fibrotic encapsulation. Implanted orthopaedic devices also experience the long term effects of bone loss originating from a mismatch in mechanical properties between the implant and bone tissue. Biomolecule functionalisation with proteins or peptides produces a biologically-active surface that reduces the potential for post-operative complications and encourages bone formation. The biomolecules investigated for enhancing bone formation generally either increase cellular adhesion or signal bone formation directly. The biomolecules can be immobilised on titanium surfaces through adsorption, chemical covalent, or physical covalent methodologies. However, none have provided a simple and scalable approach that allows a transition from the laboratory onto a manufacturing scale.

This thesis explores the application of radical-functionalised plasma polymer films (rPPFs) as novel multifunctional biointerfaces for orthopaedics. rPPFs covalently bind proteins with a reservoir of radical electron implanted through ion bombardment during the plasma deposition process. A series of reagent gas ratios for rPPF coatings are examined for the mechanical and biological properties on titanium substrates, highlighting the optimum conditions. The effects of radical flux on rPPF surface chemistry and the potential radical-induced cytotoxicity are investigated. The rPPF surfaces are protein-functionalised with fibronectin, osteocalcin, a custom fusion protein containing fibronectin and osteocalcin active fragments, and ratios of fibronectin: osteocalcin. The optimised multifunctional protein-functionalised interfaces are comparatively examined for their bone forming potency against their component proteins with primary osteoblasts and mesenchymal stem cells. Overall, this work demonstrates the versatility of rPPFs and opens a feasible avenue for translating biomolecule-functionalisation onto the manufacturing scale.


**DATE** 1 Nov 2019 (Friday)

**TIME** 12:30pm - 2pm (please arrive 15 minutes before the scheduled time, light lunch shall be provided)

**VENUE** G02, Lo Kwee-Seong Integrated Biomedical Sciences Building, Area 39, CUHK

**Online Registration:** https://cloud.itsc.cuhk.edu.hk/mycuform/view.php?id=379195

*~ All are Welcome ~*