THE UNIVERSITY OF SYDNEY

Postgraduate Research Scholarship in Plasma Surface Modification for Biomedical Devices

Medical device use is increasing with the increasing disease burden of aging populations. However, despite technological improvements, medical devices are lagging behind due to a lack of compatibility of medical device materials with the body. There is an urgent clinical need to understand how the interactions of blood and materials cause blood clots (thrombosis) and to develop materials that reduce thrombosis. Materials that can prevent thrombosis will represent a major advance for implantable biomedical devices as well as for ex-vivo diagnostic or disease/physiology modelling platforms.

Be part of collaborative, multi-disciplinary labs with expertise in biology, bioengineering, applied physics and materials science, and have access to the world class research facilities in the Charles Perkins Centre, the Sydney Nano Institute and the Australian Centre for Microscopy and Microanalysis.

The Project:

This project will develop methods to understand the interactions of blood components (blood proteins, platelets and leukocytes) with medical device materials that have been modified by plasma-based techniques. In particular, plasma activated coatings (PAC) and plasma immersion ion implantation (PIII) have been used to modify surface properties of multiple medical grade materials to manipulate biological response. PAC modified materials have shown excellent blood compatibility, but the mechanism by which this occurs is currently unknown.

This multidisciplinary project aims to study the effects of both low pressure and recently developed atmospheric pressure plasma processes for surface modification and functionalisation of materials used in implantable biomedical and microfluidic devices. State-of-the-art biomedical assays will be used to reveal the mechanisms underpinning the thrombogenicity of the surface modified materials both with and without immobilized biofunctional molecules present. Differences in blood responses to untreated, plasma treated, and biofunctionalized channels will provide insight into the effects of particular surface properties on thrombosis. The most promising surface modifications will be translated towards applications with industrial and clinical partners.

The projects present opportunities to learn and utilize a wide range of physical and biochemical surface characterization techniques, including attenuated total internal reflection Fourier transform infrared spectroscopy (ATR-FTIR); X-ray photoelectron spectroscopy (XPS); scanning electron microscopy (SEM); electron paramagnetic resonance (EPR) spectroscopy; tensiometry for surface energy analysis; visible/ UV and IR ellipsometry; atomic force microscopy (AFM) and surface profilometry. Biochemical and biomedical techniques include enzymatic coagulation assays, fluorescence and confocal microscopy, flow cytometry, cell culture and in vivo models. Through collaboration with plasma physicists, the project will also provide exposure to a variety of plasma processes for materials modification and advanced plasma diagnostic equipment, including fast CCD camera, high resolution gated optical emission spectroscopy (OES), ion energy analysers and Langmuir probes. Theoretical studies will utilize finite element codes such as COMSOL or ANSYS as well as particle-in-cell codes such as VSIM.

The knowledge generated can ultimately be used to improve or generate new materials for use in medical devices to improve their function and ultimately patient outcomes.

For further information on the research area, please contact:

Professor Marcela Bilek marcela.bilek@sydney.edu.au and Dr Anna Waterhouse at anna.waterhouse@sydney.edu.au