Ottawa-Carleton Chemical and Environmental Toxicology Seminar Series

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Antifouling surface chemistry and the prevention of thrombogenesis and bacterial adhesion on materials employed in medical devices

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Our research concerns the development of a chemispassive surface that is being employed to modify a number of devices used in medicine. The interaction of substrates with the components of biological fluids has constituted a research problem over many years. In this regard, a variety of strategies have been used to attempt an enhancement of biocompatibility with some emphasis being centered on the control of surface free energy and imposition of a plethora of surface coatings. In our work we are addressing the physical chemistry of ultra-thin covalent surface modification through the synthesis of new silane-based molecules. These moieties are bifunctional, medium-chain length trichlorosilanes containing a PEG backbone. (PEG has been the subject of intense study for many years, although its precise role in enhancing biocompatibility has remained elusive.) One of our silanes has shown remarkable properties in terms of the reduction of adsorption of biological entities from serum and blood. The structure of water intercalated in the adlayer appears to be crucial and has been studied in our lab by a number of surface analysis techniques including neutron reflectometry and MD calculations.

In particular, we are working on the several polymers employed in circuitry used in bypass surgery and renal dialysis, and in catheter technology. Also included is research on medical grade stainless steel used for stent technology. It is known that micro-clots can form on polymers exposed to blood leading to medical consequences such as cognitive disability. With regard to stents, restenosis is a particular issue. Our research of the polymer or steel surface-blood interaction shows an over 90% reduction of thrombus formation for our surface modification. With regard to bacterial adhesion, we have worked primarily with samples containing relatively high concentrations of pseudomonas, candida (fungus) and staphylococcus aureus both in static and dynamic experiments. The results of these experiments involving extensive fluorescence microscopy show a dramatic reduction in bacterial adhesion caused by the ultra-thin covalently-attached monolayer. Moreover, the surface-modified polymers or metal can be subjected to standard sterilization protocols without suffering damage.

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Zoom- https://us02web.zoom.us/j/84635893555

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