Enhancing the bioactivity of the surfaces using atmospheric plasma deposited coatings

Denis P. Dowling, Charlie Stallard, Michael Donegan and Victor J. Law

School of Mechanical and Materials Engineering,
University College Dublin, Dublin, Ireland
E-mail: denis.dowling@ucd.ie

Surface properties play a key role in the biocompatibility of implant medical devices. Atmospheric plasmas provide a means for tailoring surface properties at the biointerface through the deposition of coatings. This presentation provides an overview of a wide range of plasma polymerised coatings, which can be deposited using atmospheric plasmas. It details how both plasma processing conditions and precursor type influences the chemical and physical properties of the deposited coatings. The effect of coating properties on protein adhesion is also described.

Coatings were deposited from both gaseous and liquid precursors, using both the PlasmaTreat (air) and PlasmaStrean (helium) atmospheric plasma jet systems. The coatings were deposited from siloxanes, fluorosiloxanes, fluoorpolymers and quaternary ammonium salt precursors. Techniques such as in-situ reflectance IR and optical emission spectroscopy were used to monitor and control the deposition process. The adhesion of bovine serum albumin (BSA), immunoglobulin G (IgG) and fibrinogen (Fg) proteins, onto a number of the coatings, was evaluated under flow conditions, using a spectroscopic ellipsometry technique. The level of protein adhesion was determined in phosphate buffer solution on both uncoated and coated silicon wafer substrates.

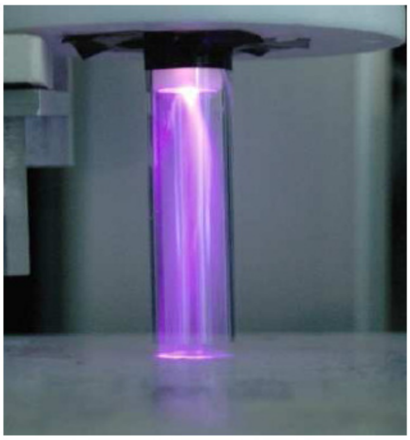

Figure 1: *PlasmaStream helium atmospheric pressure plasma jet system*

The deposited coatings were tailored to yield a range of properties as required, such as water contact angles of less than <10° (superhydrophilic) to >150° (superhydrophobic). Coating roughness (Ra) was altered from smooth (Ra <5 nm) to rough (Ra >100 nm). By controlling the deposition conditions of a HMDSO precursor for example using the PlasmaStream system
(Figure 1); coatings exhibiting either a flat surface morphology, an array of spherical clusters (up to 500 nm in diameter), or a densely packed arrangement of aligned fibres were obtained. In the case of the latter, individual fibres with diameters of up to 300 nm and fibre lengths of up to 12 μm were deposited. The level of protein adhesion was found to be dependent on both the coating and protein type. Extremely low levels of protein adhesion were observed on superhydrophobic coatings. While on hydrophobic surfaces BSA was found to adsorb via a single step mechanism, while Fg was shown to undergo multistage adsorption, indicating a structural rearrangement of the protein layer.

Acknowledgment: SFI grant No. 08/SRC/11411