Testing the longevity of surface coatings as a core part of material evaluation

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The surface of a material is the first to contact the cellular environment upon inoculation (in vitro) or implantation (in vivo) and as such these surfaces must, at minimum, possess properties amenable to cell adhesion. Many polymers used as biomaterials, such as biodegradable polyesters, lack functional moieties and their overall hydrophobic nature encourage non-specific protein adsorption. Various methods are applied to change the surface properties of polymeric biomaterials and the improvements in biological properties of the resulting materials are well demonstrated in literature. However, a number of potential issues are often overlooked when applying a surface layer to a biodegradable material. These include (i) clearance of the surface layer after degradation of the material, (ii) effect of the surface modification process on the bulk properties, (iii) longevity of the surface layer.[1]

This presentation will detail examples from different approaches to surface modification including graft copolymerization and hydrolysis of polyester-based materials. This presentation will focus on evaluation of the longevity of the surface layer (coating) and will explore the suitability of using films produced by spin coating as model substrates. This is achieved through detailed characterization of the surface with the use of scanning electron microscopy (SEM), contact angle measurements, atomic force microscopy (AFM) and x-ray photoelectron spectroscopy (XPS).[2] In addition, evaluation of size using 2D DOSY NMR of grafted non-degradable polymers will be detailed.

Several important findings are made from the semi-quantitative data that allow for optimisation of each fabrication step and for probing changes in the composition of the surface layer during degradation. Importantly, for PLGA, spun coated films are found to be a poor model substrate to mimic changes of bulk materials[2] thereby questioning the validity of a large body of published literature. Furthermore, some grafting conditions used in radiation induced grafting are found to result in surface layers that are lost within 3 days of immersion in buffer. However, several surface modification strategies are found to lead to high solution stability as illustrated with our recent work on attaching a heparin mimetic to a grafted scaffold. It is proposed that this type of considerations and experimental investigations should form a key component of a robust evaluation to demonstrate the suitability of the surface modification approach before advancing to biological studies.

References:

[1] A L Mutch, L Grøndahl, Challenges for the development of surface modified polyester biomaterials: A chemistry perspective, Biointerphases, 13 (2018) 06D501-5

[2] H Poli, A L Mutch, A A, S Ivanovski, C Vaquette, D G Castner, M N Gómez-Cerezo, L Grøndahl, Evaluation of surface layer stability of surface modified polyester biomaterials, Biointerphases, 15 (2020) 061010