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Probing the non-fouling behaviour of PEG and sulfonated PEG surfaces: An electrostatic interaction superimposed on the steric repulsion

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INTRODUCTION: The development of non-fouling surfaces has been a significant theme in biomaterial research. Surface modification using ethylene oxide chemistries has proved successful in a number of studies, where both chain density and chain length are important. Further functionalisation with sulfonate groups has more recently been considered to provide greater blood compatibility [1] via the "negative cilia" concept, in which surface grafted chains would repel negatively charged serum proteins by a combination of entropic and electrostatic forces.

METHODS: FEP substrates were coated with an amine plasma polymer layer, followed by cloud-point grafting of dialdehyde PEG molecules [2]. Further modification of the PEG layer was undertaken with sulfonisation of the end groups using $NaHSO_3$.

Characterisation of the surfaces was undertaken with XPS and atomic force microscopy direct interaction force measurements with a silica probe attached to the cantilever. Protein adsorption experiments were performed with solutions of albumin, fibrinogen or lysozyme; adsorbed proteins were detected using XPS (nitrogen signal).

RESULTS: XPS characterisation of the PEG modified surface demonstrated that a high quality of PEG coating was achieved. The sulfonate-modified PEG surface was characterised by a sulphur signal in the XPS spectra.

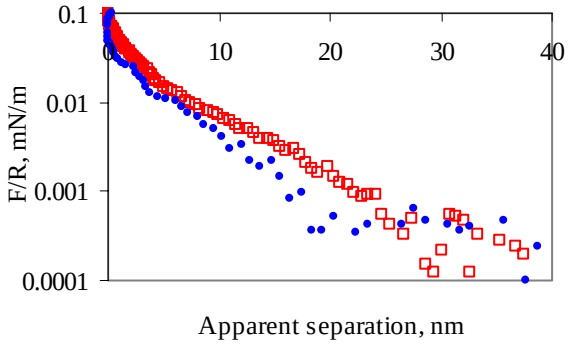

Fig. 1: Interaction forces measured between a silica sphere and the cloud-point grafted PEG surface in PBS (•) and 0.01 PBS(□) .

A repulsive interaction was observed when measuring the interaction forces between a silica sphere and the PEG-cloud-point grafted surface (*Fig. 1)*, indicating that the surface provides a steric barrier to protein adsorption. A similar repulsion was observed on the sulfonate-modified PEG surface, however, the strength of the repulsive interaction energy changed with ionic strength (*Fig.2*). Therefore an electrostatic interaction is responsible in addition to the steric repulsion.

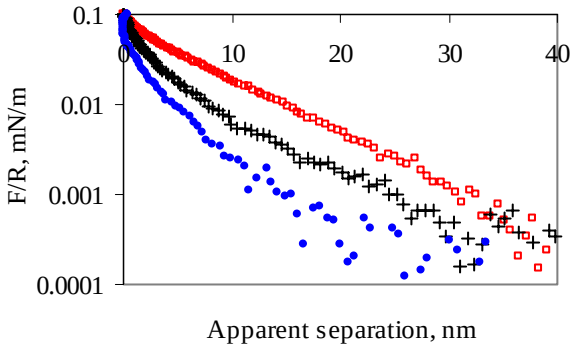

Fig. 2: Interaction forces measured between a silica sphere and the sulfonated PEG surface in PBS (•), 0.1 PBS (+) and 0.01 PBS(□).

Protein adsorption onto the modified surfaces was decreased compared the bare FEP substrate, however was greater on the sulfonated surface, and dependent on the protein charge.

DISCUSSION & CONCLUSIONS: Non-fouling properties of the cloud-point grafted PEG surfaces result from a steric repulsion between the protein molecule and the surface. Addition of sulfonate groups to the PEG chain, provides an electrostatic repulsive interaction superimposed on the steric repulsion.

REFERENCES: [1] Y.H. Kim, D.K. Han, et al. (2003) Biomaterials **24**: 2213-23. [2] P. Kingshott, H. Thissen, H.J. Griesser (2002) *Biomaterials* **23**:2043-56.

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