Bio-inert Surfaces

Caroline Moore, Andrew Marsh

Department of Chemistry, University of Warwick, Coventry, CV4 7AL, c.moore.3@warwick.ac.uk, a.marsh@warwick.ac.uk

Aim of the Project
To prepare and assess five surfaces for their resistance to protein adhesion and to characterise these thiol-gold surfaces for resistance to protein adhesion.

The Need for Bio-inert Surfaces
Protein adsorption is the method by which cell adhesion occurs on an in vivo device, this process of repeated and undesirable cell adhesion is known as biofouling. The ability to prevent biofouling would be advantageous as the process can cause the activation of the host auto-immune response leading to inflammation. This response has been seen on vascular implants, ultimately leading to the failure of the device. Ethyleneglycol bio-inert surfaces have applications in biosensors, contact lenses and drug delivery. The tertiary amine is finally chemisorbed, to produce a self covalently bond to the chip by adsorption. Supports on gold QCM chips.

Surfaces Synthesised
The surfaces in this work are supported on gold QCM chips. The use of gold chips is desirable because it allows long chain thiol molecules to covalently bond to the chip by chemisorption, to produce a self assembled monolayer (SAM). The amine is then available to couple to the amine or ethylene glycol reagent.

Characterisation by Contact Angle
Contact angles are taken to measure the hydrophobic/hydrophilic nature of a surface. A more hydrophobic surface will have a larger contact angle as the water will be repelled from the surface forming a more upright drop. As seen for the amines. The largest angles were seen for the PEG derivative (surface 3).

Conclusion
Ethylene glycol or PEG derivatives are often used to make surfaces bio-inert. The new amine oxides are found to be comparable in efficacy to this benchmark when compared with either lysozyme or fibrinogen.

Acknowledgements
With thanks to the Nuffield Foundation and URSS for funding and Kieron Clement-Smith and David Steadman for preliminary work and literature searching.

References
3. Harris L.; Tosatti S.; Wieland M.; Textor M.; Richards R., 2001, 17(18), 5605-5620

The protein adhesion was tested with fibrinogen and lysozyme on each surface. Fibrinogen is the inactive form of fibrin. It is a water soluble protein found in high concentrations in the blood and involved in blood clotting. There are abundant hydrophobic amino acid residues on the surface so it adsorbs significantly onto many surfaces.

Lysosome is a small enzyme that attacks the protective cell walls of bacteria causing them to burst. It is found in blood, mucus and tears. There are few hydrophobic amino acid residues on the surface so it adsorbs less than fibrinogen and is therefore much easier to remove from the surfaces.

The protein resistance is quantified as the percentage removal efficiency by PBS. This is calculated as Δ y/ Δ x multiplied by 100 to get a percentage. A smaller value indicates a less successful removal and thus a less bio-inert surface.

Characterisation by Quartz Crystal Microbalance
The QCM equipment is used to investigate the extent of protein binding to the surfaces. This method allows the detection of tiny changes in mass. A quartz crystal is present at the centre of the gold chip, oscillating at its resonant frequency when a potential is applied. A decrease in resonance indicates an increase in mass, such as protein adsorption.

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