Biomimetic silicone elastomer surfaces via dextran immobilization

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Purpose: Silicone polymers have been widely used for biomedical applications [1]. However, their high hydrophobicity and the difficulty in preparing cell-compatible surfaces with these materials remains a major challenge. The need for control and tissue integration at the tissue/material interface has led to the consideration of polysaccharides and proteoglycans, which are native to the cellular glycocalyx, as biomimetic coatings for biomaterials [2]. We have previously described a method of immobilizing biologically relevant molecules to PDMS surfaces [3]. Herein, we describe a method for immobilizing dextran onto silicone elastomer surfaces and the characterization of these materials.

Methods: Acid-catalyzed equilibration of a silicone elastomer in the presence of DC1107 ($(MeHSiO)_n$) was used to covalently bind Si-H group on the surface [3]. The Si-H immobilized surfaces were subsequently modified with trimethylsilyl allylamine by platinum-catalyzed hydrosilylation, followed with hydrolyzation to introduce amine group onto the silicone surfaces. Dextran was oxidized under mild conditions by potassium periodate to obtain the polyaldehyde. The oxidized dextran was then immobilized onto the silicone surface by reductive amination (Figure 1). ATR-FTIR, water contact angle and XPS were used to characterize the modified surfaces. The protein resistant properties of dextran immobilized surfaces were also investigated.

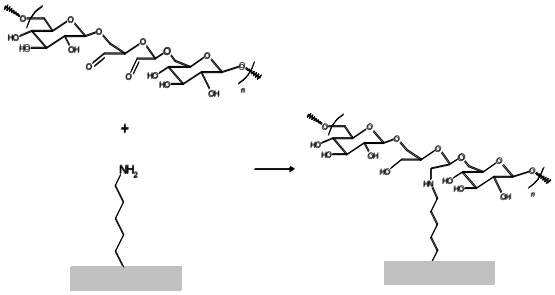


Fig 1 Schematic for immobilization of oxidized dextran onto PDMS surfaces

Results / Discussion: The elemental compositions of the surfaces were measure by XPS. As expected, following dextran modification, the C1s content increased, while significant decreases in the Si content were observed for all modified surfaces. High-resolution C1s spectra for the various surfaces, summarized in Figure 2 show the appearance of a peak at 286eV. This provides evidence for the grafting of the dextran to the PDMS surfaces. In vitro protein adsorption experiments from buffer, summarized in Figure 3, indicate that the dextran immobilized surfaces exhibit lower protein adsorption when compared to the control silicone elastomer surfaces. Consistent results were obtained for both fibrinogen and lysozyme.

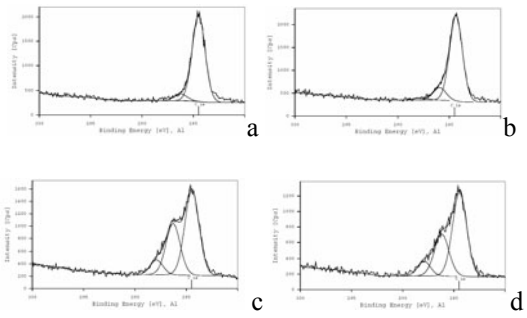
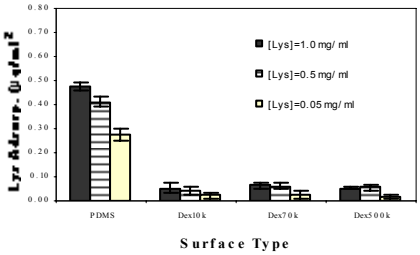
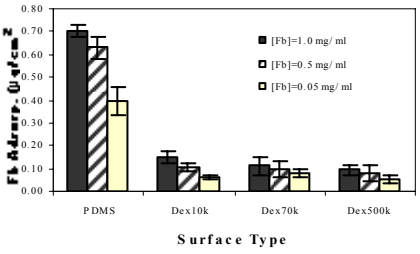


Figure 2 High Resolution C1s XPS scans of control and dextran immobilized surfaces. a) Control b) Aminated c) Dextran 10k d) Dextran 500k



a



b

Figure 3 Protein Adsorption on modified surfaces a) Lysozyme b) Fibrinogen

Conclusions: Novel biomimetic surfaces were prepared by covalent coupling oxidized dextran onto aminated silicone elastomer surfaces. Significant reductions in lysozyme and fibrinogen adsorption were observed on the modified surfaces.

References:

[1] V. Compan et al., Biomaterials 2004; 25:359–365
[2] Piehler et al., Colloids and Surfaces B: Biointerfaces 1999; 13: 325–336
[3] H. Chen et al., Biomaterials 2005; 26: 7418-7424

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