Decreased Bacterial Attachment and Protein Adsorption to Coatings Produced by Low Energy Plasma Polymerization

Introduction
Silicone rubber is among the most biocompatible materials available, exhibiting low levels of extractables, absence of plasticizers and additives and fairly low activation of blood thrombogenesis components. However, untreated silicone rubber does not efficiently resist protein adsorption and bacteria attachment/colonization. This is emphasized by the fact that long dwelling urinary catheters, which is a typical silicone medical device, causes 5% per day incidence of urinary tract infection [1,2]. A demand therefore exists for surface modifications providing the silicone material with a surface less prone to the adsorption of biological matter. In the current study, two different hydrophilic nanoscale coatings were produced by low energy plasma polymerization [3] and investigated for protein adsorption and bacterial attachment properties. Methods were setup to enable the measurement of both initial adhesion of clinically isolated bacteria on silicone and subsequent biofilm formation during prolonged growth under liquid flow. The extend of adsorption of relevant proteins to the surfaces was also investigated using quartz crystal microbalance with dissipation (QCM-D).

Materials and Methods: Coatings: Plasma polymerized poly(vinyl pyrrolidone) (PP-PVP), poly(2-methoxyethyl methacrylate) (PHEMA) or an inorganic oxide (SiOx) coating were applied onto medical grade silicon rubber sheets (Silopren LSR 2050, Momentive Performance Materials Inc.). Plasma polymerization chamber and instrumental setup was similar to that previously described [3]. Static bacteria attachment assay: Punched out pieces were placed in 24 well microtitre plates and quantification of bacterial adhesion was carried out using a method based on the assay by Christensen et al. [4], but substantially modified to enable measurement on the silicone substrate. In short, either Staphylococcus epidermidis, Staphylococcus aureus, Escherichia coli or Pseudomonas aeruginosa were suspended in a glucose/peptone medium to 106 cfu/ml and grown in the wells for a period of 3-7 hours. Attached bacteria were determined by staining with crystal violet with the extent of biofilm formation determined from absorbance measurement of the extracted dye. Flow chamber assay: Measurements of bacterial colonization during prolonged growth in liquid flow were done using a flow chamber (modified version of FCS lc, Oligene, Germany). Quantification was carried out by a similar method as described above, using crystal violet as a direct measure of the amount of adhering bacteria. Protein adsorption measurements: Gold plated QCM crystals were spin coated with polystyrene (PS) to create a hydrophobic reference surface similar to silicone. PS-coated crystals were then treated with one of the plasma polymerized coatings. Adsorption of fibrinogen, human serum albumin or immunoglobulin G was measured using a QCM-D instrument [5] (model E4, Q-Sense AB, Vastra Frolunda, Sweden) using a solution of 50µg/1 protein in PBS buffer. Results and Discussion: Our data demonstrate a significant decrease in bacterial adhesion to both PP-PVP, PP-PMEA and the inorganic oxide coating. The figure below is an example of results from the microtitre adhesion assay with S. epidermidis grown on uncoated (UNC) silicone rubber compared to 10 coated silicone rubber (left figure) and E. coli grown on uncoated silicone compared to PP-PVP coated silicone (right figure). Results from the flow chamber analysis shows PP-PVP to be very good at preventing E. coli colonization during prolonged growth in flow chamber. At this point other surfaces and bacteria remains to be tested in the flow chamber. The results will be presented at the conference. QCM measurements showed no significant decrease in protein adsorption on the PP-PVP surface but the PP-PMEA exhibited very good protein repellent properties, decreasing the adsorption of serum proteins with up to 90%. The inorganic oxide coating remains to be tested. In addition results for biofilm formation on surface preadsorped with serum proteins will be presented.

General information
State: Published
Organisations: The Danish Polymer Centre, Department of Chemical and Biochemical Engineering, University of Southern Denmark, Aarhus University, Nanon A/S, Technical University of Denmark
Publication date: 2008
Peer-reviewed: No
Event: Poster session presented at 8th World Biomaterials Congress, Amsterdam, the Netherlands.
Source: orbit
Source-ID: 235332
Research output: Research > Poster – Annual report year: 2008