Investigation Of Polyethylene Glycol (PEG) Coatings On Polydimethylsiloxane (PDMS) For Membrane Oxygenator Applications

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Study: To address the limited blood compatibility of current extracorporeal oxygenation (ECMO) systems, significant work has focused on soft lithographic microchannel devices, which intend to mimic lung capillaries. These devices use PDMS as a membrane material for its high gas permeability, as well as its amenability to microfabrication. We are developing a blood oxygenator that similarly uses PDMS bonded to silicon membranes to conduct gas exchange. The PDMS can be modified with hemocompatible coatings that decrease membrane fouling and prevent channel occlusion. Here we investigate the effects of PEG formulations on membrane hydrophilicity and fouling resistance.

Methods: PEG-silane was applied to PDMS-coated silicon and cast PDMS substrates using three protocols varying in PEG concentration. The PEG layers were characterized through contact angle for wettability, and visualized with atomic force microscopy (AFM). Finally, the layers were evaluated for protein fouling by surface antibody assay of adsorbed albumin.

Results: Application of PEG stably reduced contact angle on PDMS substrates in all formulations. AFM scans indicate the presence PEG-silane multilayers ranging from 10–50 nm thick on the surfaces in a concentration-dependent manner, particularly for cast PDMS. While none of the PEG multilayer formulations resisted protein fouling on PDMS-coated silicon, the multilayers at higher thicknesses (~50 nm) on cast PDMS were able to provide high resistance to protein adsorption. This data demonstrates the impact of coating coverage and thickness on its utility to resist protein fouling, and similar methods could be used to examine other coatings for PDMS oxygenators.