Effect of PEG Chain Length and Solvent Composition on Antifouling Capacity of Silane-PEG Coatings

Avinash J. Patil[1], PhD; Zohora Iqbal[1], PhD, William H. Fissell[2], MD; Shuvo Roy[1], PhD

[1]Department of Bioengineering and Therapeutic Sciences, University of California San Francisco (UCSF), San Francisco, CA 94143, USA; [2]Department of Medicine, Vanderbilt University Medical Center, Nashville, TN 37232, USA

Introduction

Silicon nanopore membranes (SNMs) are used in the development of hemofilters for renal replacement and immunoprotective encapsulation barriers for islet transplant. Silane-PEG (SPEG) coatings have previously shown to be effective in reducing protein adsorption on SNMs. This work investigates the effect of chain length of PEG in the SPEG molecule and solvent water content on coating thickness and protein adsorption.

Methods

Plasma treated silicon substrates were exposed to three SPEG solutions with varying PEG chain length for 2 hours at 60 °C (Fig. 1 A). SPEG1, SPEG2, and SPEG3 solutions were prepared by dissolving 663 mg, 614 mg, and 200 mg, respectively of the corresponding materials in in 50 ml of toluene. Selected samples of SPEG solutions were hydrolyzed by adding 60 µl of 1 M HCl to the 50 ml of toluene. Coating thickness was measured using ellipsometry while coating performance was evaluated by an ELISA assay to determine the relative adsorption of human serum albumin (HSA) compared to non-coated silicon substrates, which served as the control.

Results

Ellipsometry data indicated that SPEG coatings ranged from 0.70-2.04 nm in thickness. For the same PEG chain length, the coating thickness was non-significantly ($p>0.075$) greater for hydrolyzed compared to non-hydrolyzed conditions (Fig 1 B). The solvent water content (non-hydrolyzed vs hydrolyzed) had a significant effect on HSA adsorption ($p<0.008$), but there was no significant effect of PEG chain length on HSA adsorption ($p>0.37$) (Fig 1 B). Hydrolyzed SPEG1 exhibited a coating thickness of 1 nm with relative protein adsorption of less than 1.5% compared to control. Future studies will focus on further characterization of SPEG1 to determine its suitability for SNM applications in vivo.

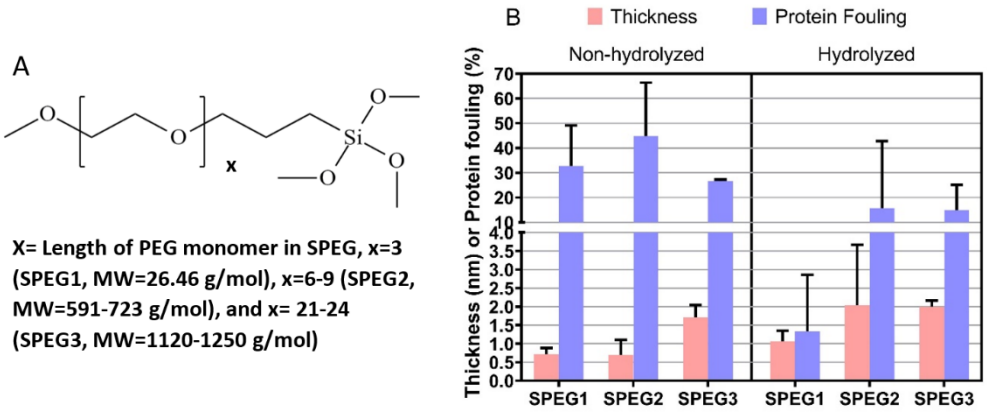

Figure 1. A) Structure of SPEG molecule, B) Coating thickness of SPEG1, SPEG2, and SEPG3 on silicon substrate and corresponding protein adsorption on those coatings under non-hydrolyzed and hydrolyzed condition.