

Slit Nanotopography on Silicon Nanopore Membranes Resists Protein Deposition and Cell Attachment

Eun Jung Kim¹, William Fissell², Tejal Desai¹ and Shuvo Roy¹

¹ Department of Bioengineering and Therapeutic Sciences, UCSF

² Division of Nephrology and Hypertension, Vanderbilt University

Background:

Silicon Nanopore Membranes (SNM) with compact geometry and uniform pore size distribution are under development for the hemofiltration unit in an implantable bioartificial kidney.^a Key concerns for long-term membrane function are centered on protein deposition and cell attachment that can result in surface fouling and thrombotic occlusion.^b

Methods:

In this study, we investigated the influence of surface coatings and nanotopography on protein deposition and cell growth on SNM substrates.

SNM substrates consisting a 6 x 6 mm slit-array patterned hemofiltration region area in the center surrounded by a 2 mm unpatterned, smooth border, were modified by physically adsorbing either collagen type I (Col I-SNM) or covalently immobilizing RGD peptide (RGD-SNM). Atomic force microscopy (AFM) was used to characterize the roughness of modified SNM surfaces. The propensity of protein adsorption on SNM surfaces was evaluated using fluorescein isothiocyanate labeled bovine serum albumin (**FITC-BSA**). Human umbilical vein endothelial cells growth on both modified and unmodified (Control) SNM were analyzed using immunohistochemistry.

The surface roughness (RMS) of RGD-SNM (12.5nm) was greater than that of Col I-SNM (7.8 nm) and Control (6 nm). In unpatterned regions, FITC-BSA adsorbed strongly to the Col I as well as RGD, and RGD-SNM was found to significantly enhance cell growth (1500 % on day 7) compared to Col I-SNM (120%) and Control (100 %). In patterned area of all modified SNMs, however, FITC-BSA protein adsorption and cell growth are strongly attenuated (below 10 % on day 7). In addition, significant actin impairment and cell detachment were observed on the patterned regions.

Results:

These results suggest that RGD is superior to Col I coatings for cell attachment. However, protein deposition and cell attachment on the slit-array region was significantly attenuated despite favorable coatings. This work will inform the development of SNM-based hemofiltration unit.

^a Fissell W et al., *Semin Dial* 22: 665-670, 2009

^b Conlisk A et al., *Ann Biomed Eng* 37: 722-736, 2009