REACTIVE AND RESPONSIVE FUNCTIONALIZED MEMBRANES

D. Bhattacharyya, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
db@uky.edu
A. Colburn, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
L. Ormsbee, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
H. Wang, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
C. Porter, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
Y. Wei, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
R. Sharma, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA
S. Hernandez, Dept. of Chemical and Materials Engineerin, University of Kentucky, USA

Surface functionalization of traditional NF, RO, and UF membranes to reduce fouling has been widely reported in the literature. On the other hand, pore functionalization of MF membranes through in-situ polymerization or attachment of macromolecules brings in new opportunities through pore conformation change and creation of high density active sites. These approaches dramatically enhance the applications of membranes in water and bio-nano field. The development of responsive, multifunctional materials and membranes for environmental applications requires a high level of control of both the characteristics of the base polymeric or inorganic support layer, as well as, its corresponding surface properties. Synthesis of membranes functionalized with appropriate macromolecules or reactive groups or enzymes and nano-catalytic particles can indeed provide applications ranging from tunable flux and separations, high-capacity metal capture, to toxic organic degradation by nanoparticles or enzymes. The use of macromolecules, such as, poly-acrylic acid (PAA), poly-glutamic acid (PLGA) provides pH responsive behavior pH modulations, whereas poly-N-isopropylacrylamide (pNIPAAm) provides temperature responsive behavior. The dependence of conformation properties of polyelectrolytes provides tunable separation and membrane flux control by pH or temperature based stimuli responsive properties. Layer-by-layer (LbL) assembly technique, most commonly conducted by intercalation of positive and negative polyelectrolytes or polypeptides, is a powerful, versatile and simple method for assembling supramolecular structures where enzymes or precise porin channels can be incorporated. The presentation will include: (1) synthesis and pore functionalization approaches, and direct polymerization of acrylic acid in membrane pores (lab-scale to full-scale), (2) pH and temperature responsive behavior, and catalytic nanoparticle synthesis in pores for environmentally important reductive and oxidative reactions, (3) pore functionalized (LbL approach) membranes for enzymatic (glucose oxidase and laccase), and environmentally important reactions,(4) porin channels for selective separations, (5) combination NF-Functionalized membrane process for practical applications in energy industries. The authors acknowledge the support of NSF KY EPSCoR program, NIH-NIEHS-SRC program, Southern services Co, Chevron Corporation, and Nanostone Membranes for full-scale membrane development work. The authors also acknowledge the highly significant research contributions of Drs. Li, Lewis, Ritchie, Hestekin, Meeks, and Gui.