COMPOSITE MEMBRANE FABRICATION WITH NANOPOROUS METALLIC FILMS

Michael J Detisch, University of Kentucky Department of Chemical & Materials Engineering
mjdeti2@uky.edu
Dibakar Bhattacharyya, University of Kentucky Department of Chemical & Materials Engineering
T. John Balk, University of Kentucky Department of Chemical & Materials Engineering

Key Words: metals, thin films, composite membranes, catalysis, water treatment

Magnetron sputtering is a physical vapor deposition method widely used for deposition of thin films of different materials on a variety of substrate materials. Sputtering allows fine control of the film thickness and composition through co-sputtering from multiple target materials. As part of this study thin films have been sputtered on top of membrane substrates. Microfiltration, ultrafiltration, and nanofiltration membranes have been investigated as substrates for thin film deposition. The resulting composite membranes have remained permeable under testing with deionized water. The base nanofiltration membrane showed permeability of 9.75 LMH/bar, while the membrane-film composite had a permeability of 2.76 LMH/bar.

Thin films of metallic alloys deposited in this way can be made nanoporous through a process called dealloying. The process involves the removal of the less noble component of an alloy by an etchant creating an open nanoporous structure. The pores created by this method commonly vary from a few nanometers to a few hundred nanometers.

This research focuses on using magnetron sputtering to deposit precursor metallic alloy films from 100 to 250nm thick on top of porous membrane substrates. These dense precursor films are then dealloyed to produce pore/ligament structures of approximately 10nm characteristic size. In these studies iron and palladium were chosen as a precursor alloy. A portion of the iron is etched away with sulfuric acid to generate an open nanoporous structure. Fe/Pd nanoparticles have been used with success to dechlorinate various chlorinated organic compounds (COCs) for wastewater treatment purposes. Nanoporous Fe/Pd films have shown similar activity in batch testing towards PCB degradation as nanoparticles. Taken together this means the composite membrane produced by fabricating a high surface area, porous Fe/Pd film on top of a membrane substrate shows promise both as a catalyst and as a platform for separations.

This project is funded by NIH-NIEHS-SRC and by NSF KY EPSCOR at the University of Kentucky.