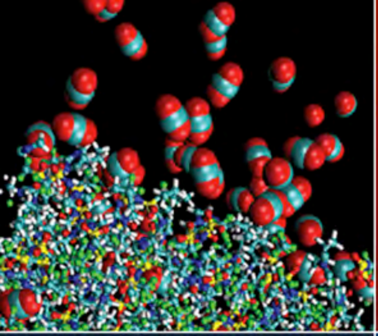

UNIVERSITY OF NOTRE DAME

Department of Chemical and Biomolecular Engineering

Graduate Seminar Series

Electrodialysis and Water-Oil Separations Using Membranes Coated with Polyelectrolyte Brushes and Multilayers

Tuesday, November 17, 2015, 3:30 pm

Eck Visitors Center

Seminar
3:30 - 4:30 pm

Eck Visitors Center

Membranes with ultrathin selective skins facilitate separations such as reverse osmosis and removal of oil from contaminated water. The minimal skin thickness affords high flux, whereas control of the skin chemistry enhances selectivity and increase fouling resistance. This presentation will first describe coating of ion-exchange membranes with polyelectrolyte multilayers to achieve K^+/Mg^{2+}, K^+/La^{3+}, and Li^+/Co^{2+} electrodialysis selectivities >1000. These unprecedented selectivities may prove useful in salt purification and recycling of Li and Co from batteries. The polyelectrolyte films on ion-exchantge membranes give rise to unique limiting currents and water splitting, which depend on the number of layers in the film. Modeling of ion partitioning suggests that deviations from electrical neutrality may occur in an electrical double-layer that spans the entire ultrathin film of a membrane. Regions depleted of cations or anions will greatly increase resistance to ion transport, and the thinnest barrier layers should give the highest ion rejections in nanofiltration.

We are also investigating adsorption of surfactants and oil emulsions on membranes coated with polyanionic brushes. During filtration of emulsions stabilized with a cationic surfactant, adsorption leads to brush collapse and rapid oil breakthrough. In contrast, polyanionic brushes do not adsorb anionic surfactants and show no fouling during filtration of oil emulsions stabilized with these surfactants. Negatively charged commercial nanofiltration membranes rapidly foul during filtration of emulsions stabilized with either cationic or anionic surfactants, showing that the high charge density in polyanionic brushes is necessary to combat fouling. Direct imaging of oil droplets during cross-flow of emulsions across brush-coated membranes confirms these results. Thus, knowledge of the surfactants present in an oil-containing solution should allow design of specific brush-coated surfaces that resist fouling.

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