Universität Duisburg-Essen
Lehrstuhl für Technische Chemie II
Prof. Dr. Mathias Ulbricht

Technisch-Chemisches Kolloquium

Montag, **18.07.2016** **15 Uhr c.t.**

Raum S05T02B16 (Campus Essen)

Multi-Functional Membranes for Advanced Separations

Prof. Dr. Ranil Wickramasinghe

Ralph E. Martin Department of Chemical Engineering

University of Arkansas, Fayetteville, AR, USA

Inspired by nature, there is great interest in developing multi-functional membranes that conduct more than one function simultaneously. Here two categories of advanced multi-functional membranes will be discussed: stimuli responsive membranes that change their physical properties in response to changes in environmental conditions; catalytic membranes that both catalyze a reaction and separate the product in one step.

Often, in membrane based separation processes the properties of the membrane surface that contact the feed stream can have a significant effect on membrane performance. For example, membrane surface properties have been shown to affect the rate of fouling during processes such as microfiltration, ultrafiltration, nanofiltration and reverse osmosis. Modifying just the membrane surface has the potential to retain the properties of the bulk membrane material but modify the interactions between components of the feed and the membrane surface. Here we have developed responsive membranes by surface modification. Two examples of stimuli responsive membranes; magnetic field responsive and ionic strength responsive membranes will be discussed.

Magnetically responsive nanobrushes have been grafted from the barrier surface of commercially available nanofiltation membranes. These nanobrushes consist of superparamagnetic nanoparticles attached to the end of a polymer chain. In an oscillating magnetic field, movement of the magnetically responsive nanobrushes leads to suppression of concentration polarization resulting in higher permeate fluxes and better rejection during filtration. Alternatively, by choosing an appropriate frequency, heating can be induced. When attached to the end of a thermo-responsive polymer chains such as poly(N-isopropylacrylamide), a change in polymer conformation can be induced upon heating leading to a change in membrane rejection.

In the second example of stimuli-responsive membranes, we have developed responsive membranes for hydrophobic interaction chromatography. Poly-N-vinylcaprolactam (PVCL) chains were grown from the surface of regenerated cellulose membranes using atom transfer radical polymerization (ATRP). PVCL is a thermo-responsive polymer with a lower critical solution temperature (LCST) that depends on the concentration of salt ions present in solution. The LCST decreases below room temperature in buffer containing 1.8 M $(NH_3)_2SO_4$ where the polymer adopts a more hydrophobic/collapsed conformation. At low ionic strength, the LCST remains above room temperature. Ligands that respond to solution ionic strength show promise for high performance hydrophobic interaction chromatography.

Finally, as an example of catalytic membranes, ceramic membranes have been functionalized by growing poly(styrene sulfonic acid) (PSSA) chains as well as polyionic liquid (PIL) chains from the surface of ceramic membranes. Our results indicate the feasibility of hydrolysis and dehydration of cellulose in one step. Further by removing the monomeric sugars as they are produced, production of sugar degradation products is minimized. These catalytic membranes hold the potential for significant process intensification.

Gäste sind herzlich willkommen!