Intermediate Pore Zeolite Membranes for Molecular Separation and Energy Storage

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Intermediate pore zeolites are microporous crystalline alumina-silicate defined by 10-oxygen member rings with pore diameter around 0.5-0.6 nm. The representative intermediate pore zeolites are the highly silicious, hydrophobic and stable MFI zeolites. This talk will highlight research results obtained in our laboratory on synthesis and separation properties of MFI zeolite membranes for separation of several industrially important liquid or vapor mixtures and their use as membrane separator for energy storage devices. MFI zeolite membranes show excellent separation performance for gas/vapor mixture with strongly adsorbing components, such as 8-component H_2 and C1-C4 gas/vapor mixture and alcohol-water mixtures. By eliminating aluminum from the framework and ensuring high crystallinity of zeolite, pure silica MFI zeolite membranes are alcohol perm-selective for the alcohol-water mixtures, offering ethanol/water or methanol/water separation factor over 180 at total pervaporation permeation flux of about 5 kg/m^2.h while operated in the pervaporation separation. For diffusion-(or molecular sieving)-controlled separation, the structure and integrity of MFI zeolite membrane are critical to their separation performance. MFI zeolite membranes only offer limited separation for H_2 over CO, CO_2 and H_2O at high temperatures, but catalytical cracking deposition of silica in MFI zeolite framework can effectively narrow the pore size of MFI zeolite, leading to MFI zeolite membranes with good H_2 selectivity at high temperatures (>300^{o}C). The MFI zeolite membranes, especially the B-oriented ones and those prepared without use of an organic template, offer excellent perm-selectivity for smaller p-xylene over bulkier o- or m-xylenes. A new application of zeolite membrane as the battery separator leads to cost-effective synthesis of high performance, safe lithium-ion and lithium-metal batteries for energy storage applications.

Biosketch

Jerry Y.S. Lin is a Regents' Professor at Arizona State University. He was department chair of chemical engineering at ASU from 2006-2009 after his 13-year appointment as a faculty member at University of Cincinnati. Prof. Lin's main research areas are membrane science, adsorption/catalysis, and energy storage. He has published about 400 papers mostly in chemical engineering journals and is an inventor of 9 US and European patents and 5 pending US patents. Prof. Lin's research was recognized by several national awards including NSF Career Award in 1995, AIChE Institute Award for Excellence in Industrial Gas Technologies in 2009 and AIChE Gerhold Award in 2021. He is an elected Fellow of American Society for Advancement of Science (**AAAS**), American Institute of Chemical Engineers (**AIChE**) and North American Membrane Society (**NAMS**). Prof. Lin is currently co-Editor-in-Chief of *Journal of Membrane Science* and *JMS Letters*.