Transport of Methanol and Protons in Proton Exchange Membranes

M.A. Hickner, *B. Pivovar, F. Wang, *T.A. Zawodzinski, J.E. McGrath

Department of Chemistry
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

*Los Alamos National Laboratory, MST-11
Los Alamos, NM 87544

Liquid fed direct methanol fuel cells (DMFC) suffer performance losses from unoxidized methanol at the anode diffusing across the proton exchange membrane (PEM) and reacting on the cathode catalyst. This transport of methanol across the membrane causes chemical "short-circuits" in the DMFC lowering the open circuit voltage and occupying catalytic sites at the cathode. A new class of PEMs has been synthesized that has intrinsically lower methanol permeation than Nafion.

This work will focus on measuring the methanol permeation of membrane by various methods. The first method involves classic concentration gradient driven diffusion using a membrane separated liquid cell. From this experiment, pure membrane properties can be studied. Two additional measurements have been developed for measuring methanol crossover in a DMFC. We will compare the methods for measuring methanol diffusion and highlight reasons for possible differences.

One of the main indicators of desirable DMFC PEM performance is its selectivity. We define the selectivity as the ratio of proton conduction to methanol permeation. Therefore, the selectivity quantifies the tradeoff between a less conductive membrane with lower methanol permeation, and a more conductive membrane with greater methanol permeation. Both methanol diffusion and proton conductivity are activation processes with their own activation energies. By examining the activation energies of each process and the tradeoff between proton conduction and methanol permeation, some membranes may prove to be more advantageous than others for a given temperature range.