Chemical and Biomolecular Engineering
Fall 2009 Seminar Series

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"Transport Phenomena in Polymer Electrolyte Membrane Fuel Cells"

Abstract

Fuel cells offer an innovative alternative to current power sources with higher efficiencies, renewable fuels, and a lower environmental cost. Specifically, polymer electrolyte membrane (PEM) fuel cells can produce energy for a variety of applications ranging from portable electronics (with methanol or ethanol fuel) to transportation (with hydrogen fuel). The critically important PEM serves as an electrolyte, exchanging protons from the anode to the cathode enabling the conversion of chemical energy to electrical energy. However, the less than ideal performance of typical PEMs contributes to significant power losses and low efficiencies due to both low proton conductivities at higher temperatures (hydrogen fuel cells) and high fuel crossover rates (methanol fuel cells). For both issues, the transport of molecules and ions in the PEM plays a critical role in the performance of a fuel cell.

Our laboratory has investigated the morphology, transport properties, and fuel cell performance of both ionic block copolymer and ionic blend membranes. In ionic block copolymer membranes, morphology, which was controlled by ion content and membrane formation conditions, has a significant impact on the transport of ions and small molecules. In ionic blend membranes, morphology (phase behavior), which was controlled by blend composition and annealing conditions, has a significant impact on selectivity (proton conductivity/methanol flux). The observed results were in good agreement with fuel cell performance data. In addition to using conventional transport measurement techniques, time-resolved Fourier transform infrared-attenuated total reflectance (FTIR-ATR) spectroscopy was used to study multicomponent transport phenomena in PEMs on a molecular scale for both the hydrogen and methanol PEM fuel cells. These experimental results will be presented, where the findings provide new insights for future PEM design for improved fuel cell performance.

Wednesday, December 2, 2009, 3:00 P.M.
Wu and Chen Auditorium, Levine Hall

Penn Engineering