142s Transport of Water in Nafion® Using Time-Resolved Ftir-Atr Spectroscopy

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Fuel cells offer an innovative and environmentally benign alternative to current power sources; however, increasing current fuel cell efficiencies requires new polymer electrolyte membranes (PEMs) with higher proton conductivities at higher temperatures, adequate water management, and reduced fuel crossover. In all of these areas, a fundamental understanding of multicomponent transport of molecules and ions in PEMs is desired for advancing fuel cell research. In this study, the transport of water in Nafion® (the most commonly used PEM in fuel cells) was investigated using time-resolved Fourier-transform infrared, attenuated total reflectance (FTIR-ATR) spectroscopy. This technique not only provides molecular-level contrast between diffusants and polymers in real time, but also can measure chemical interactions between diffusants and polymers through shifts in the infrared spectra.

Adsorption/desorption cycling of water in Nafion® and experiments at different relative humidities were explored. Cycling is a critical concern in the actual operation of a fuel cell, where both temperature and humidity levels will vary during operation and change dramatically between start up and shut down (water management). Characteristic infrared frequencies associated with hydronium ions, hydrogen-bound water, the polymer, and ion-polymer interactions were identified and quantified in real time. These results will be discussed in terms of a multicomponent transient model that incorporates diffusant-polymer interactions.