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Using Indentation to Characterize Water Transport and Structure in Nafion Thin Films[1] ERIC DAVIS, Department of Chemical and Biomolecular Engineering, Clemson University, Clemson, SC 29634, NICHOLE NADERMANN, KIRT PAGE, CHRISTOPHER STAFFORD, EDWIN CHAN, Materials Science and Engineering Division, National Institute of Standards and Technology, Gaithersburg, MD 20899 — Perfluorinated ionomers, specifically Nafion, are the state-of-the-art polymer used in fuel cells. For this application, Nafion is utilized in both a bulk (hundreds of microns) and confined (tens of nanometers) state. For Nafion thin films in a confined state, i.e., Nafion as thin film coatings on catalyst particles, in-plane transport may play a critical role in the movement of water and protons through this catalysis layer. In this study, water transport was measured for a series of Nafion thin film thicknesses using poroelastic relaxation indentation (PRI). Unlike traditional through-thickness diffusion measurement techniques for thin polymer films (e.g., quartz crystal microbalance), PRI can be used to probe the in-plane water transport behavior. Relative to bulk Nafion, reduced in-plane water diffusion was observed in thin film Nafion, and below approximately 1 micron, water diffusivity and Nafion film thickness exhibited a logarithmic relationship. Equilibrium swelling measurements of water saturated Nafion thin films were used in conjunction with pore network theory to develop a picture of how the molecular-scale structure of Nafion changes with confinement to nanoscale film thicknesses.

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