MAR16-2015-005599

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Understanding transport in model water desalination membranes

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Polyamide based thin film composites represent the the state-of-the-art nanofiltration and reverse osmosis membranes used in water desalination. The performance of these membranes is enabled by the ultrathin (˜100 nm) crosslinked polyamide film in facilitating the selective transport of water over salt ions. While these materials have been refined over the last several decades, understanding the relationships between polyamide structure and membrane performance remains a challenge because of the complex and heterogeneous nature of the polyamide film. In this contribution, we present our approach to addressing this challenge by studying the transport properties of model polyamide membranes synthesized via molecular layer-by-layer (mLbL) assembly. First, we demonstrate that mLbL can successfully construct polyamide membranes with well-defined nanoscale thickness and roughness using a variety of monomer formulations. Next, we present measurement tools for characterizing the network structure and transport of these model polyamide membranes. Specifically, we used X-ray and neutron scattering techniques to characterize their structure as well as a recently-developed indentation based poromechanics approach to extrapolate their water diffusion coefficient. Finally, we illustrate how these measurements can provide insight into the original problem by linking the key polyamide network properties, i.e. water-polyamide interaction parameter and characteristic network mesh size, to the membrane performance.