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Designing Desalination Membranes for Improved Energy Efficiency

Desalination can create new, climate-resilient water supplies from seawater, recycled wastewater, and brackish groundwater. Globally, membrane desalination is the most widely-used desalination technology because of its relative energy efficiency compared to thermal desalination technologies. Expanding the applications of membrane desalination requires further improvements in separation performance and fouling-resistance, and associated reductions in energy consumption, for the thin-film composite polymeric membranes that are the industry standard. In this talk, I will present research from the Polymeric Membranes and Transport Media project at NIST, which seeks to design more energy-efficient desalination membranes by reducing membrane thickness, improving permselectivity, and imparting resistance to fouling and mineral scaling. We developed a molecular layer-by-layer deposition process as a novel synthesis strategy for fabricating model polyamide films and desalination membranes with controlled thickness, chemistry, and topography. These model materials have enabled the study of how the structure and properties of polyamide affect desalination performance. I will discuss the results of two specific studies using model polyamide films and non-traditional measurement techniques: poroelastic relaxation indentation measurements of water diffusion and electrochemical impedance spectroscopy measurements of salt transport. The results of these studies have improved understanding of water and salt transport in polymeric membranes and provide insights that can guide the design of more energy-efficient desalination membranes.