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3D morphological characterization of the polyamide active layer of RO and NF membranes using TEM and soft X-ray scattering TYLER CULP, Pennsylvania State Univ, MOU PAUL, ABHISHEK ROY, STEVE ROSENBERG, MICHAEL BEHR, The Dow Chemical Company, MANISH KUMAR, ENRIQUE GOMEZ, Pennsylvania State Univ, PENN STATE TEAM, DOW TEAM
— Polyamide-based thin-film composite (TFC) membranes used for reverse osmosis (RO) and nanofiltration (NF) separation processes are at the forefront of water desalination and purification technologies due to their high salt rejection, high energy efficiency, and ease of operation. Nevertheless, in spite of the benefits of RO and NF membranes, many open questions about the internal nanostructure of the membrane active layer remain, such as the dispersion and distribution of acid functional groups. We demonstrate that resonant soft X-ray scattering (RSOXS), where the X-ray energy is tuned to absorption edges of the constituent materials, is a powerful tool to examine the microstructure of the polyamide layer. In conjunction with complementary techniques such as transmission electron microscopy (TEM), where tomography is used to obtain a 3D reconstruction of the polyamide active layer, the effect of cross-linking can be quantified in 3D for a systematic series of membranes. This relationship can then be applied to a series of commercially available RO and NF membranes where the effect of polyamide cross-linking on their respective structure and water transport properties can be evaluated. The combination of RSOXS with traditional characterization tools provides a strategy for linking the chemical structure to the morphology and water transport properties of RO and NF membranes.

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