Advanced membrane materials for desalination and water treatment

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Water scarcity is the one of the Grand Challenges of the 21th century. Membrane-based desalination and water treatment, including reverse osmosis (RO) and nanofiltration (NF) membranes, are currently leading technologies for sustainable supply of clean water. Polyamide (PA) thin film composite (TFC) membranes, consisting of an ultrathin PA selective layer on a porous support, are the predominant material platform of RO and NF membranes. The PA selective layer is conventionally prepared via interfacial polymerization of multifunctional amine and acyl chloride monomers. Despite of its high permselectivity, the PA layer has a complex and rough physical structure and standardized chemistry, which limits the enhancement of the membrane performance and durability and hampers our understanding of the membrane structure-property relationship. This concern necessitated the fabrication of the TFC membranes with the precisely controlled, well-defined and multifunctional structure. In this talk, I will demonstrate that advanced membranes with well-defined and functional structures can be fabricated using new fabrication techniques, including molecular layer-by-layer, layered interfacial polymerization, dual slot coating and surface patterning, or using novel and bio-inspired materials. The fabricated TFC membranes exhibit the superior performance and durability compared to the commercial membranes. In addition, the proposed fabrication and material platforms can allow us elucidate the structure-property relationship of the membrane.