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Understanding Functionalized Silica Nanoparticles Incorporation in Thin Film Composite Membranes: Interactions and Desalination Performance

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Abstract

Incorporation of functional nanoparticles in polymer membranes is a promising approach for the development of advanced thin film nanocomposite (TFN) membranes with improved desalination performance. This study was aimed to fabricate TFN membranes incorporated with functionalized silica nanoparticles (SNs), which were synthesized with different sizes (~50 and ~100 nm) and surface functionalities (hydroxyl, epoxy and amine). Research focused on getting a better understanding of the interfacial interactions between SNs and polymer matrix and structure-property correlation of the TFN membranes. The physicochemical properties of the functionalized SNs and the TFN membranes were characterized using ATR-FTIR, TGA, DLS, SEM, TEM, XPS, tensiometer and streaming potential analysis. The results confirm successful incorporation of the surface functionalized SNs into the polymer membranes. The concentration, size and surface functionality of SNs were found to have strong impact on the surface hydrophilicity, morphology and chemistry of the TFN membranes. The SNs hybridized TFN members showed increased permeate flux and insignificant change in salt rejection. The surface functionalization of SNs with amine and epoxy moieties could facilitate the chemical interaction between SNs and polymer monomers, resulting in stabilizing the TFN membranes. Our research outcomes have provided new insight into the structure-performance correlation of TFN membranes and can be beneficial for fabrication of a wide range of nanoparticle incorporated membranes.