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Development of advanced nanocomposite membranes using graphene nanoribbons and nanosheets for water treatment

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Abstract

Water-intensive industries have to comply with stringent environmental regulations and evolving regulatory frameworks requiring the development of new technologies for water recycling. Development of polymeric membranes may provide an effective solution to improve water recycling, but require finely-tuned pore size and surface chemistry for ionic and molecular sieving to be efficient. Additionally, fouling is a major challenge that limits the practical application of the membranes in water recycling in these industries. In this work, four different graphene oxide (GO) derivatives were incorporated into a polyethersulfone (PES) matrix *via* a non-solvent induced phase separation (NIPS) method. The GO derivatives used have different shapes (nanosheets *vs* nanoribbons) and different oxidation states (C/O=1.05-8.01) with the potential to enhance water flux and suppress fouling of the membranes through controlled pore size, hydrophilicity, and surface charge. The permeation properties of the PES/GO membranes were evaluated using a water sample from the Athabasca oil sands of Alberta. The results for contact angle and streaming potential measurements indicate the formation of more hydrophilic and negatively charged PES/GO nanocomposite membranes. All graphene-based nanocomposite membranes demonstrated better water flux and rejection of organic matter compared to the unmodified PES membrane. The fouling measurement results revealed that fouling was impeded due to enhanced membrane surface properties. Longitudinally unzipped graphene oxide nanoribbons (GONR-L) at an optimum