High-Performance Nanofiltration Membranes from Polyphenol−Graphene Oxide Liquid Crystals Prepared Using Natural Extract

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Abstract:

Oxygen functionalities on graphene oxide (GO) nanosheets have a significant role in the performance of GO-based laminar membranes. The influence of these groups on nanochannel spacing, electrostatic repulsion, and transport resistance in aqueous and polar environments is well recognized. In this work, the antioxidative properties of olives, Olea europaea, were exploited to gradually reduce GO and the effects of progressive deoxygenation on the properties GO membranes were systematically monitored. The optimization of the reaction process in this manner enabled the fabrication of an ultrafast membrane with enhanced molecular sieving characteristics. Ultrathin (∼30 nm thick) membranes prepared from liquid crystalline polyphenol−GO dispersions with a water permeance of 60.4 ± 2.8 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$ showed dramatic improvement over GO membranes (water permeance of 10 ± 3.4 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$). This is combined with enhanced molecular sieving characteristics of >90% for probes such as methyl orange with hydrated radii greater than 5.0 Å and stability in crossflow filtration tests wherein Rose Bengal (974 Da) is retained at > 90 % for 100 h compared to GO, which falls below 50 % retention in the same amount of time. This improvement is attributed to the confluence of the loss of oxygen functional groups and cross-linking attachment of polyphenols to the GO nanosheets. The results will facilitate new understanding in the design of novel bio-inspired composite membranes.

Keywords: nanofiltration, graphene oxide, green, polyphenol composites, stability