

Holey graphene and hydrophobic eutectic solvents embedded in sulfonated poly (ether sulfone) hybrid UF membranes for pharmaceutical contaminants removal from wastewater

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Abstract

Pharmaceutical contaminants emerging in aquatic ecosystems pose substantial threats to environmental sustainability and public health, necessitating the development of effective methods for water purification^{1,2}. This research investigates the development of advanced sulfonated polyether sulfone (SPES) membranes enhanced with hydrophobic deep eutectic solvents (HDES) in combination with holey graphene (HG)^{3,4}. The goal is to improve membrane attributes, including mechanical durability, water permeability, contaminant selectivity, and antifouling properties. Membranes were fabricated using the phase-inversion method and subsequently analysed using X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). XRD analysis revealed predominantly amorphous structures with optimized molecular packing from HDES integration. Raman spectroscopy identified characteristic defect peaks, confirming successful incorporation of HG into the membrane matrix. SEM images illustrated a uniform HG distribution and robust interfacial bonding, which are essential for enhanced mechanical integrity and reduced membrane fouling. Initial findings indicated exceptional membrane performance, achieving pharmaceutical rejection efficiencies of about 95% for ciprofloxacin (CPX), 87% for sulfamethoxazole (SMX), and 99% for tetracycline (TCT). Water flux was significantly enhanced, achieving approximately 130 LMH at an operating pressure of 3.8 bar, which is markedly superior to that of pristine SPES membranes (78 LMH). Moreover, the incorporation of HG improved mechanical strength by approximately 20% and reduced the water contact angle from 75° (for pristine SPES) to 45°, indicating a notable increase in hydrophilicity. The developed SPES-HDES-HG membranes offer a promising, environmentally friendly, and cost-effective solution for removing pharmaceutical pollutants from wastewater. Future studies will focus on assessing membrane longevity, sustained antifouling efficacy, and consistent performance across 7 pH levels (from 5 to 9), thereby facilitating broader applicability in municipal wastewater treatment.

References

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Figures

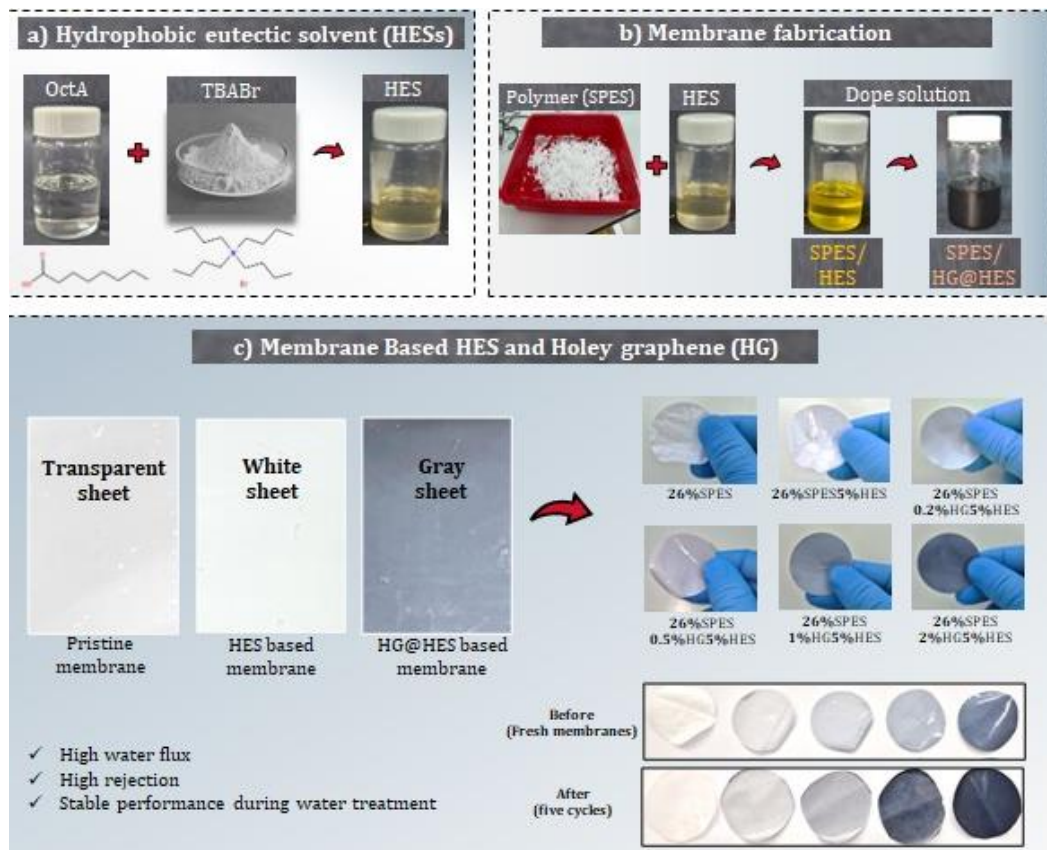


Figure 1. Novel HG@HDES based membranes for water treatment.