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In situ preparation of polyelectrolyte complexes/silica hybrid hollow fiber membrane for pervaporation dehydration processes

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Abstract: It is gaining increasing importance to prepare the hybrid membranes possessing considerable permeability, selectivity and stability for pervaporation processes. In this study, polyelectrolyte complexes (PEC)/silica (SiO_2) hybrid hollow fiber membranes were prepared *in situ* via sol-gel process. γ-glycidyloxypropyltrimethoxysilane (GPTMS) was introduced as precursor and crosslinker into poly (diallyldimethylammonium chloride)–sodium carboxymethyl cellulose complexes to form SiO_2 particles *in situ* and enhance the interaction between inorganic and organic components. PEC/SiO_2 hybrid membrane (PECM/SiO_2) achieved an enhanced flux compared with the PEC pristine membrane without GPTMS. Furthermore, the membranes were further applied in practical organics/water mixtures including fusel oil and ethyl acetate (EAc) aqueous solution.

Introduction

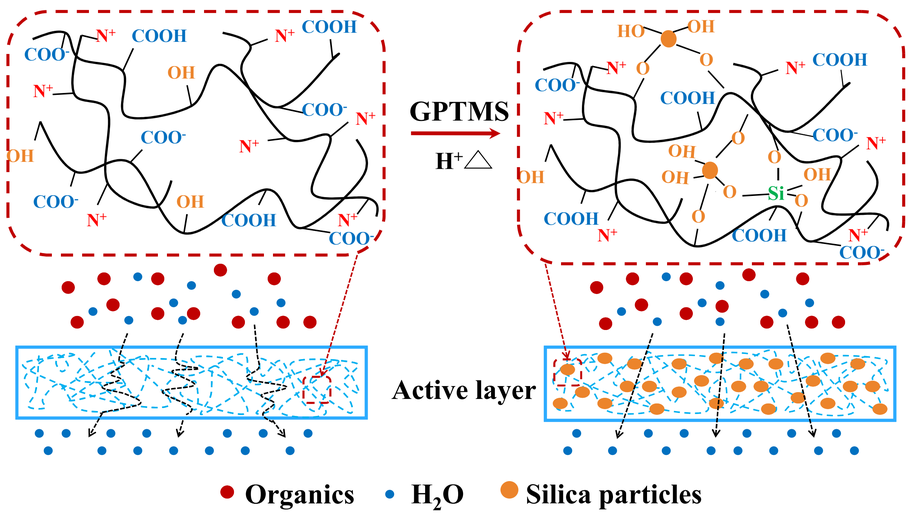

Fig. 1. Schematic diagram of chemical structure and separation process.

Results and discussions

➢ Characterizations of PECM and PECM/SiO_2

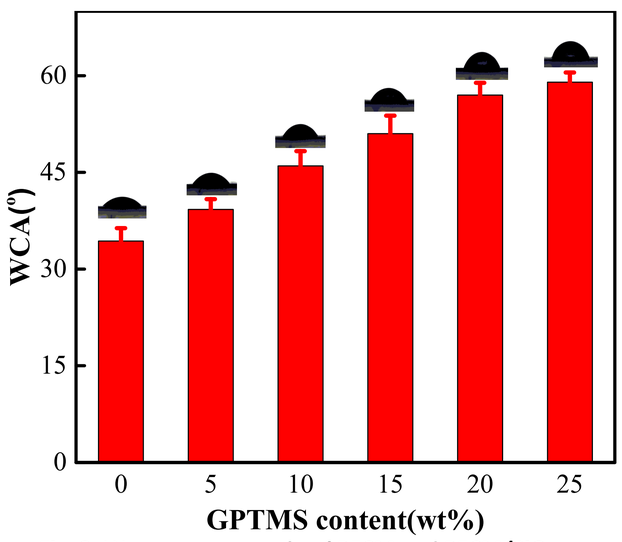

Fig. 2. Water contact angle of PECM and PECM/SiO_2

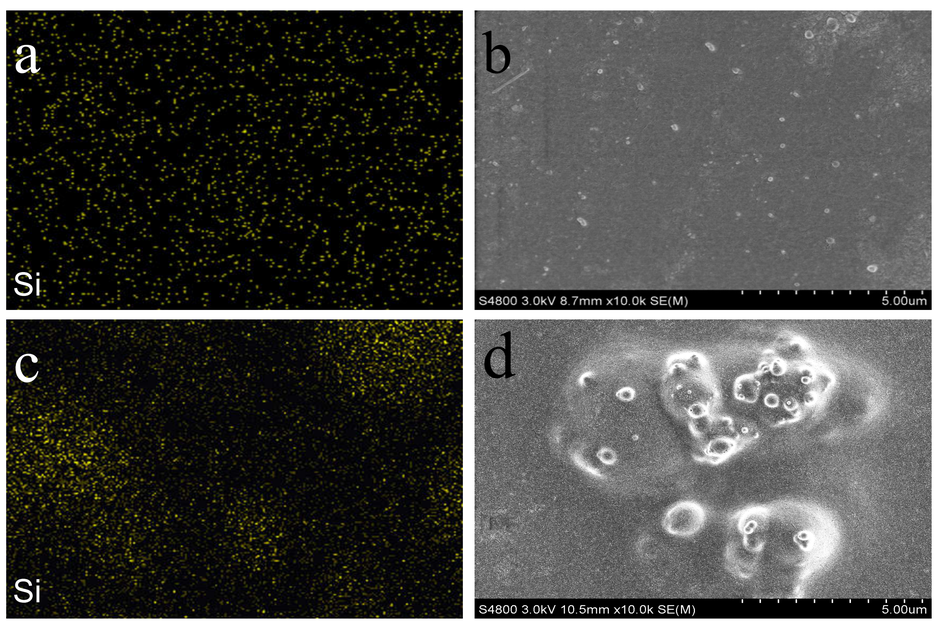

Fig.3. EDS mapping for Si from the surface and FESEM(x10.0k) surface morphologies of (a)(b) PECM/SiO_2-10; (c) (d) PECM/SiO_2-25 (the x of PECM/SiO_2-x is the mass fractions of GPTMS respect to PEC).

➢ Pervaporation performance of PECM and PECM/SiO_2

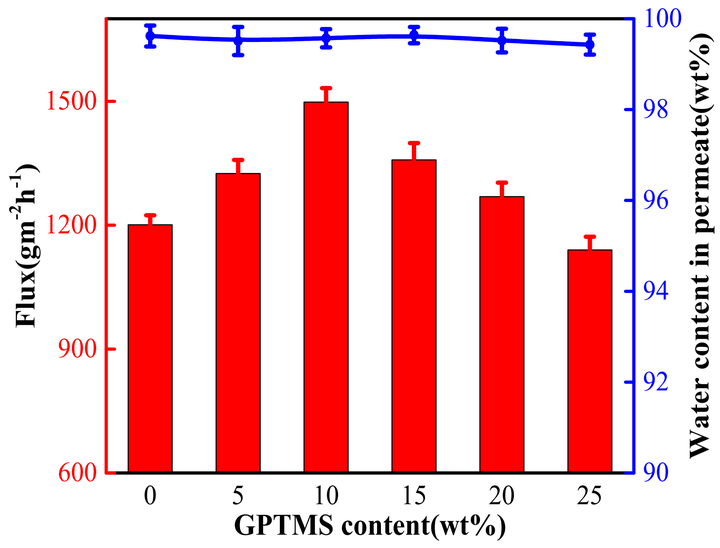

Fig. 4. impacts of GPTMS content on the pervaporation performances of PECM/SiO_2 in 90.0 wt% isopropanol/water mixtures at 50 °C.

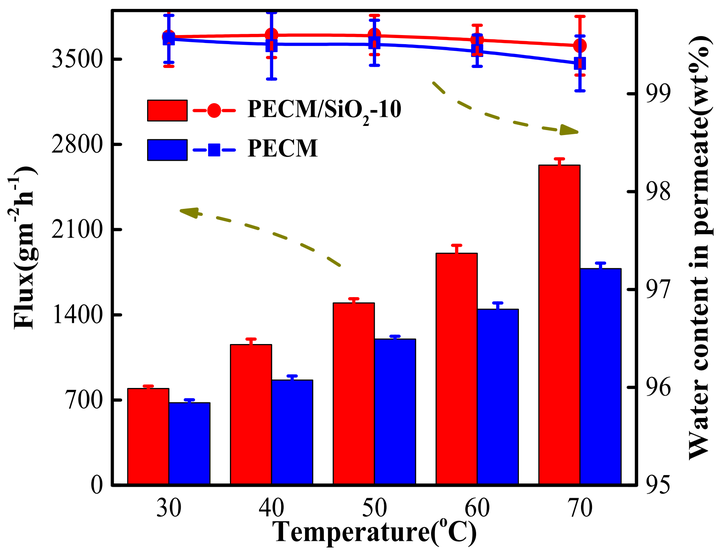

Fig. 5. Impacts of feed temperature on pervaporation performances of PECM and PECM/SiO_2-10 in 90.0 wt% isopropanol/water mixtures

➢ Practical application of PECM/SiO_2 in fusel oil and EAc aqueous solution.

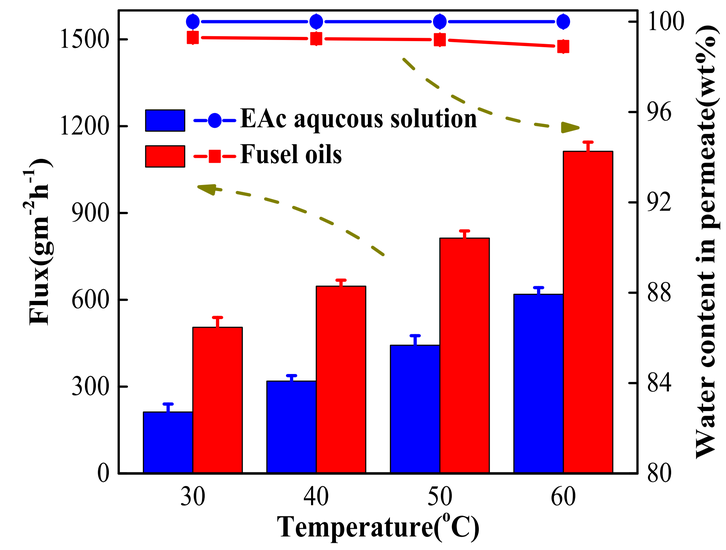

Fig.6. Pervaporation performance of PECM/SiO_2-10 in fusel oil and 98.0 wt% EAc aqueous solution.

Conclusions： A novel hybrid hollow fiber membrane building based on PDDA–CMCNa PEC introduced GPTMS to form silica particles *in situ* in the membrane matrix via sol-gel process. The silicon particles were uniformly dispersed in PECM/SiO_2, which increased the interface channels inside the membrane and provided extra free volumes. Moreover, the pervaporation performance of PECM/SiO_2 in fusel oil and EAc aqueous solution exhibited appreciable elevation, making PECM/SiO_2 promising candidate for organics/water mixtures pervaporation dehydration processes.

Acknowledgement

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References

X. Li, A. Sotto, J. Li, B. Van der Bruggen, Progress and perspectives for synthesis of sustainable antifouling composite membranes containing in situ generated nanoparticles, J. Membrane Sci. (2017) 502-528.