

Fabrication of dual-layer hollow fibre membranes with intrusion anchored structure for highly stable separation performance in DCMD

Derrick Ng^a, Guang Yang^a, Zhen Huang^{a,b}, Jianhua Zhang^b, Stephen Gray^b, Zongli Xie^{a,*}

^a CSIRO Manufacturing, Private Bag 10, Clayton South, Victoria 3169 Australia.

^b Institute for Sustainable Industries and Liveable Cities, Victoria University, PO Box 14428, Melbourne, Victoria 8001 Australia.

*Corresponding author: zongli.xie@csiro.au, +613 9545 2938

Abstract:

High-performance hydrophilic/hydrophobic dual-layer membranes with a Janus structure have been intriguing for membrane distillation due to its distinctive features in improving fouling and wetting resistance. However, it is challenging to ensure the long-term structural stability owing to the delamination caused by the opposite affinity between the two different kinds of materials. Herein, a hydrophilic layer containing graphene oxide/poly(vinyl alcohol) (PVA)/sulfosuccinic acid (GOSP) was formed on the outer surface of a microporous polypropylene (PP) hollow fibre membrane. To enhance the interfacial attachment and structural stability, a physically anchored structure was constructed by the partial intrusion of the coating mixture into the pores the PP membrane. By tuning the ratio of PVA/GO, the nanostructure of the GOSP layer transformed from 2-dimensional lamellar membrane to a 3-dimensional mixed matrix membrane, exhibiting various water transport properties. More importantly, the fabricated dual-layer membrane with the partially intruded pore channels exhibited superior antiwetting and antifouling performance for desalination and wastewater treatment in the direct contact membrane distillation (DCMD) process. For surfactant containing saline water, the GOSP/PP dual layer membrane with optimised PVA/GO ratio (10 wt% of PVA with respect to GO, 100 mg/L GO) possessed noticeably enhanced anti-wetting property than the pristine PP membrane. The enhanced stability of the GOSP-PP dual-layer membrane was further evidenced when treating real seawater and leachate. In particular for leachate treatment, the GOSP/PP membrane produced high quality permeate with less than 1 mg/L ions and 10 mg/L total organics and maintained stable water flux while the leachate being concentrated by 5 times (80% water recovery), providing a great potential using MD towards zero liquid discharge.

Keywords: dual-layer, membrane distillation, PVA, desalination, anti-wetting.