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Nanofiltration Membrane with A Mussel-Inspired Interlayer for Improved Permeation Performance

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Abstract:

A mussel-inspired interlayer of polydopamine (PDA)/poly(ethyleneimine) (PEI) is co-deposited on the ultrafiltration substrate to tune the interfacial polymerization for the preparation of nanofiltration membranes (NFMs). The solution height increases with the PDA/PEI co-deposition time from 45 min to 135 min due to the capillary effect of the substrate pores. The prepared TFC NFMs are characterized with thin and smooth polyamide selective layers by ATR/IR, XPS, FESEM, AFM, zeta potential and water contact angle measurements. Their water permeation flux measured in a cross-flow process increases to two times as compared with those TFC NFMs without the mussel-inspired interlayer and show a high rejection of 97% to Na_2SO_4.

Introduction

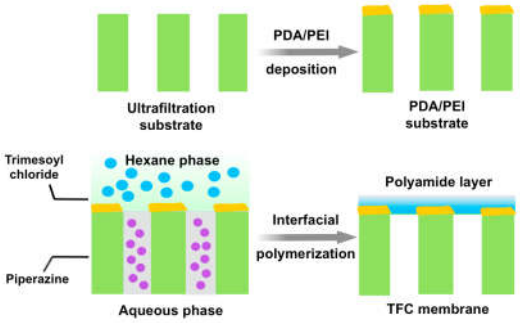

Fig. 1. Schematic illustration of the interfacial polymerization mediated by PDA/PEI mussel-inspired interlayer and the resulted TFC NFMs polyamide layer.

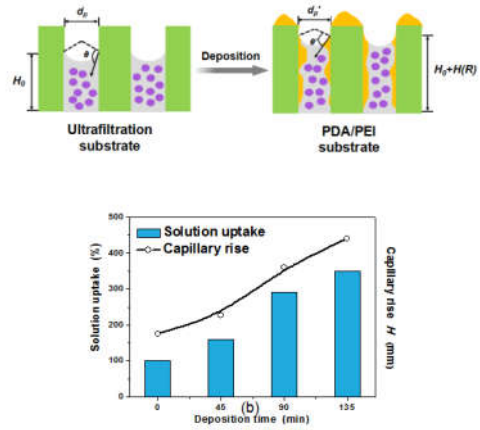

Fig. 3 (a) Schematic illustration of the original and PDA/PEI modified PSf substrates of increasing capillary rise. (b) Solution uptake and theoretical calculated capillary rise of PSf substrates before and after certain time of PDA/PEI co-deposition (0 min, 45 min, 90 min and 135 min, respectively).

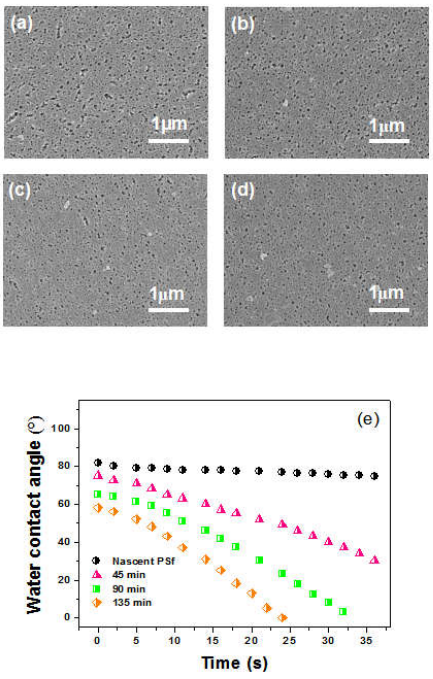

Fig.2 (a-d) Surface FESEM images of PSf substrates before and after certain time of PDA/PEI co-deposition (0 min, 45 min, 90 min and 135 min, respectively). (e) Water contact angle of the PSf substrate surfaces after PDA/PEI co-deposition with different times.

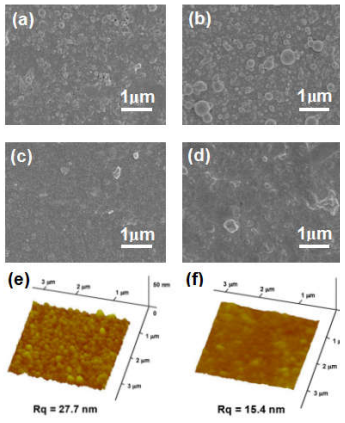

Fig. 4. (a-d) Surface FESEM images of TFC NFMs after interfacial polymerization with the deposition times of PDA/PEI for 0 min, 45 min, 90 min and 135 min, respectively, the AFM images of resulted morphology of TFC NFMs (e) without or (f) with the PDA/PEI mussel-inspired interlayer.

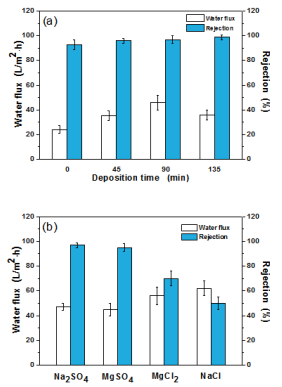

Fig. 5. Performance of TFC NFMs with or without PDA/PEI mussel-inspired interlayer. (a) Effect of different PDA/PEI deposition times on the separation performance of Na2SO4 solution. (b) Water flux and rejection rate of different inorganic salt solution with TFC NFMs prepared under the optimized condition. (Test conditions: inorganic salt concentration = 1000 mg/L, pH = 6, 30 ºC, 0.6 MPa, cross-flow rate = 30 L/h.)

Conclusions

Our results show that this hydrophilic interlayer can regulate the adsorption/diffusion of diamine monomer for the interfacial polymerization, and the resulted membrane structures with the nanofiltration performances. Moreover, the TFC NFMs with the PDA/PEI hydrophilic interlayer achieve the thin and smooth polyamide selective layer. The versatility of this mussel-inspired interlayer could potentially offer the new pathway for a wide range of TFC NFMs preparation and applications.

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References

"Nanofiltration Membrane with A Mussel-Inspired Interlayer for Improved Permeation Performance", Langmuir, 2017, 33 (9), pp 2318–2324.