Tailoring surface pore size of hollow fiber membranes in TIPS process

Supplementary Information

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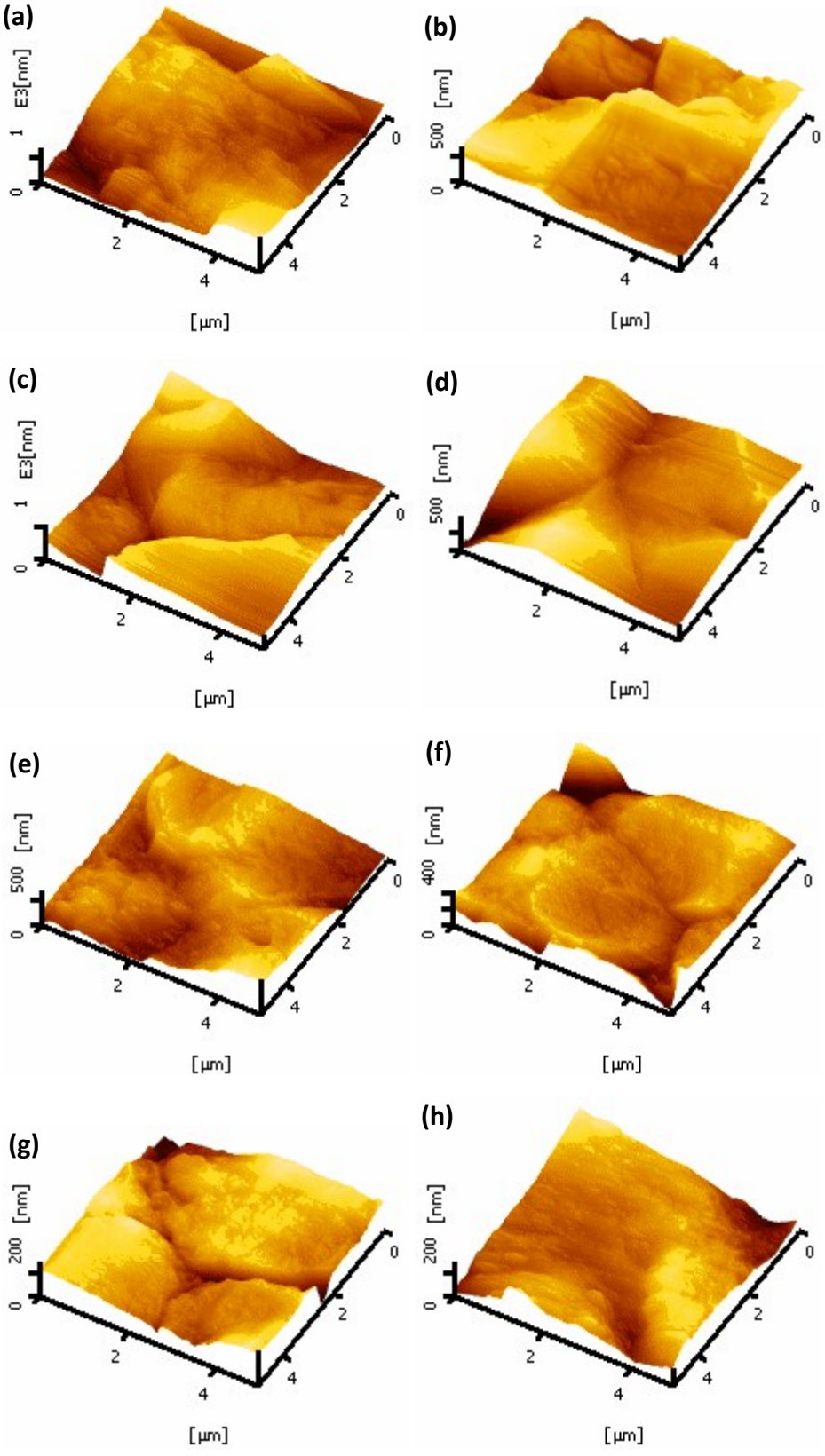
AFM measurement results:



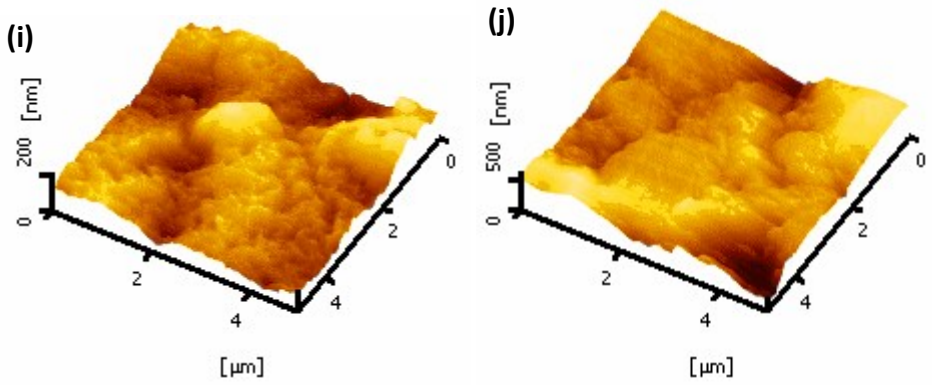


Fig. S1. AFM images of the outer surfaces of PVDF hollow fiber membranes prepared by different extruded solvents: (a) GTA, (b) DEP, (c) ATBC, (d) Glycerol, (e) PEG 400, (f) 1,3-Butanediol, (g) GBL, (h) TEP, and (i) NMP, and (j) normal PVDF membrane.

PVDF membranes performances:

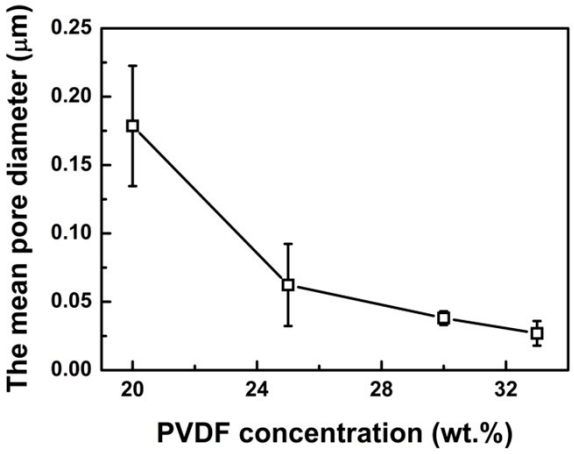


Fig. S2. Mean pore diameters of PVDF hollow fiber membranes prepared with different PVDF concentrations.

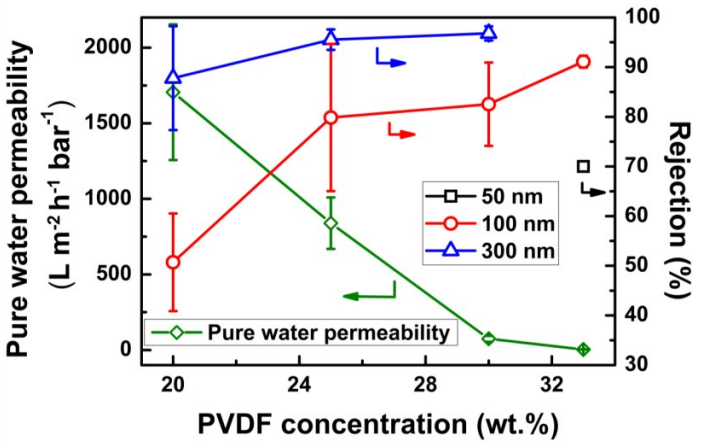


Fig. S3. Pure water permeability and rejection of PVDF hollow fiber membranes prepared with different PVDF concentrations.

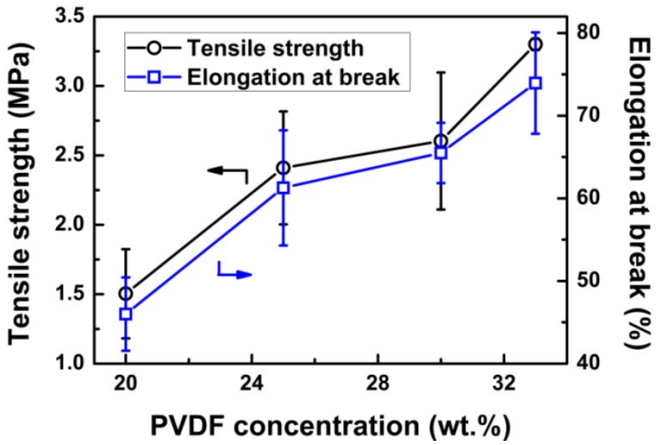


Fig. S4. Mechanical strength of PVDF hollow fiber membranes prepared with different PVDF concentrations.

***Bulk porosity measurement*:**

The bulk porosity of PVDF hollow fiber membranes was obtained by weight and volume measurements. Wet membranes were cut into 10 cm in length, l (cm), to freeze-dried two days, then weighted their weights, m (g), with 7 samples for every measurement. Bulk porosity, ε (%), was calculated using the following equation [1]:

$$\varepsilon = \frac{\frac{1}{4}\pi l \rho (OD^2 - ID^2) - m}{\frac{1}{4}\pi l \rho (OD^2 - ID^2)} \times 100$$

(1)

where *OD* and *ID* are the outer and inner diameters of the membrane (mm), ρ is the PVDF density (g/cm^3).

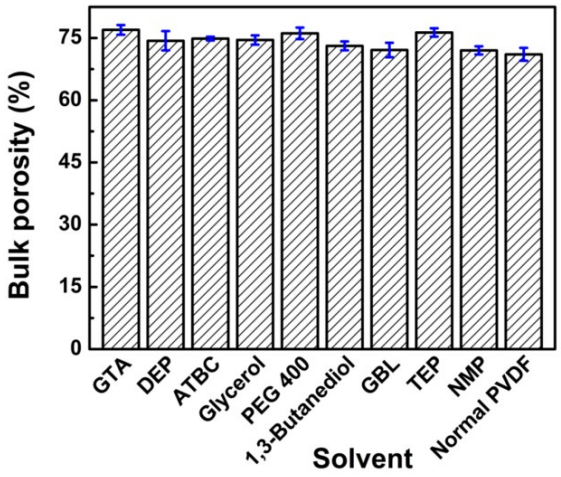


Fig. S5. Bulk porosity of PVDF hollow fiber membranes prepared with different extruded solvents and normal PVDF membrane.

Effect of mixed extruded solvent:

Table S1 Effect of mixed extruded solvents on membrane performances.

Solvents	Pure water permeability (L m^{-2} h^{-1} bar^{-1})	Rejection of PS particles with different size (%)				Tensile strength (MPa)	Elongation at break (%)
		50 nm	100 nm	300 nm	500 nm		
NMP (100 wt%)	26.4±7.3	81.2±1.2	85.6±2.1	–	–	3.3±0.3	64.8±5.8
NMP/GTA (50 wt%/50 wt%)	1571±108	–	65.0±5.2	92.0±1.5	–	3.2±0.2	52.0±6.2
GTA (100 wt%)	4110±173	–	27.9±10	20.4±12	69.0±2.2	3.0±0.4	57.7±5.7

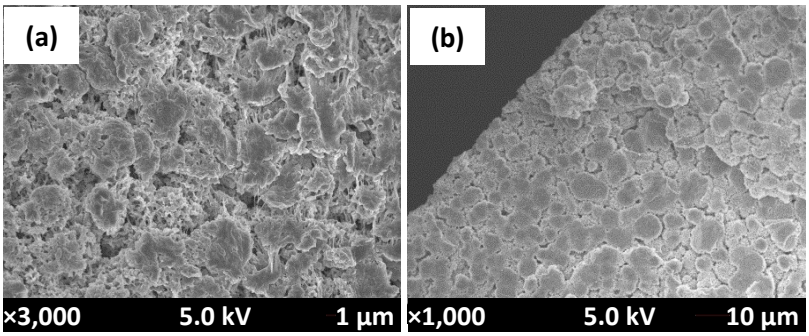


Fig. S6. SEM images of the PVDF hollow fiber membrane prepared by extruding the mixed solvent of 50 wt% NMP and 50 wt% GTA: (a) outer surface and (b) cross-section near the top outer surface.

Reference

1. N. L. Le and S. P. Nunes, *J. Membr. Sci.*, 2017, **533**, 171-178.