Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.
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Supporting Information

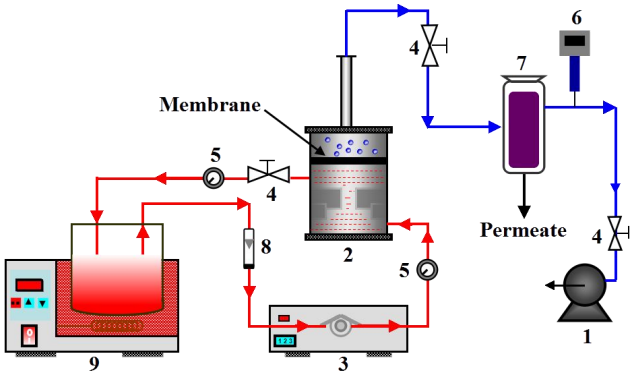
Nanodisperse ZIF-8/PDMS Hybrid Membranes for Biobutanol Permselective Pervaporation

Hongwei Fan, Naixin Wang, Shulan Ji, Hao Yan, Guojun Zhang*

Center for Membrane Technology, College of Environmental and Energy Engineering, Beijing University of Technology, Beijing 100124, China;

E-mail: zhanggj@bjut.edu.cn

Scheme. S1.



Scheme. S1. Schematic diagram of the pervaporation apparatus fabricated in-house.
1. Vacuum pump; 2. Membrane module; 3. Peristaltic pump; 4. Regulator; 5. Digital temperature gauge; 6. Vacuum gauge; 7. Cold trap; 8. Flowmeter; 9. Thermostat water bath.

Fig. S1.

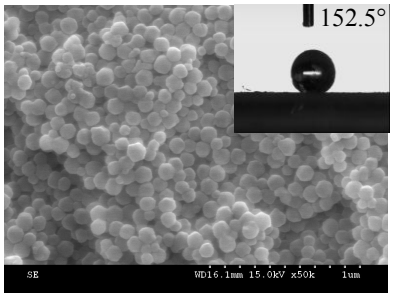


Fig. S1. SEM images of the synthesized ZIF-8 nanoparticles. The upper right inset in the photo shows the profile of water droplet on the surface with the water contact angle.

Fig. S1 shows that the ZIF-8 nanoparticle size is about 90nm with a narrow size distribution. Furthermore, ZIF-8 nanoparticles surface exhibits a super-hydrophobic behavior (water contact angle of >150°) (upper right of Fig. S1),[S1, S2] which is in good agreement with previous reports.[S3]

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Fig. S2.

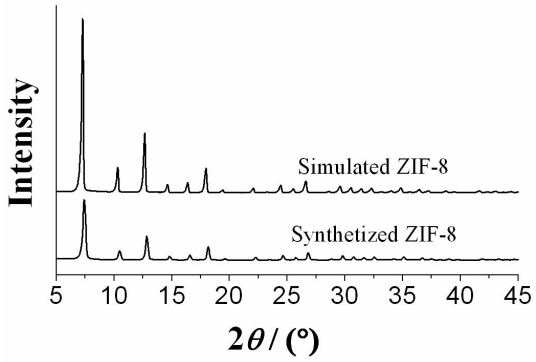

Fig. S2. Experimental and simulated XRD patterns of ZIF-8 materials

As shown in Fig. S2, XRD confirmed the as-synthesized product of a highly crystalline ZIF-8 structure without any impurity phase.

Fig. S3.

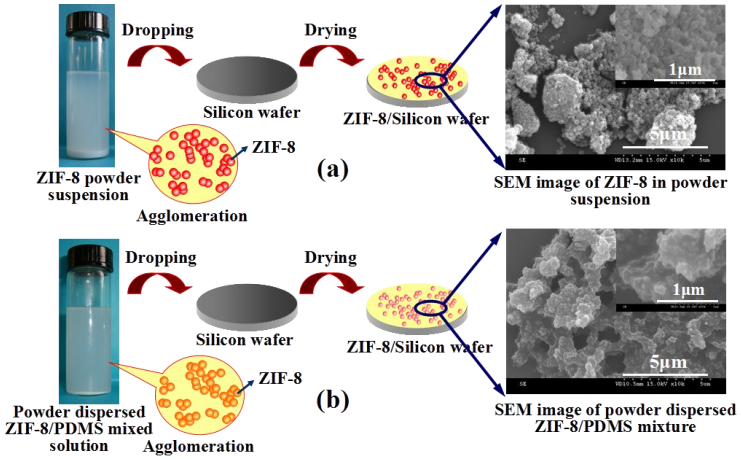

Fig. S3. Characterization process of the nanoparticle dispersion in (a) ZIF-8 powder suspension and (b) powder dispersed ZIF-8/PDMS mixed solution with the mass ratio of 1:1.

Fig. S4.

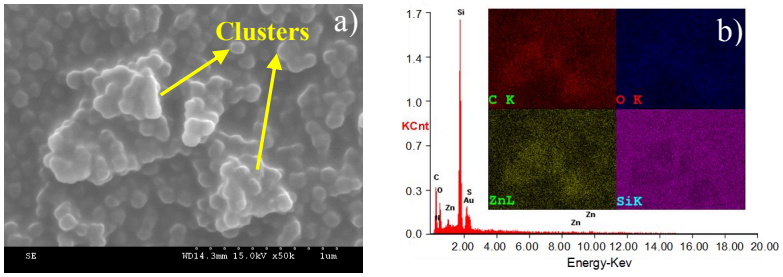

Fig. S4. a) Surface SEM image and b) surface element analysis with EDS mapping of the powder-dispersed ZIF-8/PDMS nanohybrid membrane with the mass ratio of 1:1.

Fig. S5.

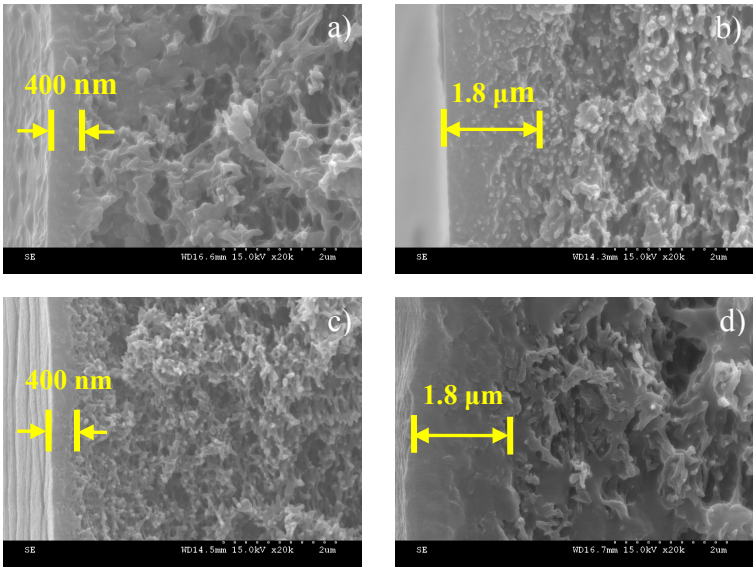

Fig. S5. Cross-sectional SEM images of ZIF-8/PDMS nanohybrid membrane with a) no post-treatment and b) post-treatment; After two layers of dipping into suspension-dispersed ZIF-8/PDMS (1:1, w/w) mixed solution (1wt.%, PDMS). Cross-sectional SEM images of pure PDMS composite membrane with c) no post-treatment) and d) post-treatment; After two layers of dipping into PDMS solution (1wt.%, PDMS).

Fig. S6.

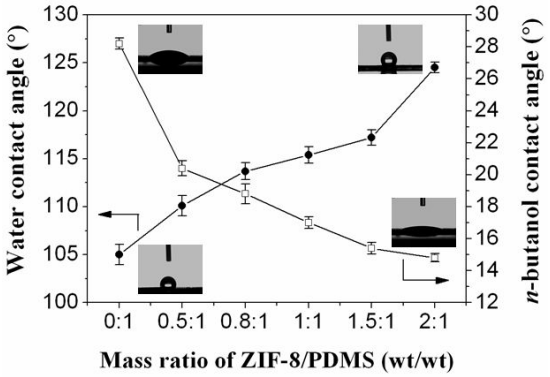

Fig. S6. Static contact angle of water and *n*-butanol on the suspension-dispersed ZIF-8/PDMS nanohybrid membrane surface with various mass ratio of ZIF-8/ PDMS; two layers of dipping into the ZIF-8/PDMS mixed solution (1 wt.%, PDMS), with post-treatment. Error estimates were varied from 0.4 % to 1.1 % for the water and from 1.8 % to 4.3 % for the *n*-butanol contact angle.

Fig. S7.

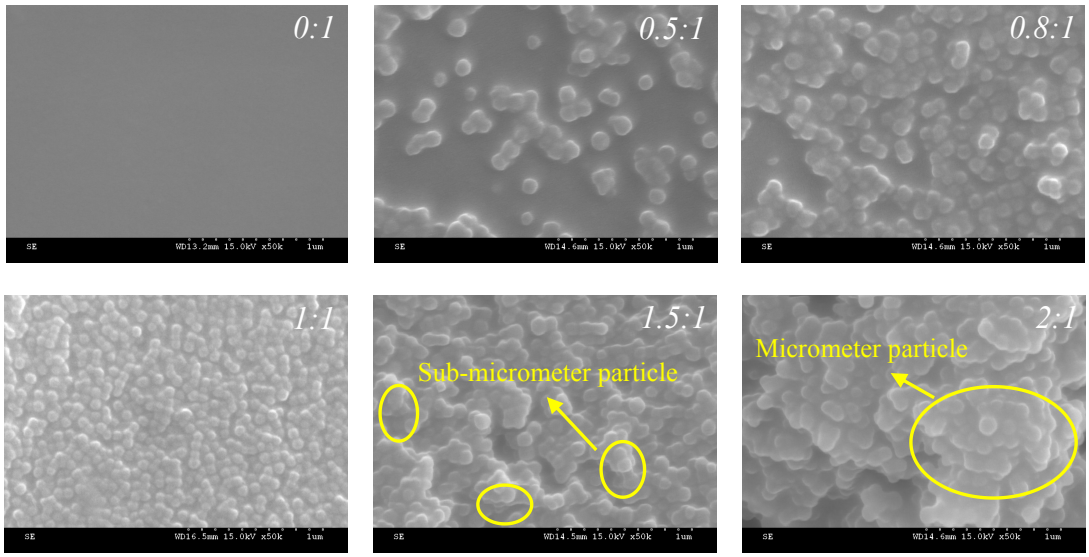

Fig. S7. Surface SEM images of suspension-dispersed ZIF-8/PDMS nanohybrid membrane with various mass ratio of ZIF-8/PDMS (upper-right corner); two layers of dipping into the ZIF-8/PDMS mixed solution (1 wt.%, PDMS), with post-treatment.

Fig. S8.

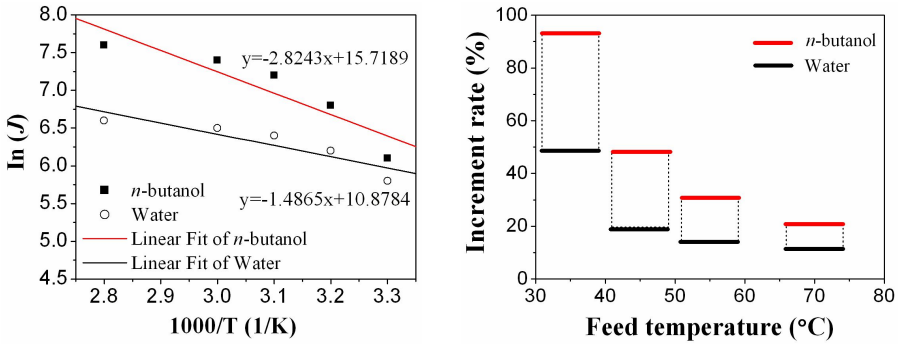

Fig. S8. Arrhenius plot showing the temperature dependence of the permeation fluxes of water and *n*-butanol at various feed concentrations (left); Effect of feed temperature on flux increment rate (right).

Table S1.

Table S1 Pervaporation performance of various butanol permselective membranes in literatures

Organophilic membrane	Selective layer thickness/μm	Feed concentration /wt.%	Feed temperature /°C	Downstream side pressure/kPa	Total flux /g m^{-2} h^{-1}	Separation factor	Reference
CMX-GF-010-D (polysiloxane)	10	1[a]	37	<0.3	330	39	[S4]
PERTHESE 500-1	125	1[a]	37	<0.3	33	56	[S4]
PDMS	65	1[a]	37	<0.13	95	34	[S5]
PERVAP-2200	2	1	37	<1	330	10	[S6]
ZIF-71–PEBA	10-20	1[a]	37	<0.4	520.2	18.8	[S7]
PDMS/ceramic composite membrane	10	1[a]	40	–	457	26	[S8]
Silicalite-filled PDMS	15	1[a]	40	0.07~0.4	134	92	[S9]
Silicalite-filled PDMS	–	1[a]	45	<0.67	250	32	[S10]
PTFE	40	1	50	–	805	10	[S11]
PVDF	10	7.5[a]	50	6.7	4126	6.4	[S12]
PDMSc	30	1.5[a]	55	0.2	670.2	43.1	[S13]
PTMSP	22	1.5[a]	70	0.27	1030	70.0	[S14]
Silicone-silicalite-1	306	1[a]	78	0.27~0.67	70	110	[S15]
Si-PDMS	0.3	1[b]	80	–	7100	32	[S16]
Si-PDMS	0.3	2[b]	80	–	8900	27.6	[S16]
ZIF-8–PMPS	2.5	1[b]	80	–	6400	40.1	[S17]
ZIF-8–PDMS	0.8	1[a]	80	<0.2	4846.2	81.6	[S18]
Suspension-dispersed ZIF-8/PDMS	1.8	1[a]	80	<0.2	1097	65.9	This work
	1.8	5[a]	80	<0.2	2800.5	52.81	This work
	1.8	5[a]	50	<0.2	1879.9	42.5	This work
	1.8	5[a]	40	<0.2	1358.8	34.2	This work

[a] *n*-Butanol aqueous solution.
[b] *i*-Butanol aqueous solution.

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