Supporting Information

Enhanced CO_2 Separation Performance of Mixed-Matrix Membranes through PIM-1 based Surface Engineering Using Non-Solvent Induced Surface Deposition

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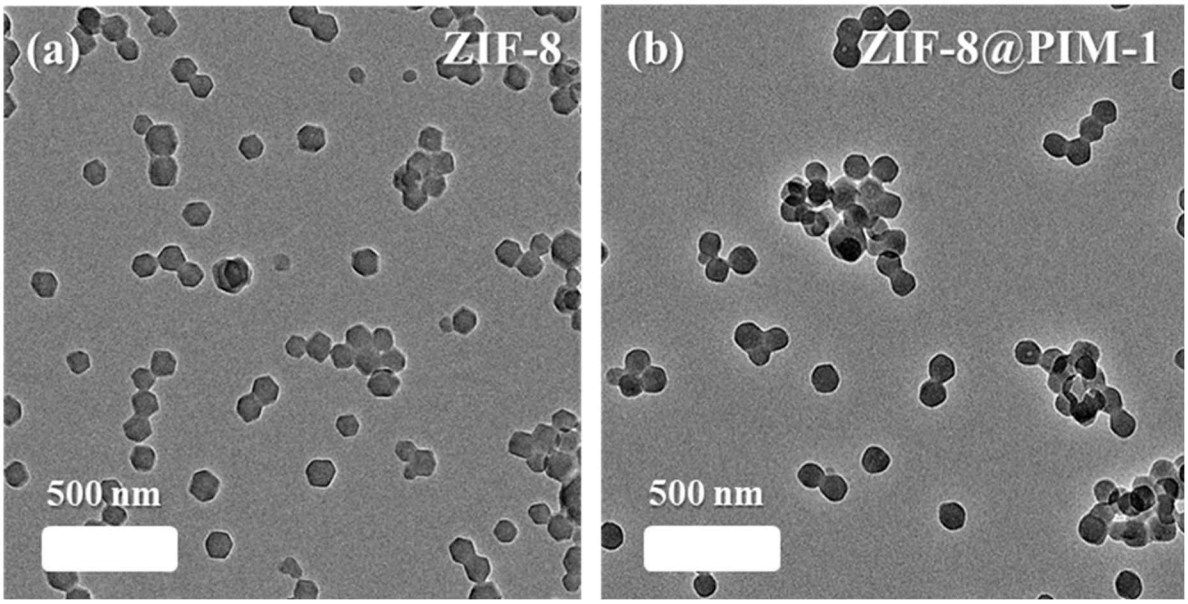

Fig. S1. TEM images of (a) ZIF-8 and (b) ZIF-8@PIM-1 particles.

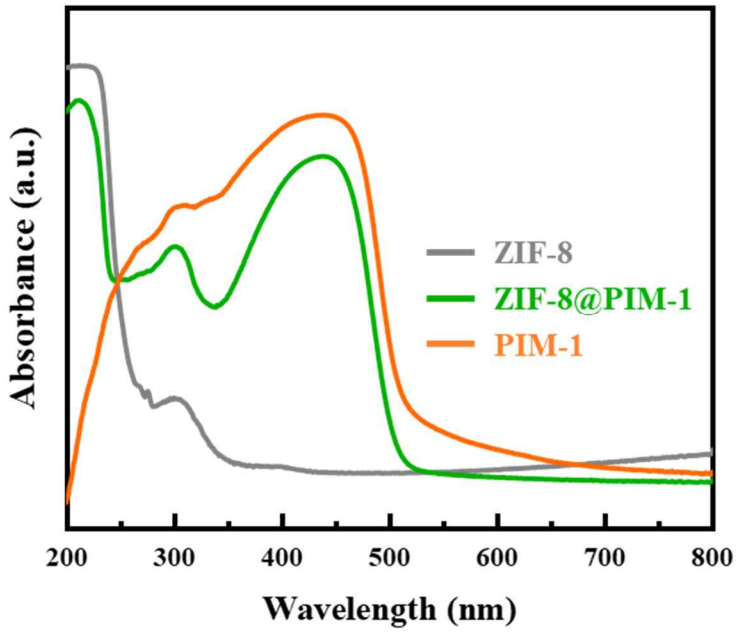

Fig. S2. UV-Vis Diffuse Reflectance Spectroscopy (DRS) of (b) ZIF-8, ZIF-8@PIM-1 particles and PIM-1 powder.

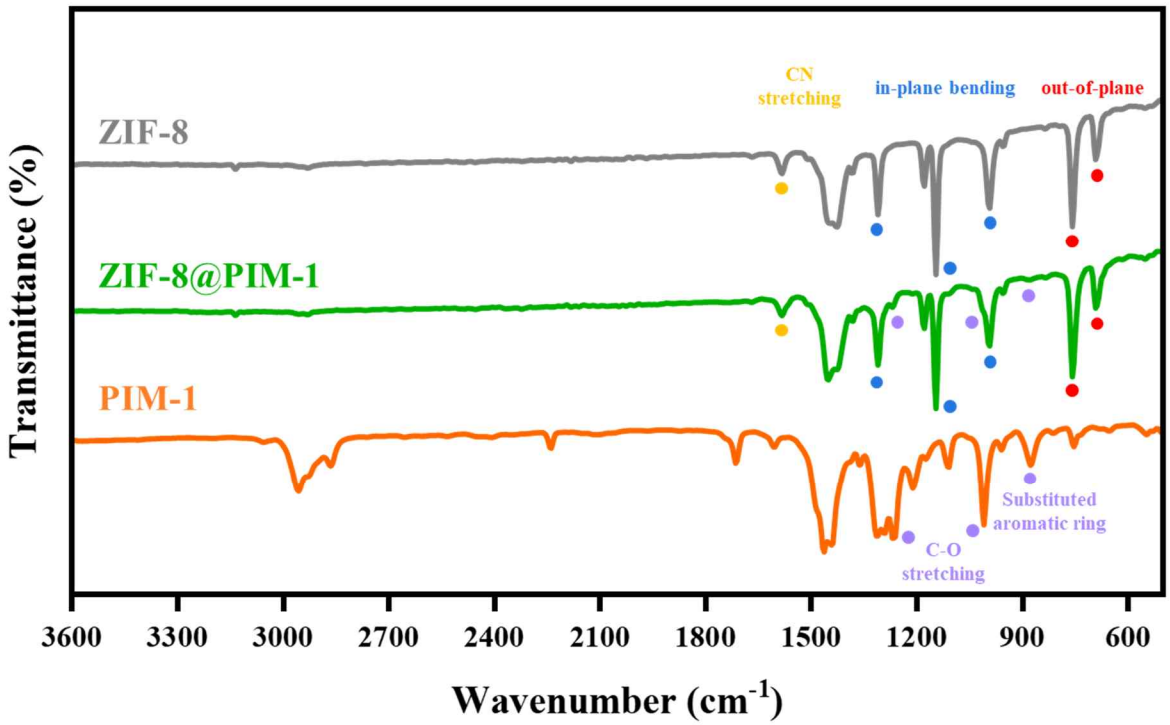

Fig. S3. ATR-Fourier transmittance infrared (FT-IR) spectroscopy for (a) ZIF-8, (b) ZIF-8@PIM-1 particles and (c) PIM-1 powder.

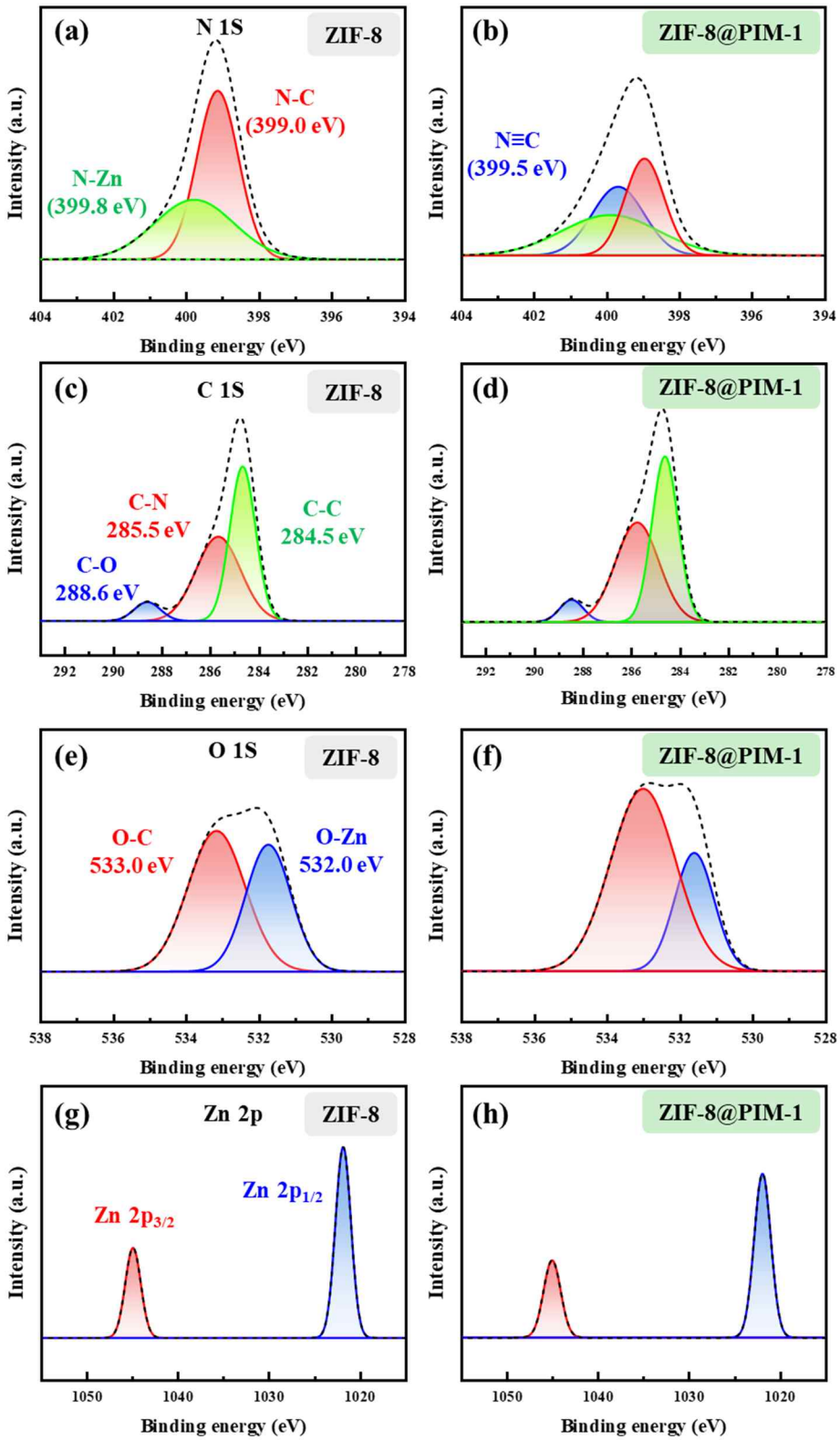

Fig. S4. High-resolution XPS spectra of (a, b) N 1s, (c, d) C 1s, (e, f) O 1s and (g, h) Zn 2p for ZIF-8 and ZIF-8@PIM-1 particle, respectively.

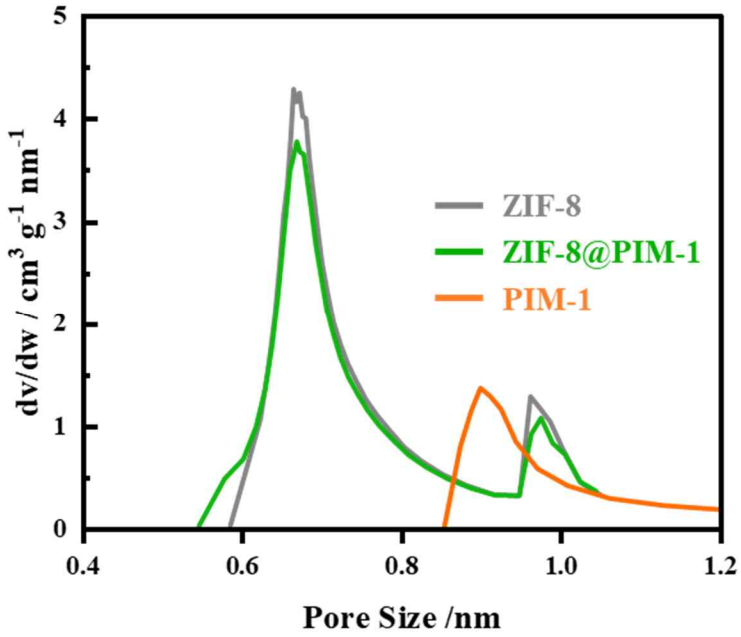

Fig. S5. Pore size distribution using the Horvath-Kawazoe method.

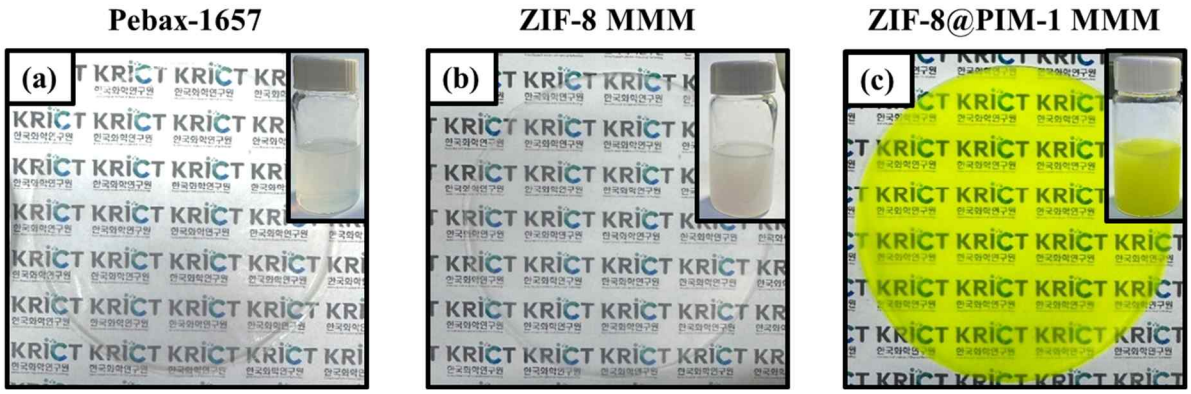

Fig. S6. Optical images of (a) Pebax-1657 membrane, (b) ZIF-8 MMMs and (c) ZIF-8@PIM-1 MMMs.

Table S1. Solubility coefficient (*S*), diffusion coefficient (*D*), solubility selectivity (α_S) and diffusivity selectivity (α_D) for Pebax-1657 based MMMs.

Membrane materials	Filler content (wt%)	*S* (cm^3 (STP)/(cm^3 material atm))		*D* ($\times 10^8$ (cm^2/s))		α_S	α_D
		CO_2	CH_4	CO_2	CH_4	CO_2/CH_4	CO_2/CH_4
Pebax-1657	0	0.98	0.10	55.06	35.72	9.8	1.5
ZIF-8 MMMs	5	1.09	0.15	52.84	25.83	7.1	2.1
	10	1.18	0.19	52.16	22.40	6.2	2.3
	15	1.21	0.27	56.52	18.30	4.5	3.1
	20	1.29	0.31	62.45	21.82	4.2	2.9
ZIF-8@PIM-1 MMMs	5	1.04	0.12	53.34	30.15	8.6	2.1
	10	1.24	0.23	49.64	17.18	5.4	2.3
	15	1.25	0.31	55.93	12.99	4.0	3.1
	20	1.35	0.35	59.67	11.86	3.8	2.9

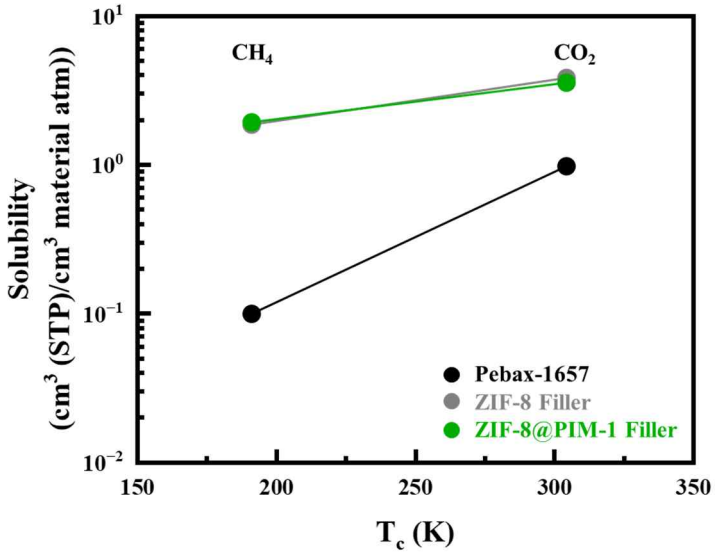

Fig. S7. CO_2 and CH_4 solubility coefficients as a function of penetrant critical temperature (T_c) for Pebax-1657 membrane, ZIF-8 filler and ZIF-8@PIM-1 Filler at 3 atm and 35 °C.

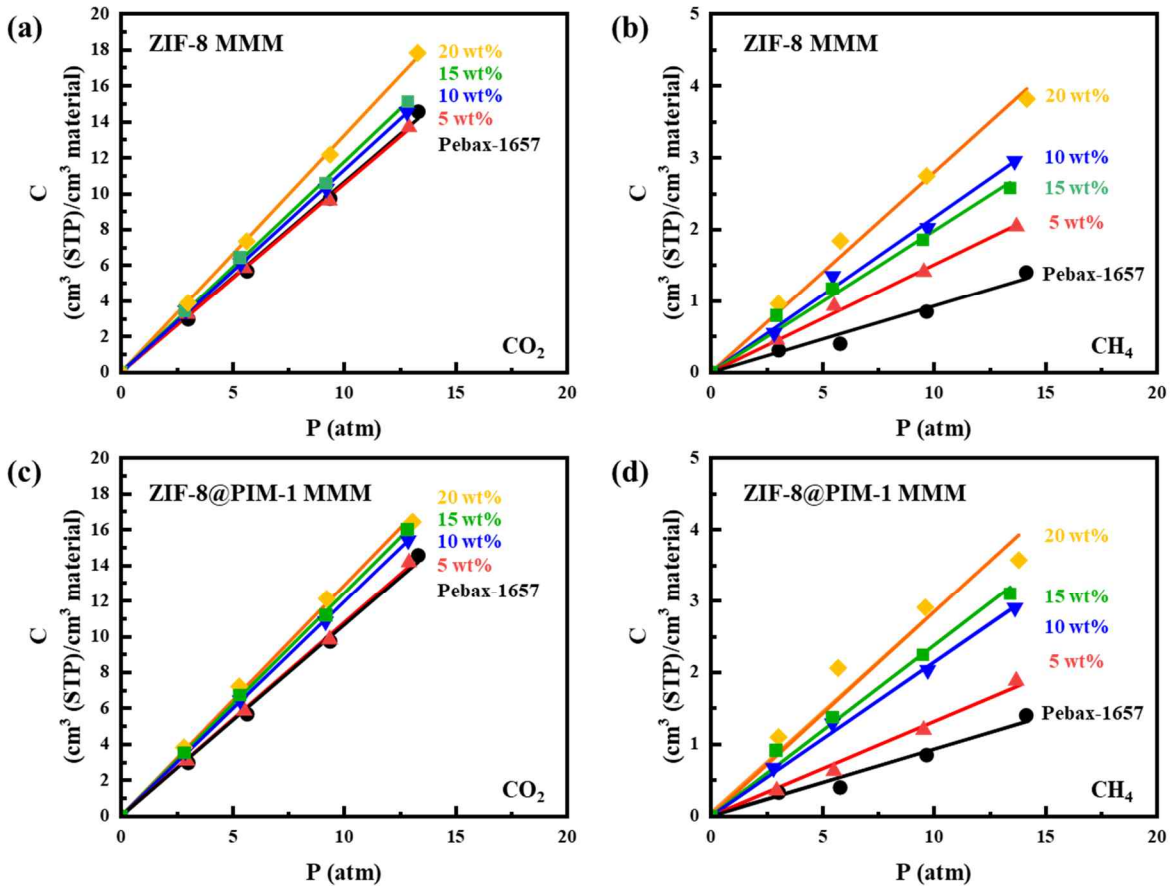

Fig. S8. Sorption isotherms at 35 °C of (a) CO_2 and (b) CH_4 for ZIF-8 MMMs and (c) CO_2 and (d) CH_4 for ZIF-8@PIM-1 MMMs.