membranes

Supplementary Material

Modified Graphene Oxide-Incorporated Thin-Film Composite Hollow Fiber Membranes through Interface Polymerization on Hydrophilic Substrate for CO_2 Separation

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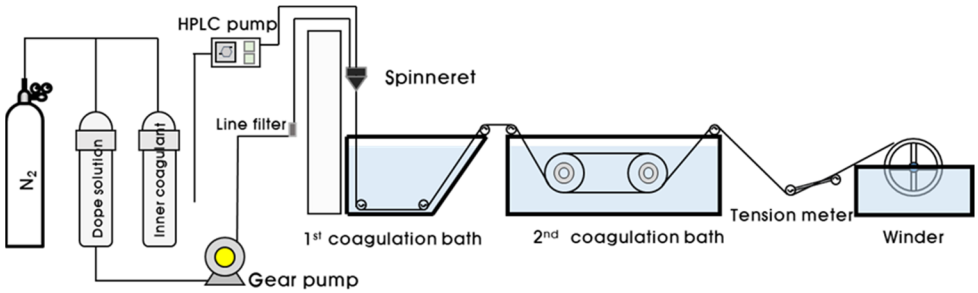

Figure S1. Schematic diagram of hollow fiber spinning process.

Permeate gas flux measurement

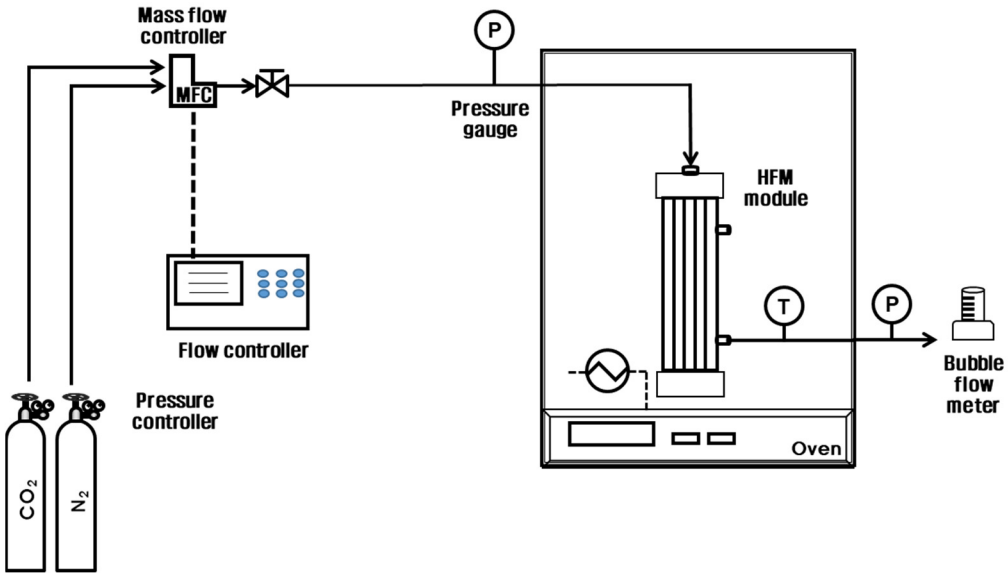

Figure S2. Schematic diagram of gas permeation experiment apparatus.

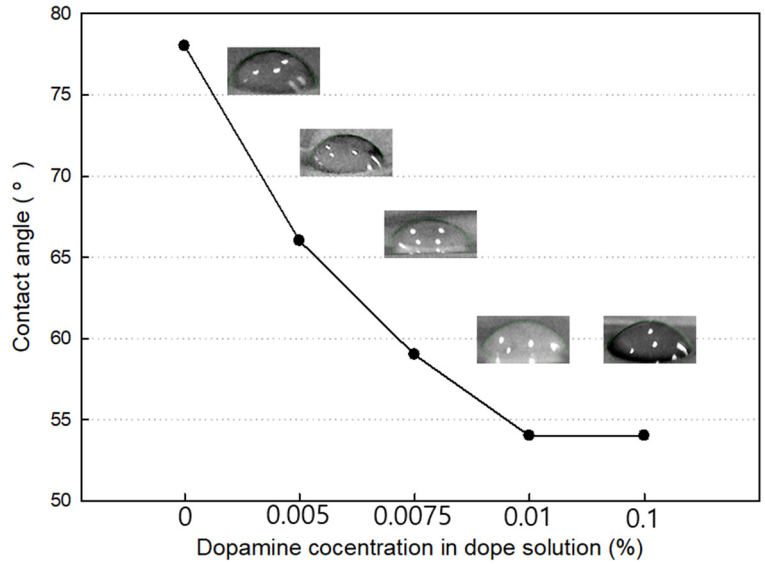

Figure S1. Effect of dopamine concentrations on contact angle changes.

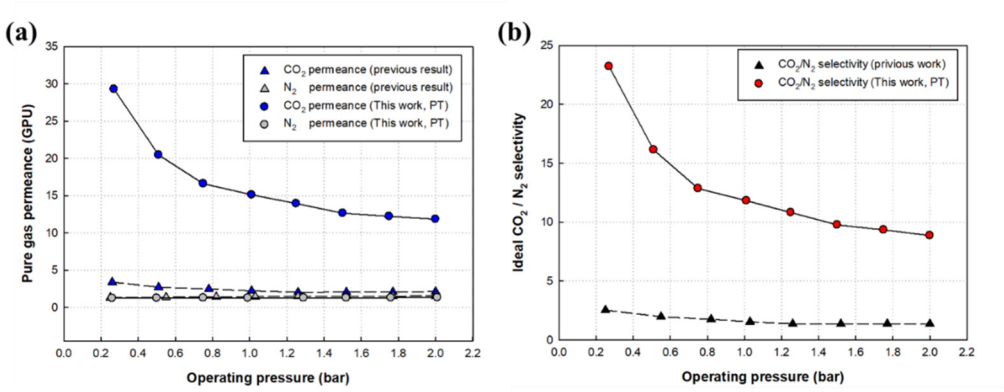

Figure S4. Comparison between previous work results and this work against gas permeance and ideal gas selectivity, showing the effect of SDS on the TFN composite membrane.

Hollow fiber membrane surface interfacial energy

The surface characteristics of hollow fiber membranes were examined by measuring the surface interfacial energy. The interfacial energy was determined based on the AFM results and contact angle test results on the membrane surface using the Young-Dupre equation below, and the results are presented in Table S1.

$$-\Delta G_{SL} = \gamma_L [1+\cos\theta/\Delta]$$

Here, γL is the liquid surface tension (D.I water: γ_L = 72.4 mJ/m²), θ is the contact angle, and Δ is the relative surface area (Δ = the actual surface area divided by the planar area (3 × 3, from AFM analysis) [S1].

Table S1. Surface roughness and contact angle measurement of TFC hollow fiber membranes.

Membrane	R_q (nm)	R_a (nm)	Contact angle (°)	Relative surface area (Δ)	$-\Delta G_{SL}$ (mJ/m²)
PT	1.77	1.44	44.2±1.5	1.005	124.0
PTS 0.1	1.98	1.53	42.5±0.5	1.006	125.5
PTS 0.3	3.81	2.96	37.3±1.2	1.010	129.4
PTS 0.5	4.36	3.52	33.1±1.1	1.011	132.4

R_a = average surface roughness, R_q = root mean square surface roughness, −ΔGSL = solid-liquid interfacial free energy.

Table S2. Summary of CO2 permeance and CO2/N2 selectivity MMMs membranes results.

Type	Polymer (membrane type, operating pressure)	Permeance Of CO_2 (GPU)	CO_2/N_2 Selectivity (-)	Ref.

NH_2-SiO_2 (Silica)	PEBAX 1657 (flat sheet, 5 bar)	119	25.85	[S2]
ETS-4 (Tit.silicate)	PES (HFM, 0.25 bar)	17	33	[S3]
PDA-ZIP-8 (Zeolite)	PVAm (flat sheet)	297	83	[S4]
APTMS-MIL-53 (MOF)	Ultem (flat sheet, 5 bar)	17.8	41.8	[S5]
Cu-MOF2 (MOF)	Polyozazoline (flat sheet)	3	55	[S6]
UIO-66-NH_2 (MOF)	Pebax-1657 (flat sheet)	338	57	[S7]
MIL-53+NHCOH (MOF)	Pebax-1657 (flat sheet, 2 bar)	4.6	65.02	[S8]
CuBDC (MOF)	Polyactive (flat sheet , 2 bar)	3.3	66	[S9]
Amin-GO (GO)	PES (flat sheet, 2 bar)	13.26	37.88	[S10]
GO (GO)	PSf (5bar)	65.24	17.26	[S11]
PGO (GO)	PES-PEG-Dopa	73	60	This work
β-CD-MWCNT (CNT)	CA (flat sheet, 3 bar)	400.93	32.92	[S12]
f-MWCNT (CNT)	PES (HFM, 0.25 bar)	21	27.35	[S13]

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