Supplementary data:

Recent progress on Pebax-based thin film nanocomposite membranes for CO_2 capture: the state of the art and future outlooks

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Table S1- Comparison of this contribution with other published review articles

Year	Field	Topic reviewed	Ref.
2015	aqueous media-based separation processes	TFN membranes in different separation processes (*e.g.*, reverse osmosis (RO), forward osmosis, and nanofiltration), challenges of TFN membrane fabrication, and possible approaches to overcome TFN fabrication problems	1
2015	water desalination process	recent developments in TFC membrane for desalination, substrates, monomers for thin film, and organometallic compounds as additives	2
2016	CO_2 separation	IP method for TFC/TFN preparation, enhancing TFN performance through parameter manipulation (*i.e.*, nanoparticle modification, monomer, solvent, support properties, preparation conditions, etc.)	3
2016	CO_2 separation	composite membrane structure, fabrication of multi-layer composite membranes, CO_2 separation applications, and TFC/TFN membrane challenges	4
2017	CO_2 separation	development of polyactive-based TFC membrane for CO_2/N_2 separation	5

2019	CO_2 separation	diverse techniques for synthesis of TFC/TFN membranes	6
2019	CO_2 separation	continuous assembly of polymers (CAP) technology for the selective layer preparation, additives, optimization of the gutter layer	7
2019	CO_2 separation	preparation methods of polymeric TFC membranes	8
2019	gas separation and energy production	fabrication of composite membranes, theory of gas transport through composite membrane, and TFC/TFN membrane challenges	9
2020	water separation	progress of IP approach for fabrication of PI TFC/TFN membrane	10
2020	desalination and water reuse	TFN for RO, incorporation of non-porous and porous nanoparticles	11
2020	water treatment	thermally stable TFC for hot water treatment	12
2020	CO_2 separation	gas transport mechanisms, materials used as the selective layer (polymers and microporous inorganic membranes), and challenges of membranes	13
2020	gas separation	fabrication methods of ultrathin organic/inorganic membranes	14
2020	desalination and water reuse	TFN membranes with interlayered structure (TFNI), materials, and preparation techniques for TFNI membranes	15
2021	alcohol dehydration	the recent progress of polymeric membranes in pervaporation, nanomaterials in film synthesis, and influencing factors in experimental design	16
2021	gas separation and water treatment	evolution of nanofillers for TFN membranes, criteria of nanofillers for TFN membrane separation, TFN membrane applications (gas and liquid separation)	17
2022	post-combustion CO_2 capture	various materials (polymers, inorganics, and carbon materials) for the preparation of TFC membranes, and TFC/TFN membrane challenges	18
-	CO_2 separation	the fundamentals of MMMs, challenges of MMMs preparation, methods to improve the interfacial morphology, the basic concept of TFC/TFN membranes, Pebax-based TFC/TFN membranes for CO_2 separation, comprehensive study of fillers' effect on the performance of Pebax-based TFN membranes	This work

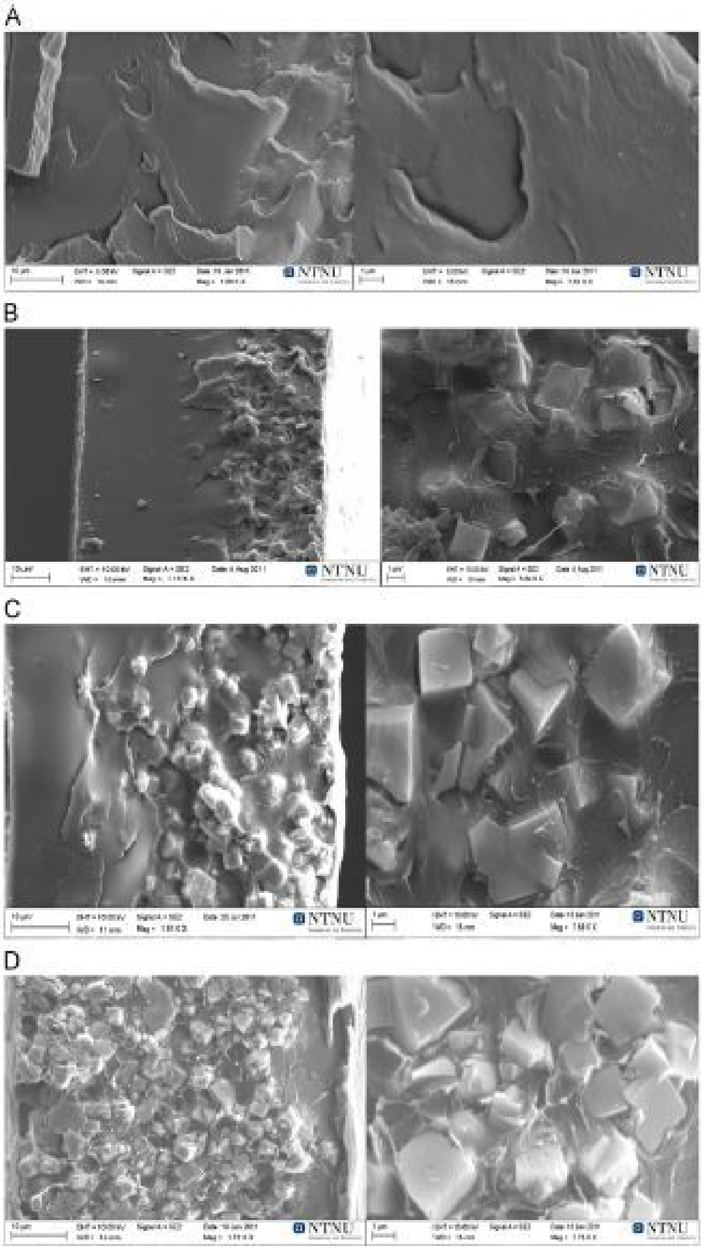

Figure S1. SEM images of the cross-section of (A) neat PVAc, (B) PVA/15 wt.% 4A, (C) PVA/25 wt.% 4A, and (D) PVA/35 wt.% 4A. Reproduced with permission from ref. 19. Copyright 2013 Elsevier.

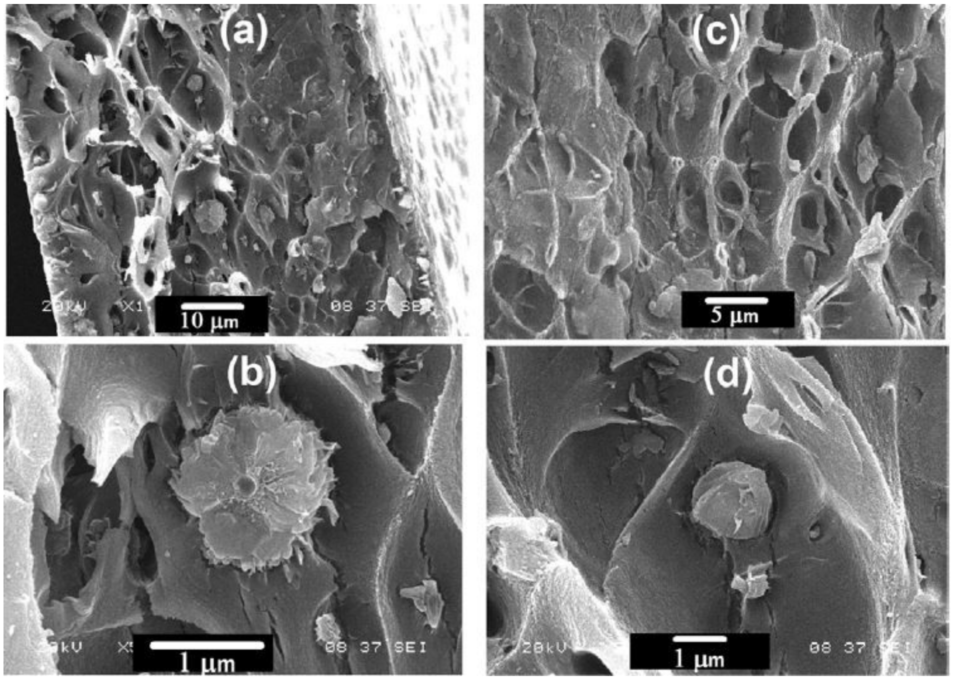

Figure S2. Cross-section images for MMMs prepared by method A using PIM-1 with 20 wt.% of: (a, b) UiO-66-NH_2 and (c, d) UiO-66-F12 h. Reproduced with permission from ref. 20. Copyright 2018 Elsevier.

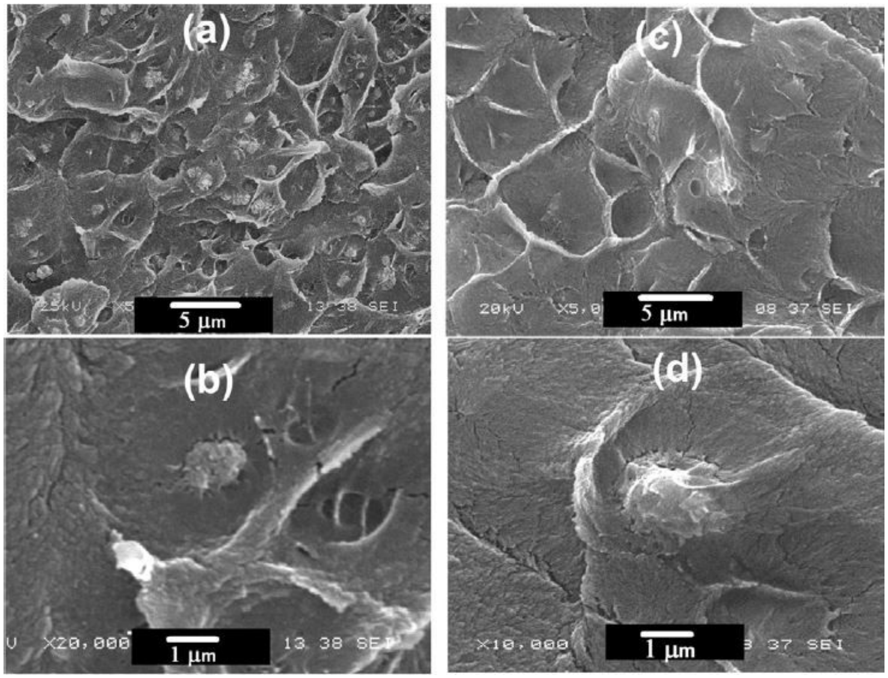

Figure S3. Cross-section images of MMMs prepared by method B where PIM-1 was synthesized in the presence of UiO-66-NH_2 filler. The polymerization time varied from (a, b) 12 h to (c, d) 72 h. Reproduced with permission from ref. 20. Copyright 2018 Elsevier.

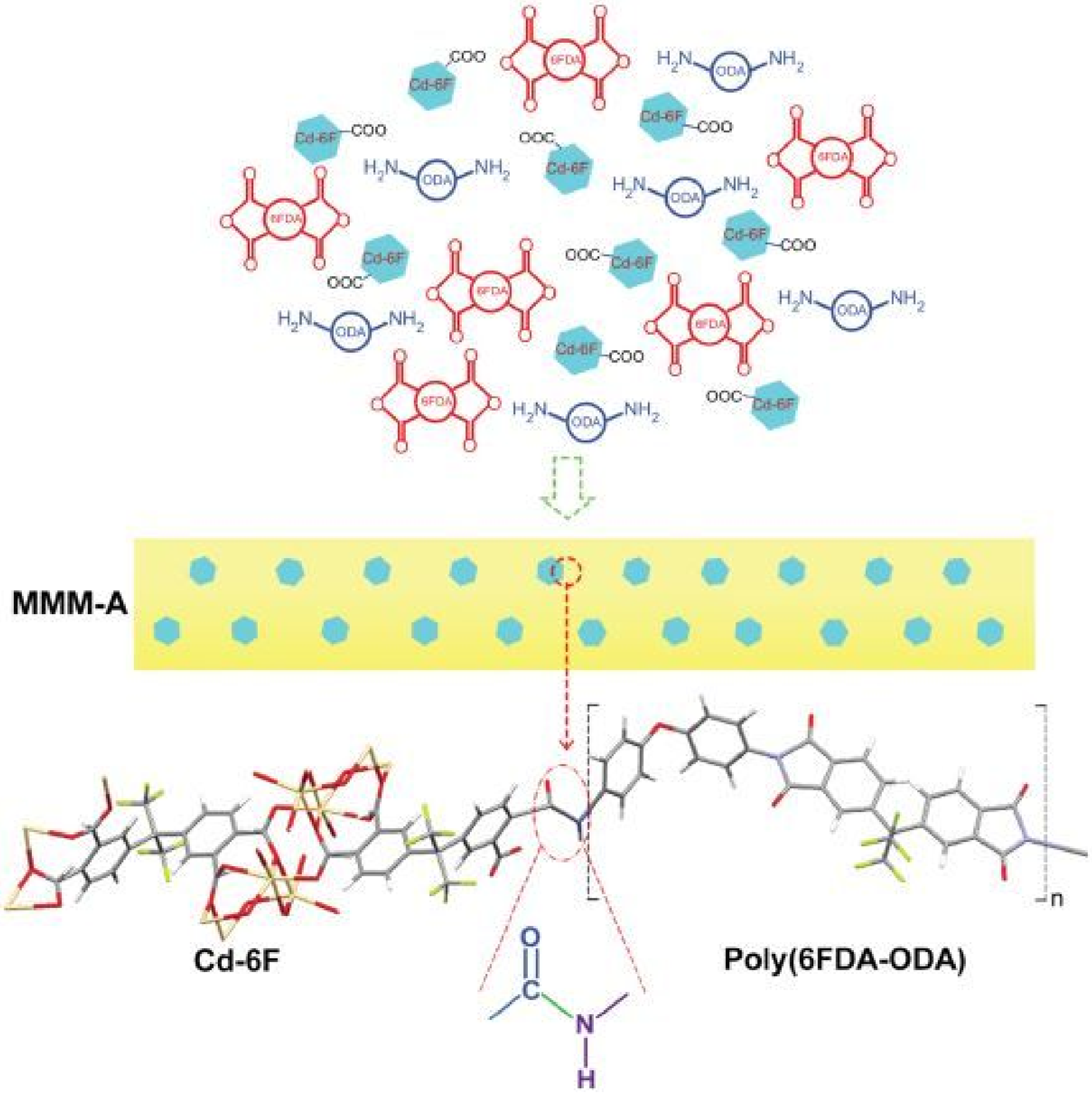

Figure S4. The possible interaction between Cd-6F and 6FDA-ODA in MMM-A. Reproduced with permission from ref. 21. Copyright 2014 American Chemical Society.

Table S2. Separation performance of 6FDA–6FpDA–DABA-25 hybrid membranes.[22]

Sample	P_{CO2} *(Barrer)*	$\alpha_{CO2/CH4}$	$\alpha_{CO2/N2}$
before annealing			
neat PI	20.3	44.13	16.92
PI/TMOS 22.5 wt.%	15.7	32.71	14.81
PI/TMOS 15%	0	0	0
PI/MTMOS 22.5%	16.6	31.92	15.51
PI/MTMOS 15%	22.8	36.19	17.28
PI/PTMOS 22.5%	19.1	35.37	19.49
PI/PTMOS 15%	18.4	35.38	19.57
after annealing			
neat PI	77.3	31.55	15.94
PI/TMOS 22.5 wt.%	79.8	37.12	16.39
PI/TMOS 15%	0	0	0
PI/MTMOS 22.5%	60.1	35.77	15.69
PI/MTMOS 15%	81.1	42.02	16
PI/PTMOS 22.5%	94.4	24.91	18.12
PI/PTMOS 15%	104	28.03	16.64

membranes contained 12.5 and 25.0 mol.% DABA. Here we just reported the 6FDA–6FpDA–DABA-25.

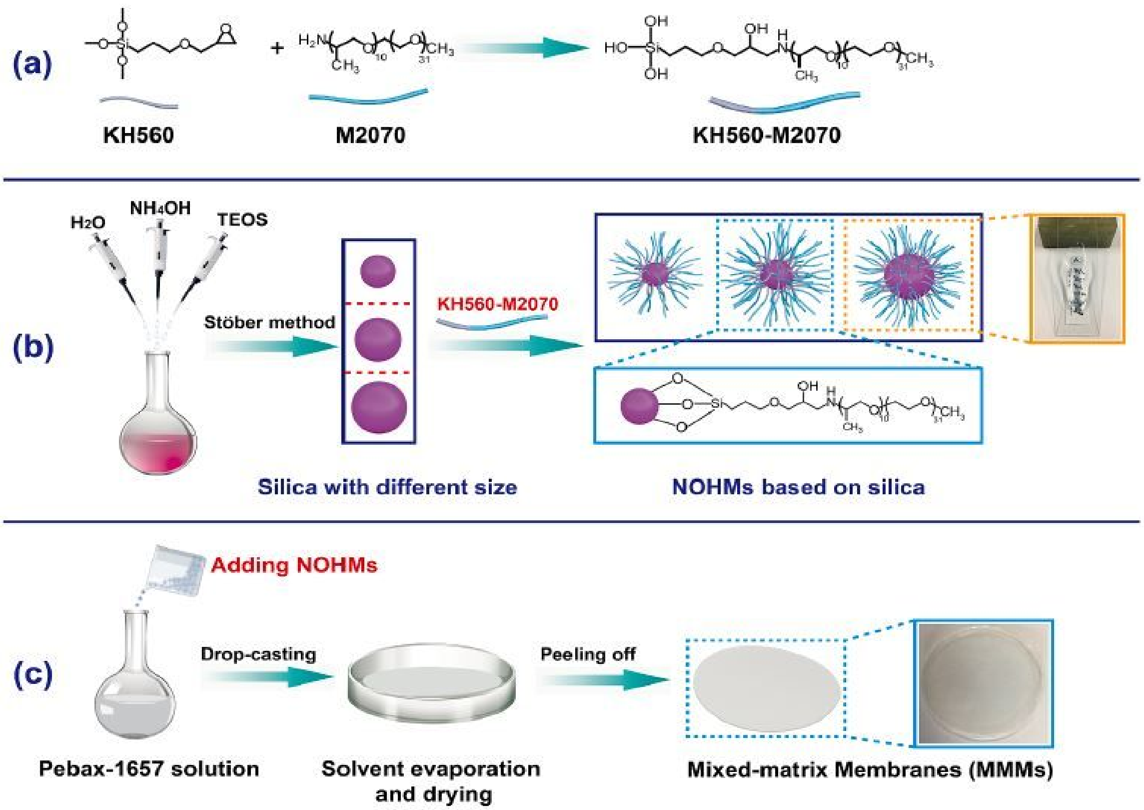

Figure S5. Schematic illustration of NOHMs and MMMs synthesis. KH560: γ-(2,3-epoxypropoxy) propytrimethoxysilane, TEOS: Tetraethyl orthosilicate, M2070: Jeffamine polyetheramine. Reproduced with permission from ref. 23. Copyright 2020 Elsevier.

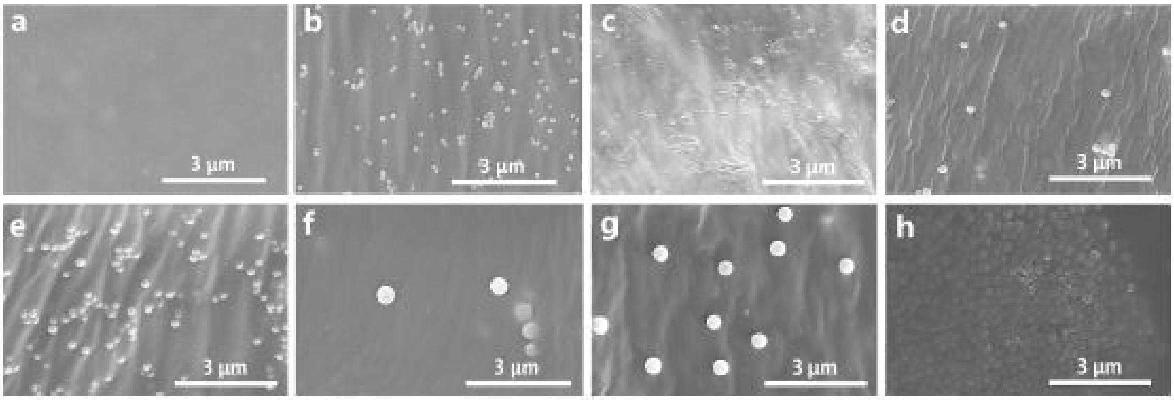

Figure S6. Cross-sectional morphology of membranes: (a) pure Pebax membrane, (b) P-NOHMs-120-(5), (c) P-NOHMs-120-(15), (d) P-NOHMs-220-(5), (e) P-NOHMs-220-(15), (f) P-NOHMs-380-(5), P-NOHMs-380-(15) and (h) P-SiO2-220-(5). Reproduced with permission from ref. 23. Copyright 2020 Elsevier.

Table S2- Synthesis and features of grafted star polymers.[24]

Polymer (PXPEG/PDMS)	Initiator	Molar ratio [a]	
		PEG	PDMS
P0$_{\mathbf{24/0}}$	I	24:1	–
P1$_{\mathbf{0/9}}$	I	–	10:1
P1$_{\mathbf{0/27}}$	I	–	30:1
P2$_{\mathbf{24/10}}$	P1$_{0/9}$	24:1	–
P2$_{\mathbf{72/10}}$	P1$_{0/9}$	72:1	–
P2$_{\mathbf{24/30}}$	P1$_{0/27}$	24:1	–

[a] Molar ratio as [macromonomer]: [initiator/macroinitator].

I is the tetra-functional ATRP initiator composed of pentaerythritol, triethylamine (TEA), and 2-bromoiso-butyryl bromide (BIBB) dissolved in anhydrous THF.

P0 was synthesized from N,N,N',N'',N''-pentamethyldiethylenetriamine (PMDETA), and Poly(ethylene glycol) methyl ether methacrylate (MeOPEG-MA) dissolved in anhydrous t-butanol (t-BuOH).

P1 was synthesized from PMDETA and monomethacryloxypropyl terminated poly(dimethylsiloxane) (PDMS-MA) dissolved in t-BuOH.

P2 was synthesized from P1$_{0/9}$, PMDETA, and MeOPEG-MA dissolved in t-BuOH.

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