Supporting information

Recent progress on membranes for CO_2 separation

*Yuheng Fan[a], Weichu Yu[*a, b], Aibin Wu[a], Wenming Shu[a], Ying Zhang[a]*

[a] College of Chemistry & Environmental Engineering, Yangtze University, Jingzhou, Hubei 434023, P. R. China

[b] Hubei Engineering Research Centers for Clean Production and Pollution Control of Oil and Gas Fields, Jingzhou, Hubei 434023, P. R. China

[*]Corresponding author email: yuweichu@126.com

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

Year	Field	Topic reviewed
2014[1]	CO_2 separation	research progress on metal organic framework membranes, the advantages of using MOFs in mixed matrix membranes and improvements in gas separation performances
2016[2]	CO_2 separation	various composite membrane preparation methods, advances in composite membranes for CO_2/CH_4 separation
2017[3]	gas separation	the performance and issues of various materials based hollow fiber mixed matrix membranes (HFMMMs) for CO_2/CH_4 and CO_2/N_2 separation
2018[4]	CO_2 separation	advances in the preparation, separation performance, and separation mechanism of supported IL membranes (SILMs), pure poly (ionic liquid) (PIL) membranes, PIL–

		copolymer membranes, PIL–IL composite membranes and polymer–IL composite membranes for CO_2 separation
2019[5]	CO_2 separation	developments and advances of ionic liquids-based membranes for CO_2 separations in recent three years, with an emphasis on the strategy of incorporating ionic liquids and CO_2 separation performance
2020[6]	CO_2 separation	recent progress on thin film composite membranes, exploration of CO_2 separation membrane in pilot-scale are presented
2020[7]	separation applications in aqueous medium	review the recent development of CO_2-switchablemembranes in aqueous medium in separation fields, challenges of CO_2-switchable membranes
2021[8]	CO_2 separation	recent trends and emerging perspectives of ionic liquid membranes for CO_2 separation
2021[9]	CO_2 separation	the recent developments in terms of both Pebax-based thin film composite and mixed matrix membranes, thermal and water stabilities of these membranes
2022[10]	gas separation	development of amine-functionalized metal-organic frameworks hollow fiber mixed matrix membranes
2022[11]	CO_2 separation	the types of natural polysaccharides that are used in membrane processes for CO_2 separation, effect of the functionalization of polysaccharides on CO_2 separation performance
2022[12]	CO_2 capture	the advancement in TFC/TFN membranes for CO_2 sequestration, factors influencing TFC membranes
2022[13]	CO_2 separation	membrane fabrication methods, mechanisms, and modification of membranes for CO_2 separation
2023[14]	CO_2 separation	different types of PIL-based membranes for CO_2 separation (neat PIL membranes; PIL-IL composite membranes; PIL-polymer blend membranes; PIL-based block copolymer membranes, and PIL-based mixed matrix membranes)
2023[15]	CO_2 separation	the advancement of these mixed matrix hollow fiber composite membranes (MM-HFCMs) for practical CO_2 separations

2023[16]	CO_2 separation	preparation approaches of COF-based membranes, advances of COF-based membranes in separating various CO_2 mixed gases
2023[17]	CO_2 separation	facilitated transport theories derived from π-complexation reactions, polymer electrolyte membranes and mixed matrix membranes as two strategies for fabricating CO_2-facilitated transport membranes
This work	CO_2 separation	the progress in membrane separation mechanisms, the development of membrane materials, such as inorganic, polymer, and new membrane materials, the future development direction of carbon dioxide separation membrane materials

Table S2. Gas separation performance of different membrane in earlier works

type	membrane	T (°C)	P(atm)	CO_2 permeability (Barrer)	CO_2 /gas selectivity		
					N_2	H_2	CH_4
Silica membrane	10%Co-SiO_2 membrane[18]	300	0.99	-	-	6.61	-
	10%Ni-SiO_2 membrane[19]	50	1.00	6.4	-	-	2.43
	0.04C-(0.9A-151) SiO_2 membrane[20]	75	0.20	13.4	-	-	2.27
	trifluoropropyl-SiO_2 membrane[21]	300	0.99	-	-	6.93	-
	heptadecafluorodecyl modified SiO_2 membrane[22]	300	1.00	-	-	13.30	-
Zeolite membrane	DDR-type membrane[23]	25	1.97	30	-	-	200
	Zeolite T membrane[24]	35	0.99	46	-	-	400
	chabazite membrane[25]	20	0.19	27	4.05	-	-

	OSDA-free CHA membrane[26]	75	1.00	100	12.5	-	-
	Si-CHA membrane[27]	25	0.99	400	-	-	130
	Si-CHA membrane[28]	25	1.97	120	-	-	480
	All-silica CHA Nanocrystals membrane[29]	30	8.88	780	-	-	32
	Zeolite Y membrane[30]	30	1.36	9.6	503	-	-
	GO layered membrane[31]	25	0.99	8500	20	-	-
	ultra-thin GO membrane[32]	20	1	-	-	-	-
	GO nanosheets membrane[33]	25	1.00	-	-	240	-
Graphene membrane	Graphene oxide doped ionic liquid membrane[34]	25	1	37	130	-	-
	Graphene mixed matrix membrane[35]	25	0.99	1327	86.4	-	72.2
	GO / PEBA membrane[36]	25	2.96	97	86	-	-
	GO mixed matrix membrane[37]	25	1.97	840	-	-	-
	γ- Al_2O_3 composite membranes[38]	25	2.96	28.56	2.4		
	AlOOH/Al_2O_3 porous ceramics membrane[39]	79	0.39	-	0.8		
Alumina-based ceramic membrane	α-alumina ceramic tube supported cellulose triacetate-tributyl phosphate membrane[40]	30	1.97	4248	0.84		
	Industrial alumina based ceramic substrate amino silicate membrane[41]	80	0.79	599	12.5		
	cellulose acetate separation membrane[42]	25	4.93	520	-	-	12
	cellulose membrane[43]	25	5	120	50	15	30
Cellulose membrane	cellulose/NMMO/water membrane[44]	25	4.93	750	45	16	30
	cellulose nanofiber membrane[45]	35	0.99	13	35	-	20
	cellulose triacetate membranes[46]	35	0.99	7.2	-	-	28
	ethyl cellulose homogeneous membrane[47]	30	0.99	-	33	-	-
	modified polyimide membrane[48]	25	0.99	8.06	-	-	51
	6FDA-type polyimide membrane[49]	35	1	65	30	-	-
Polyimide membrane	polyimide framework membrane[50]	30	3	57.25	54.52	-	-
	polyimide membrane[51]	35	2	1858	17.2	-	18.9
	9FDA polyamide membrane[52]	25	1	12.26	26.65	-	22.7

Polysulfone membrane	polyimide membrane[53]	25	1	1.19	-	-	11.9
	polyimide membrane[54]	35	4.42	150.5	-	-	27.5
	polysulfone membrane[55]	25	1	12.73	-	-	28.9
	PSF/PDMS membrane[56]	55	1	73.7	-	-	4.2
	PI/PSF membrane[57]	35	4.93	20	-	-	42
	PSF/PES membrane[58]	25	5.92	22.5	-	-	6.5
	mixed matrix membrane[59]	25	0.99	975	1.94	-	-
	PAF-56P/PSF membrane[60]	25	1	141	38.9	-	-
	F127/PIL membrane[61]	30	1.18	155.59	24.16	-	-
	PSF/PDMS/Pebax1074 membrane[62]	25	2.96	424	41.3	13.5	11.4
Polyether membrane	polyether copolyamides membrane[63]	25	1.97	100	50	-	-
	PEG/ Pebax1657 membrane[64]	30	0.59	151	47	10.8	15.5
	PEG/ Pebax1657/ PDMS membrane[65]	35	3.95	532	36.1	10.6	10.8
	polyether membrane[66]	35	0.99	131.61	30.12	-	17.03
	improved mixed-matrix membrane[67]	35	2.96	1663	14.8	-	16.9
Composite membrane	NH_2-MIL-53(Al)/CA mixed matrix membrane[68]	25	2.96	52.6	23.4	-	28.7
	PI/UiO-66-PEI-pSBMA membrane[69]	35	0.99	28	-	-	56
	TB/NH_2-MIL-53(Al) mixed matrix membrane[70]	35	3.95	308	25.4	-	23.6
	composite membrane[71]	30	0.99	17.33	30.58	-	-
MOF membrane	MOF-1 membrane[72]	25	4.98	255	410	-	328
	CO_2-selective metal-organic framework membranes[73]	30	2.96	500	42	-	95
	ZIF-62 polycrystalline MOF membrane[74]	25	0.99	2602	34.5	-	36.6
	COF-TpPa-1/ZIF-9 membrane[75]	25	1.58	551	-	-	-
ZIF membrane	ZIF-7-NH_2 membrane[76]	25	0.99	60	-	19	-
	ZIF-9 membrane[77]	25	0.99	52.3	-	21.5	-
	hybrid metal ZIF membrane[78]	55	0.99	54	-	14.1	-
	ZIF-8@CNF membrane[79]	25	2.96	550	45.	-	36.2

	ZIF-8 membrane[80]	35	0.99	-	5 -	11 .3	-
	6F-DABA-75-CM576 membrane[81]	35	3.95	3573	-	-	51.5
	CMS-600 membrane[82]	30	1.08	15060	26. 8	-	28.5
CMS membrane	PI100-600 membrane[83]	35	2	503	31	-	56.5
	polysilsesquioxane CMS membrane[84]	35	1	354	-	-	56
	CMS70/PCF membrane[85]	35	2	14	-	-	101
	multi-layer asymmetric CMS membrane[86]	35	1	310	-	-	58.8
	cPIM-1/ PPN2 membrane[87]	25	1.97	11511	24. 3	-	22.2
	GO-POSS72 membrane[88]	25	0.99	12000	20. 6	-	12
PIM membrane	PIM-1/GO mixed matrix membrane[89]	30	3.95	6169	123 .5	-	-
	PIM-PEG/PPG membrane[90]	30	1.97	1552.6	29. 3	-	16.7
	monoesterified PIM membrane[91]	35	1.97	7421	19. 2	-	11.5
	pSBMA membrane[92]	35	1.97	104	-	-	82
	macromolecule PETEDA membrane[93]	27	1.89	81.4	-	-	52
Facilitated transport membrane	poly (amidoamine) dendrimer-containing polymeric membrane[94]	57	1	975	140	-	-
	thin composite membrane[95]	35	1.68	652	41	-	-
	CO_2 facilitated transfer membrane[96]	30	4.93	98	70	-	-
	poly(N-vinylimidazole)–zinc[97] membrane	30	0.99	1000	83	-	-

References

1. S. R. Venna and M. A. Carreon, *Chemical Engineering Science*, 2014, **124**, 3-19.
2. Z. Dai, L. Ansaloni and L. Deng, *Green Energy & Environment*, 2016, **1**, 102-128.
3. M. Mubashir, Y. Y. Fong, C. T. Leng and L. K. Keong, *Chemical Engineering & Technology*, 2017, **41**, 235-252.
4. H. Gao, L. Bai, J. Han, B. Yang, S. Zhang and X. Zhang, *Chem Commun (Camb)*, 2018, **54**, 12671-12685.
5. S. Xiong, D. Yin, M. U. Javaid, L. Li, C. Pan, J. Tang and G. Yu, *Israel Journal of Chemistry*, 2019, **59**, 824-831.
6. C. Ma, M. Wang, Z. Wang, M. Gao and J. Wang, *Journal of CO2 Utilization*, 2020, **42**.
7. L. Dong and Y. Zhao, *Journal of Materials Chemistry A*, 2020, **8**, 16738-16746.
8. N. H. Solangi, A. Anjum, F. A. Tanjung, S. A. Mazari and N. M. Mubarak, *Journal of Environmental Chemical Engineering*, 2021, **9**.
9. A. S. Embaye, L. Martínez-Izquierdo, M. Malankowska, C. Téllez and J. Coronas, *Energy & Fuels*, 2021, **35**, 17085-17102.
10. N. Sunder, Y. Y. Fong, M. A. Bustam and N. H. Suhaimi, *Polymers (Basel)*, 2022, **14**.
11. F. Seidi, A. Arabi Shamsabadi, A. Ebadi Amooghin, M. R. Saeb, H. Xiao, Y. Jin and M. Rezakazemi, *Environmental Chemistry Letters*, 2022, **20**, 1083-1128.
12. M. H. Nematollahi, P. J. Carvalho, J. A. P. Coutinho and R. Abedini, *Energy & Fuels*, 2022, **36**, 12367-12428.
13. Linggaoa Shi, Li Sze Lai, Wee Horng Tay and Swee Pin Yeap, *ChemBioEng Reviews*, 2022, **9**, 556-573.
14. G. Bernardo and H. Gaspar, *Polymers (Basel)*, 2023, **15**.
15. F. Pazani, M. Shariatifar, M. Salehi Maleh, T. Alebrahim and H. Lin, *Separation and Purification Technology*, 2023, **308**.
16. B. Chen, H. Xie, L. Shen, Y. Xu, M. Zhang, M. Zhou, B. Li, R. Li and H. Lin, *Small*, 2023, **19**, e2207313.
17. S. Feng, X. Du, J. Luo, Y. Zhuang, J. Wang and Y. Wan, *Separation and Purification Technology*, 2023, **309**.
18. J. Yan, Q. Wei, X. Duan, J. He, Q. Li and Z. Nie, *Chinese Journal of Inorganic Chemistry*, 2011, **27**, 1334-1340.
19. W. Li, D. Li, L. Zheng, J. Fan and Z. Zhang, *Journal of the Chinese Ceramic Society*, 2014, **42**, 416-422.
20. Z. Zhang, Li. Zheng, D. Li and W. Li, *Journal of Shenyang University of Chemical Technology*, 2014, **28**, 308-313.
21. Z. Hong, Q. Wei, G. Li, X. Wang, Z. Nie and Q. Li, *Chinese Journal of Inorganic Chemistry*, 2013, **29**, 941-947.
22. Y. Ding, Q. Wei, X. Liu, Q. Li and Z. Nie, *Membrane Science and Technology*, 2014, **34**, 22-27.
23. S. Himeno, T. Tomita, K. Suzuki, K. Nakayama and K. Yajima, *Ind.eng.chem.res*, 2007, **46**, 6989-6997.
24. Y. Cui, H. Kita and K.-i. Okamoto, *Chemical Communications*, 2003, **17**, 2154-2155.
25. H. Gong, Masteral Thesis, Northeastern University, 2018.
26. E. Jang, S. Hong, E. Kim, N. Choi, S. J. Cho and J. Choi, *Journal of Membrane Science*, 2018, **549**, 46-59.

27. K. Kida, Y. Maeta and K. Yogo, *Separation and Purification Technology*, 2018, **197**, 116-121.
28. J. Zhou, F. Gao, K. Sun, X. Jin, Y. Zhang, B. Liu and R. Zhou, *Energy & Fuels*, 2020, **34**, 11307-11314.
29. L. Yu, A. Holmgren, M. Zhou and J. Hedlund, *Journal of Materials Chemistry A*, 2018, **6**, 6847-6853.
30. J. C. White, P. K. Dutta, K. Shqau and H. Verweij, *Langmuir*, 2010, **26**, 10287-10293.
31. H. W. Kim, H. W. Yoon, S.-M. Yoon, B. M. Yoo, B. K. Ahn, Y. H. Cho, H. J. Shin, H. Yang, U. Paik, S. Kwon, J.-Y. Choi and H. B. Park, *Science*, 2013, **342**, 91-95.
32. H. Li, Z. Song, X. Zhang, Y. Huang, S. Li, Y. Mao, H. J. Ploehn, Y. Bao and M. Yu, *Science*, 2013, **342**, 95-98.
33. C. Chi, X. Wang, Y. Peng, Y. Qian, Z. Hu, J. Dong and D. Zhao, *Chemistry of Materials*, 2016, **28**, 2921-2927.
34. M. Karunakaran, L. F. Villalobos, M. Kumar, R. Shevate, F. H. Akhtar and K. V. Peinemann, *Journal of Materials Chemistry A*, 2017, **5**, 649-656.
35. Q. Xin, F. Ma, L. Zhang, S. Wang, Y. Li, H. Ye, X. Ding, L. Lin, Y. Zhang and X. Cao, *Journal of Membrane Science*, 2019, **586**, 23-33.
36. J. Shen, M. Zhang, G. Liu and W. Jin, *RSC Advances*, 2016, **6**, 54281-54285.
37. J. Shen, G. Liu, K. Huang, Z. Chu, W. Jin and N. Xu, *ACS Nano*, 2016, **10**, 3398-3409.
38. B. Kang and H. Sang, *Journal of Material Science*, 1999, **34**, 1391-1398.
39. T. Isobe, Y. Takada, S. Matsushita and A. Nakajima, *Ceramics International*, 2015, **41**, 7759-7765.
40. K. Shankar and P. Kandasamy, *Greenhouse Gases: Science and Technology*, 2019, **9**, 287-305.
41. S. K. Sharma, B. K. Sanfui, A. Katare and B. Mandal, *ACS Applied Materials & Interfaces*, 2020, **12**, 40269-40284.
42. J. Hao, Z. Wang and S. Wang, *Polymer Materials Science & Engineering*, 1997, **13**, 65-69.
43. J. Wu, Ph.D. Thesis, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, 2002.
44. X. Jie, Ph.D. Thesis, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, 2005.
45. L. Ansaloni, J. Salas-Gay, S. Ligi and M. G. Baschetti, *Journal of Membrane Science*, 2017, **522**, 216-225.
46. H. T. Lu, S. Kanehashi, C. A. Scholes and S. E. Kentish, *Journal of Membrane Science*, 2017, **539**, 432-440.
47. X. Shang, S. Chen, X. Shi and Z. Zhu, *Chinese Journal of Chemical Physics*, 1997, **10**, 92-97.
48. P. Sysel, D. Maly, J. Vysohlid, K. Friess, K. Pilnacek, M. Lanc and O. Vopicka, *Polymer Engineering & Science*, 2017, **57**, 1367-1373.
49. F. Jianhua, K. Hidetoshi and O. Ken-ichi, *Journal of Membrane Science*, 2001, **182**, 245-256.
50. E. M. Maya, D. M. Muñoz, J. G. de la Campa, J. de Abajo and Á. E. Lozano, *Desalination*, 2006, **199**, 188-190.
51. C. Zhang, P. Li and B. Cao, *Journal of Membrane Science*, 2017, **528**, 206-216.
52. T. Zhu, Masteral Thesis, Taiyuan University of Technology, 2018.
53. H. Si, H. Jia, P. Jiang, S. Zhao and S. Zhang, *Journal of Qiqihar University(Natural Science Edition)*, 2021, **37**, 77-80.
54. H. Eguchi, D. J. Kim and W. J. Koros, *Polymer*, 2015, **58**, 121-129.
55. M. Zhang, Masteral Thesis, Taiyuan University of Technology, 2015.
56. X. He, Masteral Thesis, Taiyuan University of Technology, 2018.

57. S. Shahid and K. Nijmeijer, *Separation and Purification Technology*, 2017, **189**, 90-100.
58. H. A. Mannan, H. Mukhtar, M. Shima Shaharun, M. R. Othman and T. Murugesan, *Journal of Applied Polymer Science*, 2015, **133**, 42496.
59. Y. Meng, Masteral Thesis, LanZhou University of Technology, 2020.
60. L. Meng, Masteral Thesis, Tiangong University, 2016.
61. X. Zhou, J. Yan, H. Gao, A. Wang and Y. Bai, *New Chemical Materials*, 2018, **46**, 195-199.
62. Y. Wang, J. Ren, C. Xu, H. Li, S. Feng and M. Deng, *Membrane Science and Technology*, 2014, **34**, 27-32+48.
63. Q. Zhao, S. He, J. Lin and Q. Lin, *China Plastics*, 2019, **33**, 13-20.
64. A. Car, C. Stropnik, W. Yave and K.-V. Peinemann, *Journal of Membrane Science*, 2008, **307**, 88-95.
65. S. R. Reijerkerk, M. H. Knoef, K. Nijmeijer and M. Wessling, *Journal of Membrane Science*, 2010, **352**, 126-135.
66. X. Xiao, X. Xu, X. Li, J. Dong, X. Zhao and Q. Zhang, *Acta Polymerica Sinica*, 2022, **53**, 505-513.
67. T. Wu, Y. Shi, Y. Liu, I. Kumakiri, K. Tanaka, X. Chen and H. Kita, *Energy & Fuels*, 2021, **35**, 10680-10688.
68. M. Mubashir, Y. F. Yeong, K. K. Lau, T. L. Chew and J. Norwahyu, *Separation and Purification Technology*, 2018, **199**, 140-151.
69. B. Liu, Ph.D. Thesis, Harbin Institute of Technology, 2021.
70. C. Li, Masteral Thesis, China University of Petroleum (Beijing) 2019.
71. Y. Gao, Masteral Thesis, Shenyang University of Technology, 2021.
72. Z. Rui, J. B. James, A. Kasik and Y. S. Lin, *AIChE Journal*, 2016, **62**, 3836-3841.
73. D. S. Chiou, H. J. Yu, T. H. Hung, Q. Lyu, C. K. Chang, J. S. Lee, L. C. Lin and D. Y. Kang, *Advanced Functional Materials*, 2020, **31**, 2006924.
74. Y. Wang, H. Jin, Q. Ma, K. Mo, H. Mao, A. Feldhoff, X. Cao, Y. Li, F. Pan and Z. Jiang, *Angewandte Chemie International Edition*, 2020, **59**, 4365-4369.
75. M. Bu, Y. Feng, Q. Li, Y. Wang, S. Feng, K. Zhang, Y. Jiang, L. Fan, Z. Kang and D. Sun, *Inorganic Chemistry Frontiers*, 2021, **8**, 5016-5023.
76. H. Chang, Y. Wang, L. Xiang, D. Liu, C. Wang and Y. Pan, *Chemical Engineering Science*, 2018, **192**, 85-93.
77. J. Liu, C. Liu and A. Huang, *International Journal of Hydrogen Energy*, 2020, **45**, 703-711.
78. P.-H. Chang, Y.-T. Lee and C.-H. Peng, *Materials*, 2020, **13**, 5009.
79. M. Jia, X.-F. Zhang, Y. Feng, Y. Zhou and J. Yao, *Journal of Membrane Science*, 2020, **595**, 117579.
80. T.-M. T. Nguyen, J.-W. Chen, M.-T. Pham, H. M. Bui, C.-C. Hu, S.-J. You and Y.-F. Wang, *Environmental Technology & Innovation*, 2023, **31**, 103169.
81. Q. Wang, F. Huang, C. J. Cornelius and Y. Fan, *Journal of Membrane Science*, 2021, **621**, 118785.
82. M. Hou, L. Li, Z. He, R. Xu, Y. Lu, J. Zhang, Z. Pan, C. Song and T. Wang, *Journal of Membrane Science*, 2022, **656**, 120639.
83. J. M. Pérez-Francisco, J. L. Santiago-García, M. I. Loría-Bastarrachea, D. R. Paul, B. D. Freeman and M. Aguilar-Vega, *Journal of Membrane Science*, 2020, **597**, 117703.
84. J. H. Shin, H. J. Yu, H. An, A. S. Lee, S. S. Hwang, S. Y. Lee and J. S. Lee, *Journal of*

Membrane Science, 2019, **570-571**, 504-512.

85. J. Nie, F. Okada, H. Kita, K. Tanaka, T. Mihara, D. Kondo, Y. Yamashita and N. Yahagi, *Energy & Fuels*, 2022, **36**, 7147-7157.
86. Y. Cao, K. Zhang, O. Sanyal and W. J. Koros, *Angewandte Chemie International Edition*, 2019, **58**, 12149-12153.
87. W. Han, C. Zhang, M. Zhao, F. Yang, Y. Yang and Y. Weng, *Journal of Membrane Science*, 2021, **636**, 119544.
88. S. Mohsenpour, A. W. Ameen, S. Leaper, C. Skuse, F. Almansour, P. M. Budd and P. Gorgojo, *Separation and Purification Technology*, 2022, **298**, 121447.
89. M. Chen, F. Soyekwo, Q. Zhang, C. Hu, A. Zhu and Q. Liu, *Journal of Industrial and Engineering Chemistry*, 2018, **63**, 296-302.
90. I. Jeong, I. Hossain, A. Husna and T. H. Kim, *Macromolecular Materials and Engineering*, 2022, **308**, 2200596.
91. Y. Sun, J. Zhang, H. Li, F. Fan, Q. Zhao, G. He and C. Ma, *Separation and Purification Technology*, 2023, **314**, 123623.
92. 刘烨.
93. Z. Wang, M. Li, Y. Cai, J. Wang and S. Wang, *Journal of Membrane Science*, 2007, **290**, 250-258.
94. Z. Tong and W. S. W. Ho, *Separation Science and Technology*, 2016, **52**, 156-167.
95. S. Janakiram, X. Yu, L. Ansaloni, Z. Dai and L. Deng, *ACS Applied Materials & Interfaces*, 2019, **11**, 33302-33313.
96. M. Wang, Z. Wang, J. Wang, Y. Zhu and S. Wang, *Energy & Environmental Science*, 2011, **4**, 3955-3959.
97. K. Yao, Z. Wang, J. Wang and S. Wang, *Chemical Communications*, 2012, **48**, 1766-1768.