Polymetaphenylene isophthamide (PMIA): A potential polymer breaking through selectivity-permeability trade-off for ultrafiltration membranes

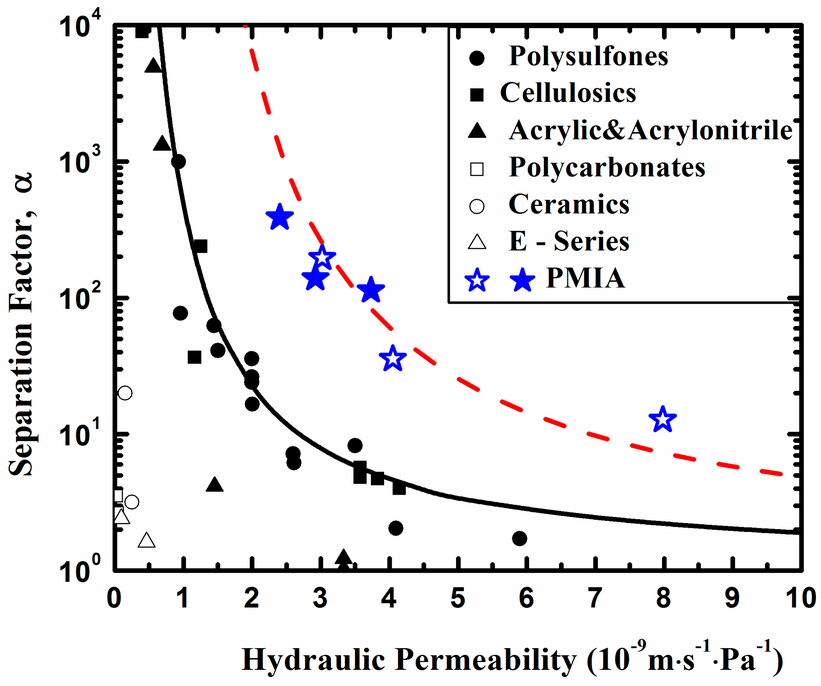
Chun-Er Lin, Shi-Yuan Du, Ming-Yong Zhou, Bao-Ku Zhu*

MOE Engineering Research Center of Membrane Water Treatment Technology

Department of Polymer Science and Engineering, Zhejiang University

Introduction

The selectivity-permeability trade-off represents the limitation for the performance of ultrafiltration (UF) membranes. Theoretically, this trade-off is mainly determined by pore structure including porosity, pore radius distribution and skin layer thickness. Benefiting from its high rigidity and high surface free energy, polymetaphenylene isophthamide (PMIA) is proposed for the preparation of high-performance UF membrane via nonsolvent induced phase separation (NIPS).



Results and Discussions

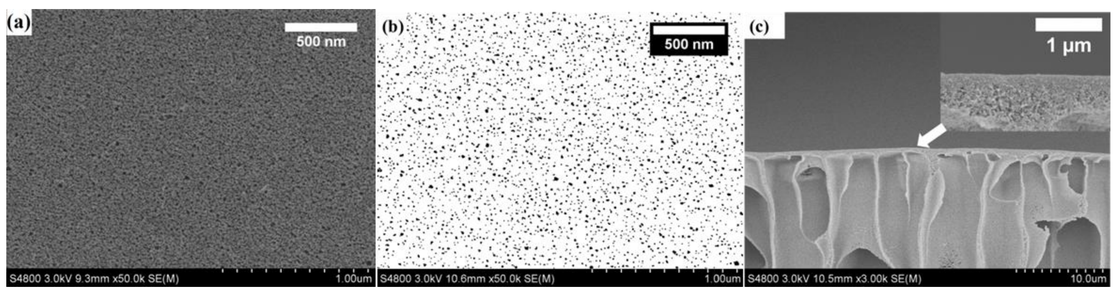


Figure 1. SEM images and binary for M30.

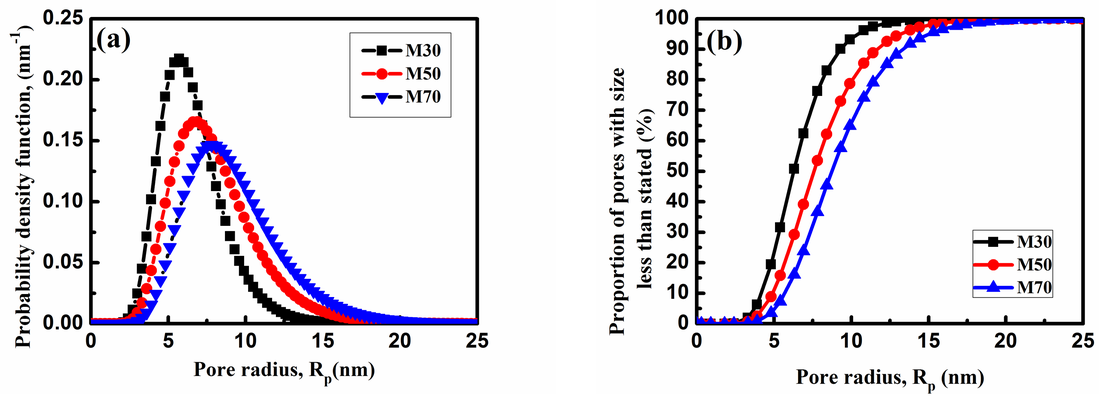


Figure 2. (a) Pore radius distribution curves and (b) cumulative curves.

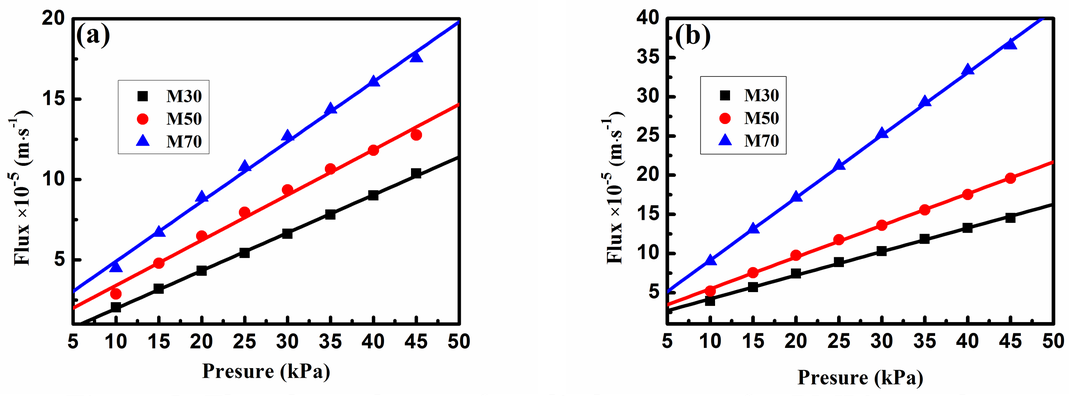


Figure 3. Flux dependence of applied pressure for PMIA membranes.

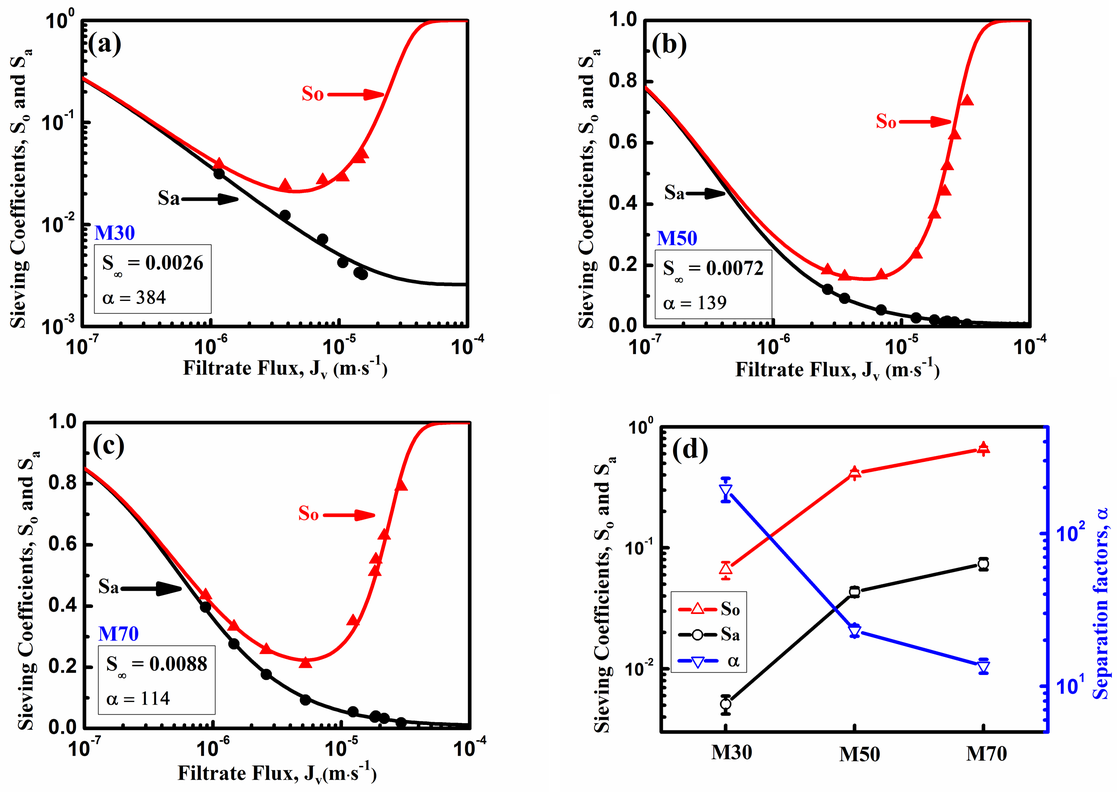


Figure 4. Sieving coefficients and separation factors for PMIA membranes.

Table 1. Pore structure parameters and performance for different membranes

Membrane	R_m (nm)	R_e (nm)	σ_p	ε (%)	L_p (10^{-9} m·s^{-1}·Pa^{-1})	α
M30	5.66	6.58	1.36	5.65	3.06	196
M50	6.81	6.84	1.40	6.88	4.02	36
M70	7.83	9.28	1.39	9.23	7.92	13
PTHK	2.55	12.25	~ 2	0.73	1.38	< 90
MX100	2.55	12.25	~ 2	0.78	1.46	< 70
YM100	2.55	12.25	~ 2	1.14	2.15	< 20
OMEGA 100-K	2.55	12.25	~ 2	1.50	2.80	27

Conclusion

Through the selectivity-permeability analysis, PMIA membrane was found to break through the selectivity-permeability trade-off. In comparison with the other UF membranes, it was confirmed that the high performance of PMIA membrane was generated from their high porosity, the narrow pore radius distribution as well as the excellent hydrophilicity. All these great properties of PMIA membrane demonstrate that PMIA is probably the most suitable polymer for preparing ultrafiltration membranes as far as we know.

Acknowledgements

The National 863 Program of China (grant number 2012AA03A602), the National 973 Program of China (grant number 2009CB623402) and the Nature Science Foundation Committee of China (grant number 20974094) are thanked for supporting this work.

References

[1] A. Mehta, A.L. Zydney. Journal of Membrane Science, 249 (2005) 245-249.
[2] S. Mochizuki, A.L. Zydney. Journal of membrane science, 82 (1993) 211-227.