

Porous gradient polymer membranes: small pores, big stories

Jiayin Yuan

Max Planck Institute of Colloids and Interfaces, D-14424 Potsdam, Germany

Jiayin.yuan@mpikg.mpg.de

Functional porous membranes with high surface area can be applied in broad fields, including catalysis, separation, filtration and energy applications.¹ There are a number of established methods for the preparation of porous membranes from neutral or weakly charged polymers. However, porous membranes from strong polyelectrolytes are far more difficult to prepare. Here we present our approach to porous polymer membrane materials from poly(ionic liquid)s.²

Poly(ionic liquid)s (PILs), a subset of polyelectrolytes, are the polymerization products of ionic liquids (ILs). They combine the advantages of polymeric materials, such as durability and good processability with the unique properties of ILs, such as tunable solubility in organic solvents with different polarity, ion conductivity, and high thermal stability.³ We have exploited these favorable properties to fabricate porous membranes from imidazolium based PILs and polyacids, triggered by electrostatic complexation between them.⁴⁻⁶ The pore structure forms as a result of microphase separation and is further stabilized by ionically crosslinked networks between the PIL polycation and the *in-situ* neutralized multivalent organic acids. The as-obtained membrane features a gradient profile in the cross-linking density along the membrane cross-section, triggered by the penetration of the base molecule from the top to the bottom into the material. The membrane pore sizes can be tuned from nanometer to micrometer scale by varying the degree of electrostatic complexation.

Furthermore, the membrane features high actuation speed in response to acetone and humidity on account of its gradient in cross-linking density combined with its porous nature that enhances the mass transport inside the membrane.

Reference

- [1] A. F. Bushell, P. M. Budd, M. P. Atfield, J. T. A. Jones, T. Hasell, A. I. Cooper, P. Bernardo, F. Bazzarelli, G. Clarizia, J. C. Jansen, *Angew. Chem. Int. Ed.* **2013**, 52, 1253-1256.
- [2] Q. Zhao, M. Yin, A. P. Zhang, S. Prescher, M. Antonietti, J. Yuan, *J. Am. Chem. Soc.* **2013**, 135, 5549-5552.
- [3] D. Mecerreyes, *Prog. Polym. Sci.* **2011**, 36, 1629-1648.
- [4] K. Täuber, B. Lепенies, J. Yuan, *Polym. Chem.* **2015**, 6, 4855-4858.
- [5] Q. Zhao, J. W. C. Dunlop, X. Qiu, F. Huang, Z. Zhang, J. Heyda, J. Dzubiella, M. Antonietti, J. Yuan, *Nat Commun* **2014**, 5.: 4293.
- (6) Z. Qiang, J. Heyda, J. Dzubiella, J. W. C. Dunlop, J. Yuan, *Adv. Mater.* **2015**, 27, 2913–2917.