Ultrathin graphene-based membrane with precise molecular sieving and ultrafast solvent permeation

R. Al Busaidi[1], Q. Yang[2], Y. Su[2] , C. Chi[2], C. T. Cherian[2], K. Huang[2], V. G. Kravets[2] , F. C. Wang[3] , J. C. Zhang[4] , A. Pratt[4] , A. N. Grigorenko[2] , F. Guinea[2,3], A. K. Geim[2] and R. R. Nair[2]
Physics department, college of science, Sultan Qaboos University, Muscat, Oman
[2]Membrane group, school of Chemical Engineering and Analytical Science & National Graphene Institute, University of Manchester, Manchester, UK
3Chinese Academy of Sciences Key Laboratory of Mechanical Behavior and Design of Materials, Department of Modern Mechanics, University of Science and Technology of China, Hefei, Anhui 230027, China
rahmaalb@squ.edu.om

Graphene oxide (GO) membranes continue to attract intense interest due to their unique molecular separation properties combined with rapid permeability. The membranes are limited to aqueous solutions due to their apparent impermeability to organic solvents, which has not yet been fully explained. Here, we report efficient and fast filtration of organic solvents through GO laminates containing smooth two-dimensional (2D) capillaries made from large (10–20 μm) flakes. Without modification of sieving characteristics, these membranes can be made exceptionally thin, down to ∼10 nm, resulting in fast water and organic solvent permeation. We attribute organic solvent permeation and sieving properties to randomly distributed pinholes connected by 1 nm graphene channels. Organic solvent permeation rates decay exponentially with membrane thickness, but water continues to permeate quickly, in agreement with previous reports[1-4]. The potential of ultrathin GO laminates for organic solvent nanofiltration is demonstrated by showing >99.9% rejection of small molecular weight organic dyes dissolved in methanol. GO membranes have enormous potential for purification and filtration technologies as a result of our research

References

[1] Nair, R. R., Wu, H. A., Jayaram, P. N., Grigorieva, I. V. & Geim, A. K. , Science 335 (2012), 442–444.
[2] Sun, P., Wang, K. & Zhu, H, Adv. Mater. 28 (2016), 2287–2310.
[3] Liu, G., Jin, W. & Xu, N, Chem. Soc. Rev. 44 (2015), 5016–5030.
[4] Fathizadeh, M., Xu, W. L., Zhou, F., Yoon, Y. & Yu, M, Adv. Mater. Interfaces 4 (2017), 1600918.