Monolayer graphene membrane for high-temperature organic solvent nanofiltration in harsh solvents

Yanqiu Lu[a,1], Liling Zhang[b,1], Liang Shen[a], Wei Liu[c], Rohit Karnikd[d], Sui Zhang[a]*

[a] Department of Chemical and Biomolecular Engineering, National University of Singapore, Singapore 117585

[b] Institute of High-Performance Computing, Agency for Science, Technology and Research, Singapore 138632

[c] School of Physics, Southeast University, Nanjing 211189, China

[d] Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139

*Corresponding author: Email: chezhasu@nus.edu.sg, Tel: (65) 65163781

[1] These authors contributed equally to this work.

Abstract:

Separation, purification and recovery of organic solvents play a key role in the pharmaceutical, chemical and petroleum industries. Organic solvent nanofiltration (OSN), which applies membranes for molecular-level separations from organic solvents, is an environmentally friendly method that requires less footprint. However, one of the main barricades of OSN is the instability of membranes that struggle to fulfill some industrial operating conditions with high temperature in harsh solvents. Monolayer graphene demonstrates atomic thickness combined with remarkable mechanical strength, excellent resistance to organic solvents and high temperature, offering new possibilities for high-temperature OSN. In this presentation, I will discuss our research on molecular transport across monolayer graphene membrane via molecular dynamics simulations and resistance model to guide the design of defect-tolerant graphene composite membrane. With both pore size and permeance taken into consideration, we engineered crosslinked P84 polyimide (PI) substrate to enable nanoporous graphene membranes for high-temperature OSN in harsh solvents. The crosslinked P84 polyimide (PI) substrate could effectively mitigate the impacts of leakage on graphene to allow selective transport without defect sealing. The resultant graphene membrane showed a rejection of 92.7% to Rose Bengal (1017.64 g mol^{-1}) in ethanol, and constant rejection (~90 %) of Allura Red AC (496.42 g mol^{-1}) in harsh polar solvent N, N-dimehtylformamide (DMF) at 100 °C for 10 days. This work may open new opportunities for industrial separation in organic solvents at high temperature and accelerate the realization of full potential of the graphene.

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