Nanoporous Two-Dimensional Materials for Gas Separations

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Abstract: In the last two decades, significant progress has been made in the field of 2D materials as selective materials for membrane applications. Due to its ease of synthesis and characterization, most of the reported works are on graphene membrane. However, pristine graphene is impermeable even to helium and pores in the form of vacancies/defects need to be incorporated into the graphene lattice for separation applications. However, any pore incorporation strategy leads to a pore size distribution due to the differences in the energy between pore nucleation and pore expansion. This invariably leads to a decrease in the selectivity and is considered to be one of the most important bottlenecks associated with graphene membrane development.

This talk will highlight our group's efforts to develop intrinsically porous 2D materials for gas separation applications. In particular, we will present our work on graphdiyne and graphitic carbon nitride and discuss the challenges associated with their development for membrane applications.

References

(1) Huang, S.; Li, S.; Villalobos, L. F.; Dakhchoune, M.; Micari, M.; Babu, D. J.; Vahdat, M. T.; Mensi, M.; Oveisi, E.; Agrawal, K. V. Millisecond Lattice Gasification for High-Density CO2- and O2-Sieving Nanopores in Single-Layer Graphene. Sci Adv 2021, 7 (9), eabf0116.
(2) Villalobos, L. F.; Babu, D. J.; Hsu, K.-J.; Van Goethem, C.; Agrawal, K. V. Gas Separation Membranes with Atom-Thick Nanopores: The Potential of Nanoporous Single-Layer Graphene. Acc. Mater. Res. 2022, 3 (10), 1073–1087
(3) Hao, J.; Gebolis, P. M.; Gach, P. M.; Chevalier, M.; Bondaz, L. S.; Kocaman, C.; Hsu, K.-J.; Bhorkar, K.; Babu, D. J.; Agrawal, K. V. Scalable Synthesis of CO2-Selective Porous Single-Layer Graphene Membranes. Nat Chem Eng 2025, 2 (4), 241–251.

Figures

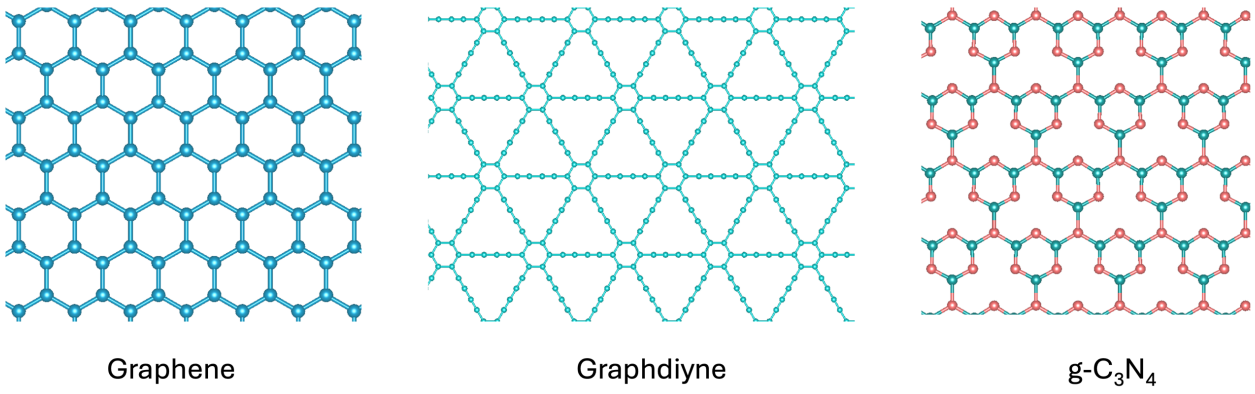

Figure 1: Graphene and its nanoporous analogues