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The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

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PIM-1-based Membranes Mediated with CO_2-philic MXene Nanosheets for Superior CO_2/N_2 Separation

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PhD Mid-Seminar

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Abstract: Membrane gas separation technologies have emerged as highly prospective avenues for the selective separation of CO_2. In this research, a novel array of mixed matrix membranes (MMMs) was engineered, integrating two-dimensional nanosheets of MXene, specifically $Ti_3C_2T_x$, into polymers of intrinsic microporosity (PIMs) to selectively separate CO_2 from N_2. The inclusion of $Ti_3C_2T_x$ nanosheets, rich in polar functional groups, significantly increases the affinity between CO_2 molecules and the fabricated MMMs. Additionally, the precise modulation of the molecular diffusion channels for CO_2 and N_2 is achievable due to the interlayer spacing between MXene layers (~0.35nm) within the PIM-1 matrix. This innovation is predicated on the synergistic effect of solution-diffusion and molecular sieving mechanisms that underpin the gas separation process, leading to a marked improvement in both selectivity for CO_2 over N_2 and the permeability of CO_2. Among the series, the MMM with a 0.5 wt% MXene displayed exceptional separation efficiency, achieving a CO_2 permeability of 12475.3 Barrer and a CO_2/N_2 selectivity of 32.7. Notably, each PIM-1/MXene membrane composition examined in this study exceeded the Robeson upper bound set in 2019, indicating their substantial promise for CO_2 separation and capture in industrial applications.