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Surpassing the Conventional Limitations of CO₂ Separation Membranes with Hydroxide/Ceramic Dual-Phase Membranes

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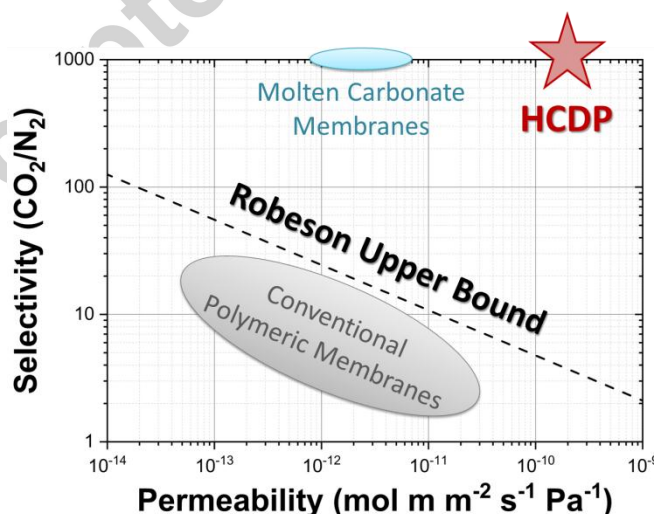
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Abstract:

We report the development of a dual-phase membrane for CO₂ separation based on a molten hydroxide liquid phase and a nanoporous yttria-stabilized zirconia solid support phase, termed hydroxide/ceramic dual-phase (HCDP) membranes, that can operate in the flue gas temperature range of 250-650 °C. HCDP membranes demonstrate selectivity for CO₂ over N₂ greater than 1,000 and CO₂ permeability of $1.78 \pm 0.16 \times 10^{-10} \text{ mol m m}^{-2} \text{ s}^{-1} \text{ Pa}^{-1}$ (5.32×10^5 barrer) at 550 °C with 20 vol% CO₂, which is more than an order of magnitude greater than the best values for dual-phase and polymer membranes reported in the literature. We also demonstrate using three different experimental methods that CO₂ absorption by molten hydroxides is reversible in the presence of water vapor at temperatures as low as 300 °C.



Graphical Abstract:

Robeson plot comparing the performance of flue-temperature (250-650 °C) hydroxide/ceramic dual-phase (HCDP) membrane with ambient-temperature polymer and high-temperature molten carbonate dual-phase membranes.

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