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PII: S0376-7388(18)31820-9
DOI: https://doi.org/10.1016/j.memsci.2018.09.028
Reference: MEMSCI16473

To appear in: *Journal of Membrane Science*

Received date: 2 July 2018
Revised date: 22 August 2018
Accepted date: 12 September 2018

Cite this article as: Maira R. Cerón, Li Sze Lai, Azadeh Amiri, Matthew Monte, Sindhu Katta, Jesse Kelly, Marcus A. Worsley, Matthew D. Merrill, Sangil Kim and Patrick G. Campbell, Surpassing the Conventional Limitations of CO_2 Separation Membranes with Hydroxide/Ceramic Dual-Phase Membranes, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2018.09.028

Surpassing the Conventional Limitations of CO_2 Separation Membranes with Hydroxide/Ceramic Dual-Phase Membranes

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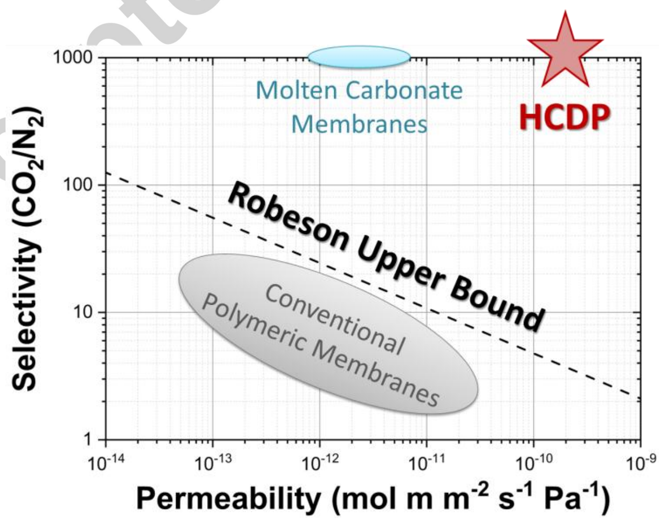
Abstract:
We report the development of a dual-phase membrane for CO_2 separation based on a molten hydroxide liquid phase and a nanoporous yttria-stabilized zirconia solid support phase, termed hydroxide/ceramic dual-phase (HCDP) membranes, that can operate in the flue gas temperature range of 250-650 °C. HCDP membranes demonstrate selectivity for CO_2 over N_2 greater than 1,000 and CO_2 permeability of $1.78 \pm 0.16 \times 10^{-10}$ mol m $m^{-2}s^{-1}Pa^{-1}$ (5.32×10^5 barrer) at 550 °C with 20 vol% CO_2, 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 CO_2 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.