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Highly CO₂ Perm-selective Metal-organic Framework Membranes through CO₂ Annealing Post-treatment

Zebao Rui ^a, Joshua B. James ^b, Y.S. Lin ^{b,*}

^a School of Chemical Engineering and Technology, Sun Yat-sen University, Zhuhai 519082, P.R. China

^b Chemical Engineering, School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ 85287, USA

Abstract

Gas separation by metal-organic framework (MOF) membranes are still unsatisfactory due partly to unsatisfied separation characteristics caused by the trade-off between selectivity and permeability. Herein, we provide a facile post CO₂ annealing method to remarkably improve both the permeance and separation factor of IRMOF-1 membranes for CO₂ separation from CO₂/H₂ mixture. Post-treatment of the IRMOF-1 membrane by annealing at 100 °C under a high pressure CO₂ stream decreases H₂ permeance while increasing CO₂ permeance, leading to simultaneous enhancement in both CO₂/H₂ separation factor from 721 up to 5781 and CO₂ permeance from 5.67×10^{-7} up to 9.38×10^{-7} mol m⁻² s⁻¹ Pa⁻¹ at CO₂ molar fraction of 98%, feed pressure of 5 atm and 298 K. The unusual separation behavior is related to the enhanced CO₂ adsorption selectivity over H₂ and reduced CO₂ affinity of the membrane due to the formation of surface carbonate anions caused by the CO₂ treatment. The proposed gas atmosphere post-treatment strategy opens a window for designing next generation MOF-related gas separation membranes.

Keywords: Metal-organic framework membrane, Gas separation, Adsorption-driven selectivity, Post-treatment, Carbon dioxide

* Correspondence concerning this article can be addressed to Jerry Y. S. Lin at jerry.lin@asu.edu

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