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PII: S0376-7388(18)30121-2
DOI: https://doi.org/10.1016/j.memsci.2018.03.036
Reference: MEMSCI16030

To appear in: *Journal of Membrane Science*

Received date: 15 January 2018
Revised date: 15 March 2018
Accepted date: 16 March 2018

Cite this article as: Zebao Rui, Joshua B. James and Y.S. Lin, Highly CO_2 Perm-selective Metal-organic Framework Membranes through CO_2 Annealing Post-treatment, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2018.03.036

Highly CO_2 Perm-selective Metal-organic Framework Membranes through CO_2 Annealing Post-treatment

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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 CO_2 annealing method to remarkably improve both the permeance and separation factor of IRMOF-1 membranes for CO_2 separation from CO_2/H_2 mixture. Post-treatment of the IRMOF-1 membrane by annealing at 100 ^oC under a high pressure CO_2 stream deceases H_2 permeance while increasing CO_2 permeance, leading to simultaneous enhancement in both CO_2/H_2 separation factor from 721 up to 5781 and CO_2 permeance from 5.67×10^{-7} up to 9.38×10^{-7} mol m^{-2} s^{-1} Pa^{-1} at CO_2 molar fraction of 98%, feed pressure of 5 atm and 298 K. The unusual separation behavior is related to the enhanced CO_2 adsorption selectivity over H_2 and reduced CO_2 affinity of the membrane due to the formation of surface carbonate anions caused by the CO_2 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

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