Porous Organic Cages-Stabilized Carbon Molecular Sieve for Efficient Gas Separation

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Abstract:

Here we present results of gas selectivity and diffusion of different gases (C_2H_6, C_2H_4, C_3H_8, C_3H_6, H_2, N_2, CO_2, and CH_4) in porous organic cages (POCs) incorporated into fluorinated copolyimides polymers (FCPs). The FCPs were synthesized by the thermal and chemical imidization reaction of fluorinated dianhydrides, nonfluorinated dianhydride, and nonfluorinated diamine. Asymmetric hollow fiber membranes formed by the dry-jet/wet-quench spinning process. Once fresh FCP fibers were synthesized, they were crosslinked with POCs, vacuum dried at 90 °C. We investigated the uptake, gas selectivity and diffusion of different gases (C_3H_8, C_3H_6, CO_2, and H_2) over synthesized POC-mixed matrixed membranes (POC-MMM) at 25 °C and pressures up to 1 bar. At 1 bar and 25 °C, C_3H_8, C_3H_6 adsorption capacities reached 2.77 and 2.65 mmol/g over POC-MMM, respectively, while CO_2, CH_4, CO, N_2 and H_2 adsorption capacities of 1.48, 0.84, 0.33, 0.11, and 0.068 mmol/g, respectively. Furthermore, stable CMS membrane was formed by pyrolysis of POC-MMMs under an inert argon atmosphere at 1 atm. To test the gas transport properties of CMS-derived POC/MMM, a lab-scale hollow fiber module with two-five fibers was constructed. The results of longer-term operation of synthesized CMS membrane that was continuously operated for 264 h (10 days) with an equimolar binary H_2/CO_2, CH_4/CO_2 and C_3H_6/C_3H_8 feed at 25°C and 1 bar feed pressure. The modification yielded promising results in the reduction of physical aging of CMS membranes.

This work was supported by the National Science Foundation Grant No. 2316143.