Ultrathin carbon-nanoporous metal oxide composite molecular sieve membrane for hydrogen separation

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Abstract:

Carbon molecular sieve (CMS) membranes are made of microporous carbon with slit-like nanopores formed by carbonization of organic precursors. They have shown great potential for gas separation due to their excellent selectivity, high stability in harsh environment and low cost. To achieve high selectivity, CMS membranes typically have a selective layer of several-micrometer thickness. Given that gas permeance is inversely related to membrane thickness, reducing the thickness of CMS membrane while maintaining high selectivity is critical. In this work, we provide a new approach for fabricating high-performance CMS membranes by employing metal oxyhydroxide nanosheets as templates and building blocks to avoid the penetration of polymer precursor solution into the porous substrate and minimize the formation of cracks. FeCoNi oxyhydroxide nanosheets were first synthesized via an one-pot hydrothermal reaction and were used to template an ultrathin poly(furfuryl alcohol) nanocomposite layer on porous alumina support. During the pyrolysis, FeCoNi oxyhydroxide nanosheets transformed into nanoporous oxide nanosheets, facilitating the gas transport in the CMS membrane. The resultant CMS membrane is around 100 nm thick and possesses excellent gas permeance and H_2/CO_2 selectivity. Meanwhile, the effects of pyrolysis temperature and nanosheets loading on the microstructure and gas separation performance of the CMS membranes were also investigated.

Keywords: Carbon molecular sieves, Hydrogen purification, Sacrificial template, 2D materials