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Nano-Structured Hydrophobic Silica Membrane for Gas Separation

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Abstract : Sol-gel derived hydrophobic silica membranes with pore sizes less than 1 nm are quite attractive for gas separation in a wide range of temperatures. A nano-structured hydrophobic membrane was prepared by sol-gel technique on a porous α–Al_2O_3 tubular support with yttria stabilized zirconia (YSZ) as an intermediate layer. Bistriethoxysilylethane (BTESE) derived sol was modified by adding phenyltriethoxysilylethane (PhTES) as an organic template. Six times dip coated modified silica membrane having a thickness of about 782 nm was characterized by field emission scanning electron microscopy. Thermogravimetric analysis, together along contact angle and Fourier transform infrared spectroscopy, showed that hydrophobic properties were improved by increasing the PhTES content. The contact angle of water droplet increased from 37° for pure to 111.5° for the modified membrane. The permeance of single gas H_2 was higher than H_2:CO_2 ratio of 75:25 binary feed mixtures. However, the permeance of H_2 for 60:40 H_2:CO_2 was found lower than single and binary mixture 75:25 H_2:CO_2. The binary selectivity values for 75:25 H_2:CO_2 were 24.75, 44, and 57, respectively. Selectivity had an inverse relation with PhTES content. Hydrophobicity properties were improved by increasing PhTES content in the silica matrix. The system exhibits proper three layers adhesion or integration, and smoothness. Membrane system suitable in steam environment and high-temperature separation. It was concluded that the hydrophobic silica membrane is highly promising for the separation of H_2/CO_2 mixture from various H_2-containing process streams.

Keywords : gas separation, hydrophobic properties, silica membrane, sol–gel method
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