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Centimeter-Scale Continuous Silica Isoporous Membranes for Molecular Sieving

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Abstract

Nanoporous molecular sieving membranes with high densities of uniform pores over macroscopic areas are highly desired to achieve a high permeation rate and a high molecular selectivity. In the first part of this work, our primary calculation using a quasi-steady state model indicates that the effective way of achieving a high molecular permeation is to increase the pore density and area of sieving membrane. Then the experimental work has been projected to prepare the centimeter-scale continuous silica isoporous membrane (SIM) consisting of parallel nanochannels under the support of porous polyethylene terephthalate (PET) film. Without using any expensive facilities or harsh conditions, simple wet-chemistry growth followed by membrane transfer was used to produce SIM with a large area up to 2.5 cm × 2.5 cm with ultrasmall thickness (ca. 90 nm) and high pore density (ca. 4.0×10^{12} cm^{-2}). The prepared SIM-PET membrane demonstrated a molecular permeation rate almost one order of magnitude larger than commercial dialysis and nanoporous polycarbonate membranes. Moreover, thanks to uniform pore size (2.3 nm in diameter) and negatively charged surface of silica nanochannels, the membrane showed a precise selectivity at the molecular level in terms of molecular size and charge. Simultaneous achievement of high permeability and high