Rigid double-stranded siloxane-induced high-flux carbon molecular sieve hollow fiber membrane for CO_2/CH_4 separation

신주호, 유현정, 이종석†
서강대학교
(jongslee@sogang.ac.kr†)

Carbon molecular sieve (CMS) membranes are a promising candidate for natural gas processing due to their peculiar pore structure-induced excellent separation performance. Formulating ultrathin, defect-free CMS hollow fiber membranes is, however, still challenging due to damage on porous sub-structures induced by thermal relaxation of polymer chains during pyrolysis. Herein, we report a new methodology enabling high separation performance and good plasticization resistance in CMS fiber membranes by uniform integration of double-stranded polysilsesquioxanes into the polyimide matrix. Our hybrid CMS fibers substantially enhanced CO_2 permeance by as much as 546% compared to the precursor fiber analogues due to the thin molecular sieve selective layer. Also, poly(dimethylsiloxane) coating delayed physical aging, still showing a high CO_2 permeance of 354 GPU with CO_2/CH_4 selectivity of 56 after 72 days of aging. Furthermore, they exhibited excellent plasticization resistance up to a CO_2 partial pressure of 13 atm with CO_2/CH_4 separation factor of 74 for an equimolar CO_2/CH_4 feed mixture.