In-situ formation of thin film, mixed-matrix membranes with ZIF-8 in PVI-POEM comb copolymer for CO_2 capture

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Despite several studies on free-standing, mixed-matrix membranes (MMMs), the development of high-permeance, thin-film membranes on low-cost, porous supports is still challenging. Here, the successful fabrication of ultra-high-permeance, thin-film MMMs on a porous polymer substrate is described based on a dual-functional imidazole-based comb copolymer and a highly porous zeolitic imidazole framework (ZIF-8). The comb copolymer of poly(vinyl imidazole)-poly(oxyethylene methacrylate) (PVI-POEM) is synthesized via free-radical polymerization, and it exhibits CO_2-philicity, strong adhesion, and good interactions with fillers. The synergistic effect of the CO_2-philic PVI-POEM comb copolymer matrix and highly porous ZIF-8 filler played a pivotal role in improving the CO_2 permeance. Optimization of the preparation process, such as ZIF-8 loading, substrate type, and coating layer thickness, leads to an extremely high CO_2 permeance of 4474 GPU with high CO_2/N_2 and CO_2/CH_4 ideal selectivities of 32.0 and 12.4, respectively, which is far beyond the current trade-off limit for membranes. It is attributed to the in-situ formation of inverse, asymmetric morphology of MMMs and partial infiltration of PVI-POEM chains into ZIF-8 particles.

Reference

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