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A strategy to enhance CO_2 permeability of well-defined hyper-branched polymers with dense polyoxyethylene comb graft

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Abstract

Hyper-branched polymers comprised of dense polyoxyethylene (POE) comb graft and poly(methyl methacrylate) (PMMA) backbone are prepared with a well-defined chemical structure and the gas transportation properties are investigated. The CO_2 permeation is strongly dependent on the POE weight fraction. To enhance the CO_2 permeability, a thin film layer of the hyper-branched polymers is formed on a polydimethylsiloxane (PDMS) support with thickness less than 60 µm, where poly(vinyl alcohol) (PVA) is blended to improve the membrane formability. The CO_2 permeability is increased by decreasing the thickness of the CO_2-selective layer. The permeability coefficient of the resulting thin film composite (TFC) membranes exceeds 1,000 barrer with 40.5 wt% of POE methacrylate (POEM) fraction, when the thickness of the selective layer is smaller than 25 μm. It reaches a maximum of 1,470 barrer for 15 μm selective layer thickness with a CO_2/N_2 selectivity of 24.5. The permeability coefficient of the selective layer alone is 490 barrer, with CO_2 selectivity of >30. Formation of a POE-rich domain upon microphase separation is confirmed by DSC and SAXS, and this is deemed crucial to enhance CO_2 permeability, due to improved CO_2 solubility in the selective layer. A dense POE comb architecture on the graft chain results in higher CO_2 permeability than that on the polymer backbone.