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A strategy to enhance CO₂ permeability of well-defined hyper-branched polymers with dense polyoxyethylene comb graft

Ikuo Taniguchi^{1,*}, Norihisa Wada², Kae Kinugasa¹, Mitsuru Higa^{2,*}

¹International Institute for Carbon-Neutral Energy Research (WPI-I²CNER), Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395, Japan

²Graduate School of Science and Engineering, Yamaguchi University, 2-16-1 Tokiwadai, Ube 755-8611, Japan

ikuot@i2cner.kyushu-u.ac.jp

mhiga@yamaguchi-u.ac.jp

*Correspondence author: Tel: +81 92 802 6712; Fax: +81 92 802 6712.

*Correspondence author. Tel: +81 836 85 9203; Fax: +81 836 85 9201.

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 CO₂ permeation is strongly dependent on the POE weight fraction. To enhance the CO₂ 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 CO₂ permeability is increased by decreasing the thickness of the CO₂-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 CO₂/N₂ selectivity of 24.5. The permeability coefficient of the selective layer alone is 490 barrer, with CO₂ 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 CO₂ permeability, due to improved CO₂ solubility in the selective layer. A dense POE comb architecture on the graft chain results in higher CO₂ permeability than that on the polymer backbone.

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