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Polyurethane gas separation membranes with ethereal bonds in the hard segments

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Abstract

Polyurethanes (PUs) and polyurethane-ureas (PUUs), with good mechanical stability and the possibility of tuning the gas transport properties are promising materials for selective gas separation membranes. Here, we synthesized various types of PUs and PUUs with polytetramethylene glycol (PTMG), isophoronediisocyanate (IPDI) and different ethereal chain extenders (1:3:2 molar ratio). FTIR and DSC results showed that the phase separation would vary in PUs and PUUs structures by changing the length and functionality of the chain extenders. More mixing was inferred for PUs and PUUs with high ethereal content. In contrast, phase separation was more likely with increases in the chain extender length. Pure (CO_2, CH_4, O_2 and N_2) and mixed gas (CO_2:N_2 (50:50 vol.%) and CO_2:CH_4 (50:50 vol.%)) permeation measurements correlated well with the phase separation in the polymer structure. The octanediamine-based PUU with the highest amount of phase separation showed the highest permeability (160 barrer for CO_2 and CO_2/N_2 selectivity of 30). On the other hand, the 3,6-dioxa- 1,8-octanediol- based PU, despite having the same chain extender length as octanediamine-based PUU, presented the lowest phase separation and gas permeability (62 barrer for CO_2 and CO_2/N_2 selectivity of 29).

Keywords: Polyurethane, polyurethane-urea, phase separation, gas separation, membrane