

Morphological Effect of Dispersed Phase on Gas Separation Properties through Heterophase Polymer Membrane: Theoretical and Experimental Approaches.

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INTRODUCTION

Heterophase polymer system has been attractive for a potential applicability to gas separation membrane material. It has been known that there is a trade-off between gas permeability and its selectivity in common polymers. Therefore, the heterophase polymer can be an alternative for a gas separation membrane material because its transport properties can be readily controlled by blending of two different polymers¹.

The transport properties of immiscible polymer blends strongly depend upon the intrinsic transport properties of corresponding polymers. Another important factor to determine the transport properties is their morphology: volume fraction, size and shape of dispersed phase^{2,3}. Although the effect of the volume fraction of the dispersed phase on the transport properties has been widely investigated, the size and shape effects have been paid attention very much.

In an immiscible polymer blend of two polymers, its morphology is primarily controlled by its volume fraction of dispersed phase. Therefore, the effect of the size of the dispersed phase can be hardly seen. Therefore, a block copolymer has been commonly employed to control their morphology when each block is miscible with one or the other phase.

In this work, gas transport properties will be measured by varying the morphology of the heterophase polymer membrane. The transport properties will be interpreted in terms of their morphology. The effect of the volume fraction of the PI phase and, in particular, its size effect will be investigated experimentally and theoretically.

EXPERIMENTAL

Styrene-isoprene-styrene triblock copolymer (SIS) was obtained from Japan Synthetic Rubber Co.. Casting solutions were prepared from the commercially available poly(-2,6 dimethyl-1,4-phenylene oxide) and polyisoprene in mono-chlorobenzene at a total concentration of 5 weight%. Then membranes were prepared by casting the solution on a glass plate. The solvent was removed by evaporation at 70°C for one day, and the membranes were dried at 60°C in a vacuum oven for two days. The thickness of the obtained membranes was about 40-50 μm .

RESULTS AND DISCUSSION

The permeability of gases in immiscible blend membranes is known to mainly depend on the properties of the matrix component. Therefore, in these systems the phase inversion may be regarded as one of the most important factors. It is affected largely by the viscosity difference between the two components⁴. In immiscible blends consisting of rubbery and glassy polymers, the phase inversion can be observed at low content of rubbery part. In this work, Figure 1 shows that the oxygen permeability of PPO/PI blends increases abruptly at about 20 wt% PI content. It indicates that the phase inversion occurs near this point. The oxygen permeability of PPO/PI (9/1) blend as a function of SIS content is shown in Figure 2. It reveals that the addition of the block copolymer leads to the change of the blend morphology, which causes the permeability to increase until block copolymer content reaches to 4 wt%. Compared with the oxygen permeability of PPO/PI (8/2) in Figure 1, it may be concluded that the maximum permeability in Figure 2 is due to the formation of the bicontinuous structure having a penetrating path of PI.

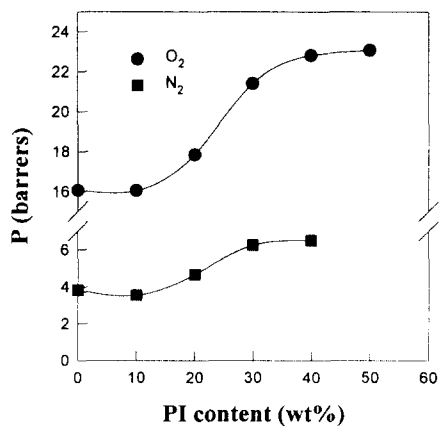


Figure 1. O₂ and N₂ permeability of PPO/PI blends

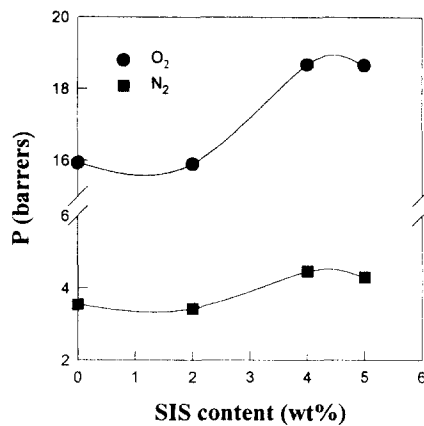


Figure 2. O₂ and N₂ permeability versus SIS contents in PPO/PI (9/1) blend

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