PERMEATION OF CARBON DIOXIDE AND NITROGEN GASES THROUGH POLY(AMIDE-IMIDE)/POLYURETHANE AND POLYCARBONATE/POLYURETHANE BLEND MEMBRANES

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ABSTRACT

Thermoplastic polyurethane(PU)-based blend membranes were prepared by the solvent evaporation process. The gas sorption, diffusion, and permeation properties of PU-based blend membranes have been studied. The morphology of PU-based blend membranes was investigated by SEM. The result showed that phase separation occurred with increasing blend ratio. CO_2 permeation behaviors of blend membranes were affect by blend composition. Thermoplastic polyurethane(PU)-based membranes showed high CO_2 permeation and CO_2/N_2 selectivity of the blend membrane was improved with increasing the blend ratio.

INTRODUCTION

The scientific and commercial progress in the area of polymer blends during the past decades has been tremendous and was driven by the realization that, by blending, new materials can be developed and implemented more rapidly and economically.[1]

Thermoplastic polyurethane are suitable materials for preparing gas separation membranes with high permeability.[2,3] However, the use of polyurethane membrane for gas separation is limited by its low selectivity of separation gases. In order to overcome this problem, a poly(amide-imide)(PAI) and a polycarbonate(PC), which possess high carbon dioxide selectivity compared to PU, have been chosen as the blend materials, prepared PAI/PU and PC/PU blend membranes.

The objective of present study is a detailed investigation of the morphology and carbon dioxide transport properties of PU-base blend membranes. Efforts have been made to correlate the permeation behavior with the existing theoretical models.

EXPERIMENTAL

Thermoplastic polyurethane(PU)-based blend membranes were prepared by the solvent evaporation process. Polymer solutions of PC, PAI, and PU were prepared separately at concentration of 5 wt.% with varying blend ratio(PC or PAI : PU = 0:100, 5:95, 10:90, 15:85 wt.%). The mixture solution were poured into glass petri-dish and the solvent was evaporated at 80 °C and resulting membranes were dried in a vacuum oven for 3 days at 60 °C. The morphology of PU based blend membranes was investigated by SEM. The CO_2 permeabilities of pure gases and ideal separation factor(α) through the PU-based blend membranes were measured by a soap film flowmeter. Sorption isotherms of CO_2 in the polyurethane blend membranes were obtained by use of micro-balance(Cahn Instruments Inc., C-1000) as shown in Figure 1 and analyzed on the basis of dual-mode sorption model. The CO_2 selectivity from CO_2/N_2 mixture was calculated according to the ratio of gas composition at the feed side and the permeate side.

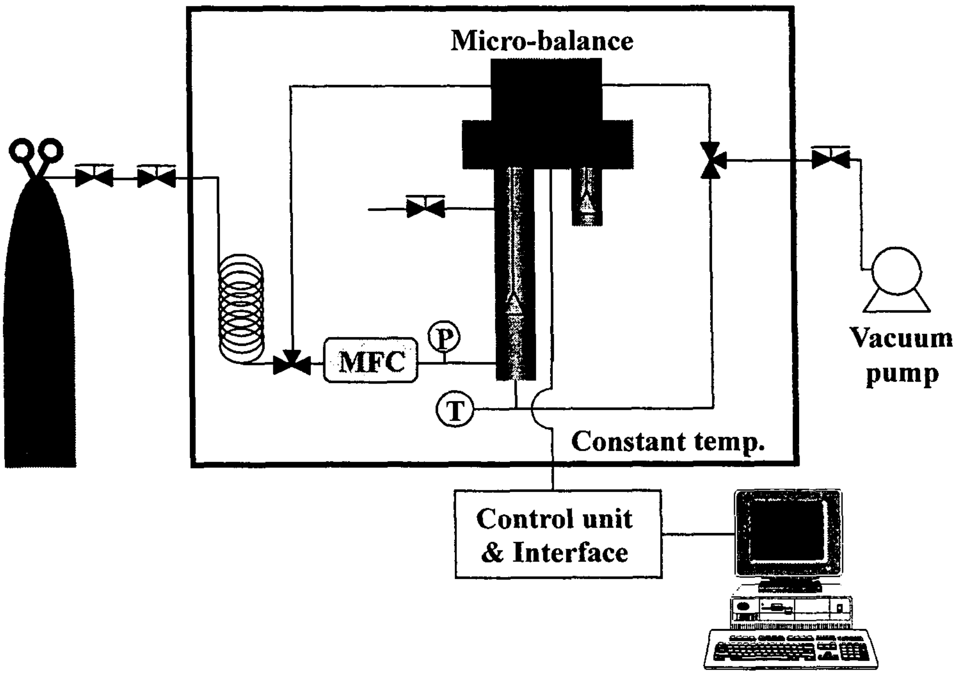

Figure 1. The experimental set-up for gas sorption measurement.

RESULTS AND DISCUSSION

Thermoplastic polyurethane-based membranes were prepared by the solvent evaporation process. The CO_2 separation properties of PU-based blend membranes with different blend ratio have been studied. The morphology of PU based blend membranes was investigated by SEM. As shown in Figure 2, the resulting membranes were immiscible and phase separation occurred with increasing blend ratio.

For PC/PU blend membranes, the CO_2 permeability of membranes were in the order of 14.82 ~ 38.11 × 10^{-10} $cm^3(STP)\cdot cm/cm^2\cdot s\cdot cmHg$ as shown in Table 1. The CO_2 permeability of PAI/ PU blend membranes were in the range of 9.89 ~ 15.37 × 10^{-10} cm^3 $(STP)\cdot cm/cm^2\cdot s\cdot cmHg$. The CO_2 permeability of the PU-based membranes decreased with increasing the blend ratio from 0 to 15 wt.%. However, CO_2 ideal separation factor of blend membranes increased with blend ratio.

The PU-based blend membrane showed high CO_2 permeation and the CO_2/N_2 selectivity of the blend membrane was improved with increasing blend ratio. CO_2 permeation behaviors of blend membranes were affect by blend composition. The permeation properties of PAI/PU blend membranes are directly comparable to existing commercial gas separation membranes. As a result, thermoplastic polyurethane(PU)-based blend membranes exhibit good perspective for future industrial application.

REFERENCES

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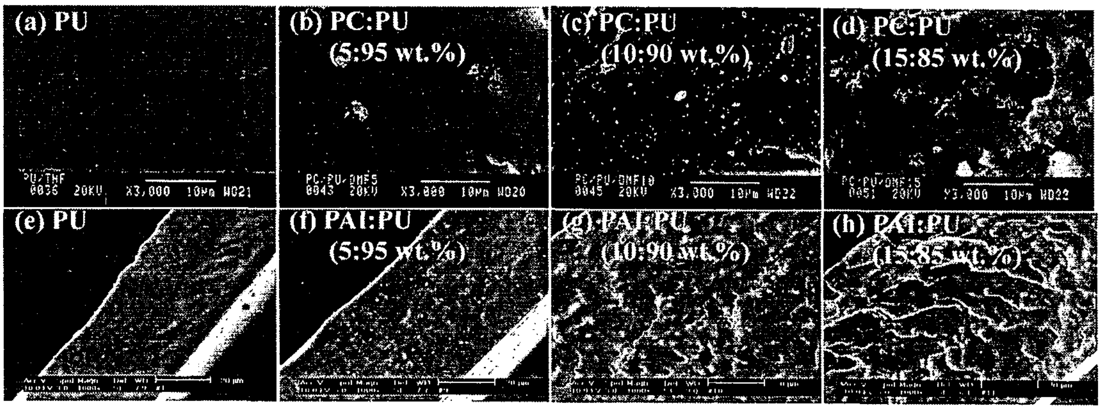

Figure 2. The SEM photographs of thermoplastic polyurethane-based membranes.

Table 1. The CO_2 permselective properties of polyurethane-based membranes(T = 25 °C, 6 atm)

Membrane	P_{CO_2} (Barrer)	P_{N_2} (Barrer)	Ideal separation factor(-)
PC/PU(0:100)	38.11	2.59	14.71
PC/PU(5:95)	28.88	1.57	18.39
PC/PU(10:90)	18.72	0.96	19.5
PC/PU(15:85)	14.82	0.78	19.0
PAI/PU(0:100)	15.37	1.52	10.11
PAI/PU(5:95)	13.80	0.71	18.42
PAI/PU(10:90)	12.19	0.51	23.90
PAI/PU(15:85)	9.89	0.37	26.73