

Gas Sorption, Diffusion and Permeation of Ordered Polymeric Membranes

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There are many studies on an amorphous polymeric membranes for separation of gas, ion, solute, water, and so on. Although the separation membrane is successful in a certain sense, membrane technology expects a much more efficient polymeric membrane. We have studied gas sorption, diffusion, and permeation of ordered (crystalline or mesophase) polymeric membranes to develop highly separative polymeric membranes like enzyme. Here two types of ordered membranes are presented: one is poly(4-methyl pentene-1)(PMP) and the other is mesophase of syndiotactic polystyrene (SPS).

CO₂, O₂, N₂ and CH₄ gas permeability coefficients and diffusion coefficients of PMP with three different degree of crystallization, 29.3, 51.4, and 77.5% were plotted against the degree of crystallization. The plot demonstrated a linear relationship. One could evaluate the gas permeability coefficient and diffusion coefficient of purely amorphous and crystalline PMP by an extrapolation of the linearity. Figure 1 shows the relationship of diffusion coefficient of crystalline part of PMP and kinetic diameter of penetrant gas of CO₂, O₂, N₂ and CH₄. One can recognize even CH₄ gas diffusion of PMP crystal, although no permeation through crystalline part is well known for crystalline polymeric membrane.

SPS can form δ form complexed with organic solvent such as toluene. Mesophase of SPS is prepared by annealing of δ form, which indicates desorption of solvent remaining almost no structural change of both conformation backbone chain and crystal lattice (Figure 2). Mesophase containing molecular cavity with the size and shape of solvent, eg., toluene or p-xylene can sorb the same solvent in a manner of Langmuir sorption while it can not do throughly solvent with different size and shape, eg., m-xylene. This suggests a molecular recognition of p- and m-xylene and mesophase SPS might be useful for separation membrane and adsorptive material.

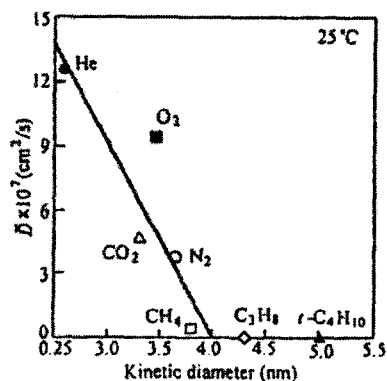


Fig. 1 The plot of diffusion coefficient of crystalline part of PMP against kinetic diameter

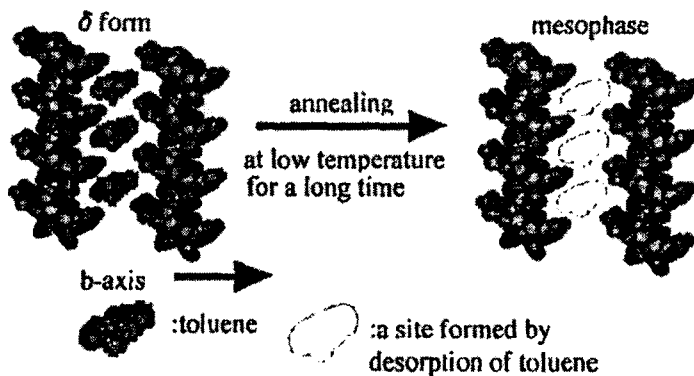


Fig. 2 Schematic representation of δ form and mesophase of SPS