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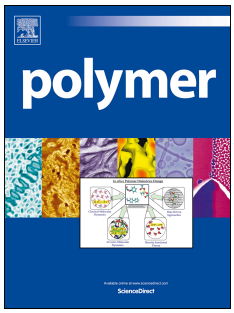

Oxygen diffusivity and permeation through polymers at elevated temperature

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Oxygen diffusivity and permeation through polymers at elevated temperature

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Abstract

Oxygen permeability (*P*), diffusivity (*D*) and solubility (*S*) properties are representative of gaseous diffusion in polymers and required for the understanding of polymer physics driven phenomena as well as the quantification of mass transport or polymer degradation processes when diffusion limited oxidation effects result in spatially dependent oxidation behavior. Precise *P, D, S* characterization data for O_2 in polymeric materials at elevated temperatures have not been reported due to instrumental challenges and competitive reactively driven oxygen loss (oxidation reactions), although estimations have been accomplished from indirect measurements of oxidation depths when analyzed with theoretical degradation models. This study offers an overview on experimental approaches which have been applied to the characterization of a range of thin polymer films. As an overview, the O_2 permeation features of three epoxy thermo-set materials, polyimides (Kapton and bismaleimides), and polypropylene for 25 to 140°C were investigated with time-dependent flux measurements and yield permeation data which so far have not been available in the literature. Arrhenius plots of *P* for two epoxies (828/D230 and 828/D400) show the influence of the glass transition temperature, and intriguingly a transition originates mostly through noticeable changes in *S* but not *D*. Multiple material behaviors demonstrating the influence of reactive oxygen loss are discussed. Polymer oxidation chemistry will often interfere with physical permeation measurements at elevated temperatures, in conflict with perhaps the expectation for simple non-reactive O_2 transport. Misleading data may result unless the underlying reactive oxidative loss is considered and compensated for, or permeation data are compared at multiple O_2 partial pressures to validate non-reactive experimental conditions.

Key words: O_2 permeability/diffusivity/solubility, temperature dependence, reactive transport conditions, competitive oxidation, thermo-set polymers and T_g

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