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OXYGEN DIFFUSION INTO POLYMER-CLAY COMPOSITE FILMS AS A FUNCTION OF CLAY CONTENT AND TEMPERATURE

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A simple fluorescence technique is proposed for the measurement of the diffusion coefficient of oxygen into polystyrene-clay composite films as a function of clay content and temperature. The composite films were prepared from the mixture of surfactant-free pyrene (P)-labeled polystyrene latexes (PS) and modified Na-montmorillonite (MNaLB) clay at various compositions at room temperature. Here pyrene was used as the fluorescent probe. These films then annealed at 200 °C above glass transition (T_g) temperature of polystyrene for 10 min. Oxygen diffusion into composite films were monitored with steady state fluorescence (SSF) measurements. To evaluate the effect of MNaLB content on oxygen diffusion, diffusion measurements were performed at room temperature for seven different MNaLB content (0, 5, 10, 20, 30, 50 and 60 wt. %) films. The diffusion coefficients, D of oxygen were determined by the fluorescence quenching method by assuming Fickian transport and were found to be increased from 7.4 x 10-10 to 26.9 x 10-10 cm^2s^{-1} with increasing MNaLB content. This increase in D values can be explained with formation of microvoids in the film. On the other hand, to examine the effect of temperature on oxygen diffusion, diffusion measurements were performed over a temperature range of 25-70 °C for 0, 5 and 20 wt. % MNaLB content films. Diffusion activation energies were calculated and found to be decreased from 2.44 to 0.44 kcal/mol with increasing MNaLB content. No clay content and temperature effects were observed on quenching rate constant, kq and mutual diffusion coefficient, Dm values. The results showed that D values are strongly dependent on both temperature and clay content in the film.