The Role of Penetrant Structure on the Transport and Mechanical Properties of a Thermoset Adhesive

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(ABSTRACT)

In this work the relationships between penetrant structure, its transport properties, and its effects on the mechanical properties of a polymer matrix were investigated. Although there is a vast amount of data on the diffusion of low molecular weight molecules into polymeric materials and on the mechanical properties of various polymer-penetrant systems, no attempts have been made to inter-relate the two properties with respect to the chemical structure of the diffusant. Therefore, two series of penetrants – *n*-alkanes and esters – were examined in this context, with the goal of correlating molecular size, shape, and chemical nature of the penetrant to its final transport and matrix mechanical properties. These correlations have been demonstrated to allow quantitative prediction of one property, given a reasonable set of data on the other parameters.

A series of *n*-alkanes (C_6-C_{17}) and esters (C_5-C_{17}) have been used to separate the effects of penetrant size and shape, from those due to polymer-penetrant interactions, in the diffusion through a polyamide polymeric adhesive. These effects have been taken into account in order to yield a qualitative relationship that allows for prediction of diffusivity based upon penetrant structural information. Transport properties have been analyzed using mass uptake experiments as well as an *in-situ* FTIR-ATR technique to provide detailed kinetic as well as thermodynamic information on this process.

The phenomenon of diffusion and its effects on the resulting dynamic mechanical response of a matrix polymeric adhesive have been studied in great detail using the method of reduced variables. The concept of a *diffusion-time shift factor* ($\log a_{Dt}$) has been introduced to create doubly-reduced master curves, taking into account the effects of temperature and the variations in the polymer mechanical response due to the existence of a low molecular weight penetrant.