Chapter 1   Introduction

Polymeric adhesives are currently utilized and have much potential in a variety of applications ranging from building construction and bonding of automotive panels, to the manufacture of flexible circuits for missile technology.   However, most of these applications are largely influenced by the fact that the integrity of these materials cannot be predicted over a typical lifetime. Two of the most important factors that determine the lifetime of the materials are temperature and exposure to solvents (usually low molecular weight liquid penetrants). Both of these factors may constitute part of the environment to which a polymer is subjected, and in most cases, are unavoidable.

For the above reasons, this demands extensive knowledge of the effect of the above factors on the properties of the polymer. These effects have been the topic of study of many investigations that have been carried out over the last few decades. *The current study is an attempt to gain insight into the influence of low molecular weight "penetrants" on the transport and mechanical properties of a polyamide-type adhesive, and to be able to predict the behavior of the adhesive, in a selected environment.*

The presence of a low molecular weight liquid in a polymeric adhesive can be one of the most important factors that influences the overall performance of an adhesive system in real-life applications[1]. Water is one example; but, this thesis is focused on organic fluids as penetrants. These low molecular weight species may enter a polymer-substrate system via diffusion through the matrix material and/or through cracks and crazes. Once a penetrant is introduced into a system, it may lead to a variety of chemical and physical changes in the material.   These changes include solvent induced crystallization[2,3], plasticization of the material[4,5], and/or creation of a weak boundary layer between the adhesive and a substrate[6]. Most of these changes alter the properties of the material to a considerable extent, and may render the material unsuitable for many purposes. Therefore, there exists a great need to gain insight into the factors that control this process of diffusion of penetrants.

The kinetics governing liquid diffusion in a polymer is the result of a complex combination of many variables. Some of these variables are based on external factors such as temperature and stress that have been shown[7] to strongly influence the transport process.   Others are based on structural features of the polymer and the penetrants themselves. This study will focus on developing correlations between the structure of a penetrant and its diffusion properties within a polymeric adhesive. Penetrant structure will be characterized in terms of *size* and *shape* of the molecules. The role *of specific interactions between the penetrant and polymer matrix* in the diffusion phenomenon will also be explored.

As alluded to above, the existence of a low molecular weight species within a polymer matrix can greatly alter the performance of the polymer in its applications. Thus, there is also the need to predict the changes in mechanical response of a material as a result of such a diffusion process. Such a prediction will be attempted in this study by

invoking the principles of reduced variables, a prominent example of which was proposed by Williams, Landel, and Ferry[8,9].

One of the *most important* and *unique* features of this study will be the correlation between the chemical structure of the penetrant, and the subsequent effect on the transport properties on the one hand, and the changes it induces in the mechanical response of a polymer, on the other. These correlations of the three properties will enable the prediction of one parameter, given a reasonable set of data on the other parameters. Such predictive capability, if available, could broaden the range of application of this scheme to other polymers and many penetrants. These ideas are pictorially represented in Figure 1-1.
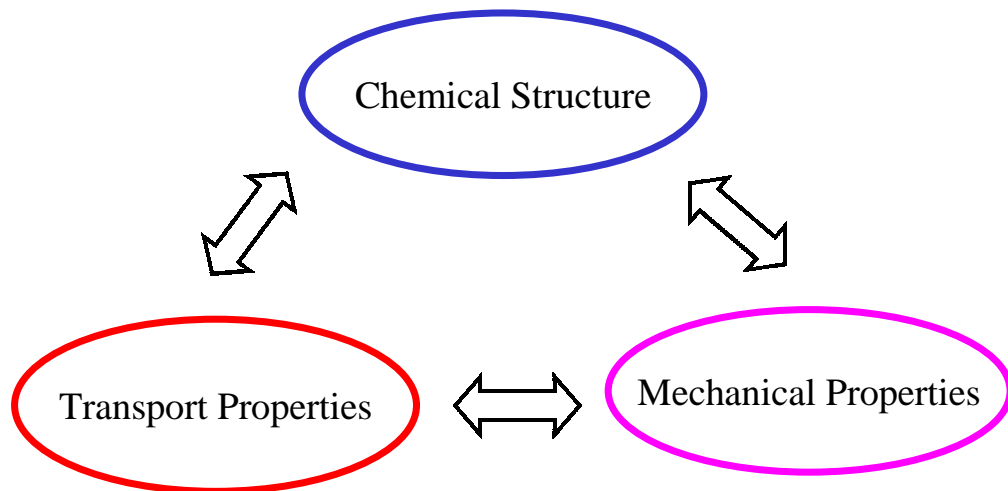
Figure 1-1. Objective of this project: inter-relate the three properties shown above using information starting with the chemical structure of a penetrant

Endnotes

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