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Monitoring Diffusion in Real Time in Thin Polymer Films Using SAW Devices

Gregory C. Frye, Stephen J. Martin and Antonio J. Ricco

Sandia National Laboratories, Division 1846,
P.O. Box 5800, Albuquerque, NM 87185 USA

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The ability of surface acoustic wave (SAW) devices to characterize the permeation properties of molecular species in thin polymer films has been investigated. For polyimide and polystyrene films, the low concentration behavior of N_2O and a series of organics appears to be consistent with one-dimensional Fickian diffusion. Diffusion coefficients (D) obtained from the absorption transients for several short-chain organic molecules ranged from 10^{-9} to 10^{-14} cm^2/sec. For polyimide, D was found to decrease exponentially with absorbate molar volume and to increase linearly with absorbate partial pressure. A small but fast response to the absorbates in a chemical vapor-deposited (CVD) polysiloxane film was determined to be due to rapid permeation but low solubility. A major advantage of the SAW measurement technique is that the small diffusional length scale of thin films, when combined with the high sensitivity of a SAW device, results in the ability to rapidly monitor polymer permeation properties.

1. Introduction

The ability to prepare organic polymer films with a wide variety of molecular structures can be useful in tailoring the amount of absorption and the diffusional properties of various types of molecular species in a given film. This flexibility makes these films useful in preparing selective or complete permeation barriers, such as gas separation membranes and semiconductor passivation layers,[1] as well as for chemical sensor applications.[2] However, it is often difficult to directly characterize the properties of these thin films due to the low total volume present in