

ABSTRACT

THESIS: Infrared Spectroscopic Study of Polyimide Film Degradation
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This thesis focuses on the study of solvent degradation on polyimide films. Polyimides spun on silicon and freestanding polyimide films were exposed to solvents as a function of time at a constant temperature. The polyimide spun on silicon was immersed in dimethyl sulfoxide (DMSO) at 90°C for 30, 90, 270, and 450 min. Infrared spectra were obtained via multiple-bounce attenuated total reflection (ATR) and reflection-absorption (RA) spectroscopy. Thickness calculations were made using interference fringes obtained from RA spectra for each time interval. A reduction of thickness was observed with a total difference of 1.5 μm suggesting film degradation as a function of solvent exposure. Spectral changes in the symmetric and asymmetric carbonyl stretching modes were observed in both the ATR and RA sampling, which could be attributed to further curing of the polymer.

Two experiments were performed on the freestanding polyimide film. The first experiment exposed the film to DMSO and the second to n-methyl pyrrolidinone (NMP).

In both instances, the freestanding film was immersed in the solvent at 98°C for 30, 90, 270, and 450 min. Infrared spectra were obtained via single-bounce ATR and transmission spectroscopy. No noticeable differences in spectra were observed. Thickness calculations were made using interference fringes obtained from transmission spectra. After immersion in DMSO, the thickness of the film increased initially, but then no significant changes in thickness occurred after 30 min. The initial increase in thickness may be due to solvent being trapped inside the film.

After immersion in NMP, the thickness calculations showed no change in film thickness. However, our data as well as past researchers suggested some increase in thickness must occur due to solvent absorption. We propose that film degradation may be occurring in the NMP at approximately the same rate as swelling, thus no net decrease in thickness could be observed. This hypothesis is supported by the fact that a yellow coloration was visually observed to be in the solvent after immersion of the freestanding film. A subtraction of a spectrum of fresh NMP solvent from the spectrum of the yellow-colored solvent showed bands consistent with polyamic acid, a starting material for the freestanding film, which could have been formed from a hydrolysis reaction.