

OPTICAL PROPERTIES OF FLUORINE-CONTAINING POLY(ARYL ETHER) AND POLY(ARYL ETHER KETONE)

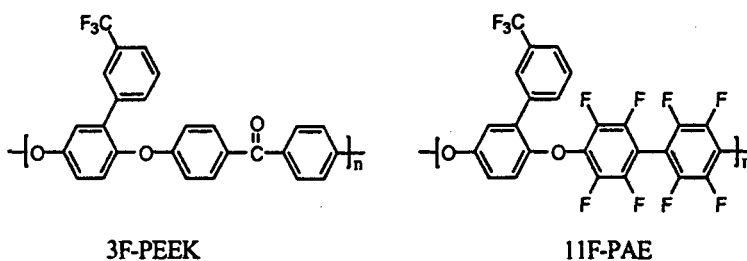
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Introduction

Fluorinated polymers are expected to be used as microelectronic and optical devices, due to their unique properties. Polymer optical waveguides are attractive for economical and practical optoelectronic integrated circuits and multichip interconnections¹. The key requirements imposed on the polymer materials include high transparency at the wavelength of optical communication (1.3 and 1.55 μm) and high decomposition temperature to withstand fabrication processing and operation conditions².

A series of fluorinated PAEKs and PAEs were developed by us recently³. In this paper, the optical properties of 3F-PEEK and 11F-PAE were presented. The polymers were prepared via typical aromatic nucleophilic substitution reaction. The structure of polymers was as follows:



Results and Discussion

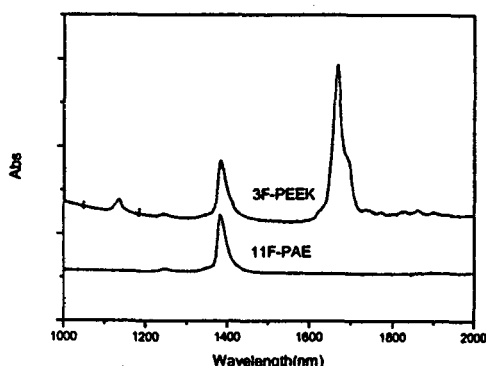


Figure 1. Light absorption spectra of 3F-PEEK and 11F-PAE.

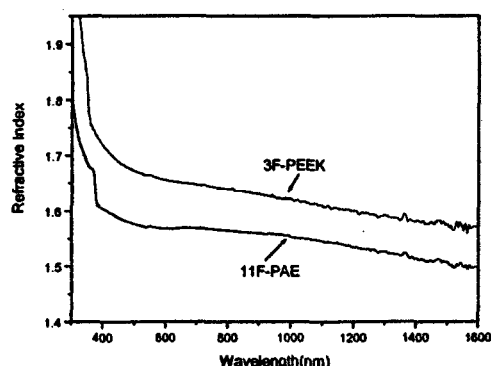


Figure 2. Refractive indices of 3F-PEEK and 11F-PAE films.

The light absorption spectra of 3F-PEEK and 11F-PAE thin films were showed in Figure 1. The absorption in the visible region was mainly caused by electron transition, but the absorption in the near-infrared region was mainly caused by the harmonics and

their coupling of the stretching vibration of chemical bonds⁴. Carbon-hydrogen(C-H) bonds strongly affected the absorption. Except for a small absorption peak, the highly fluorinated 11F-PAE film had no obvious absorption peaks over the entire telecommunication wavelength region(1.1-1.7 μ m). On the other hand, 3F-PEEK had an absorption peak due to the third harmonic of the stretching vibration of the C-H bond ($3\nu^{\text{CH}}$, 1.13 μ m), a peak due to the combination of the second harmonic of the stretching vibration and deformation vibration of the C-H bond ($3\nu^{\text{CH}}+\delta^{\text{CH}}$, 1.38 μ m), and a peak due to the second harmonic of the stretching vibration of the C-H bond ($2\nu^{\text{CH}}$,1.66 μ m). However, it had a small light absorption at the telecommunication wavelength of 1.3 and 1.55 μ m.

The refractive index dependence on wavelength was showed in Figure 2. The refractive indices of polymers decreased with increasing wavelength. The refractive indices of 11F-PAE were lower than that of 3F-PEEK during the entire region. The main reason was the introduction of fluorine atoms. According to the Maxwell Equation: $\epsilon=n^2$, the dielectric constant(ϵ) of 11F-PAE would be lower than that of 3F-PEEK. Both 3F-PEEK and 11F-PAE showed excellent thermal stability. The temperatures at which 5%weight loss was observed were 502 $^{\circ}$ C and 532 $^{\circ}$ C in air, respectively. A typical TGA trace was showed in Figure 3.

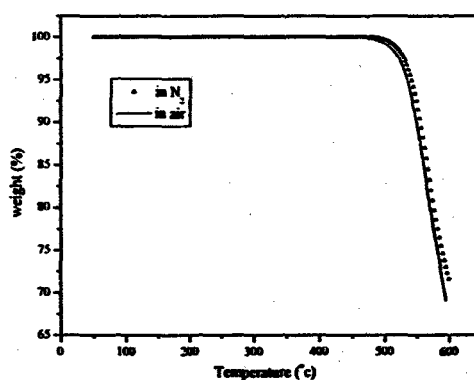


Figure 3. TGA traces of 11F-PAE.

Conclusions

In this study, optical properties of aromatic fluorinated polymers, 3F-PEEK and 11F-PAE were discussed. 3F-PEEK and 11F-PAE films showed low light absorption at the telecommunication wavelength of 1.3 and 1.55 μ m. In the near-infrared spectra, 11F-PAE showed lower refractive index than that of 3F-PEEK. In addition, they had high thermal stability.

References

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