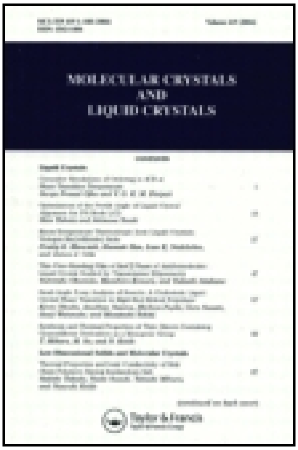

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Chloro-Fluorinated Poly(arylene ethers) for Optical Waveguide Application

Kwansoo Han [a] , Woo-Hyuk Jang [a] & Tae Hyung Rhee [a]

[a] Telecommunication R&D Center, Samsung Electronics Co., LTD., Suwon P.O. Box 105, Kyungki-Do, 449-600, Korea

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Chloro-Fluorinated Poly(arylene ethers) for Optical Waveguide Application

KWANSOO HAN, WOO-HYUK JANG, and TAE HYUNG RHEE
Telecommunication R&D Center, Samsung Electronics Co.,LTD. Suwon P.O. Box 105, Kyungki-Do 449-600, Korea,

Optical polymers which exhibit good thermal stability, refractive index controllability, and low optical loss in the optical communication wavelengths were developed by using chloro-fluorinated poly(arylene ethers).

Keywords: optical polymer; chloro-fluorinated poly(arylene ethers)

INTRODUCTION

There have been a great deal of interests and researches on polymer optical waveguides [1-2]. Polymers suitable for waveguide applications must have high thermal stability, refractive index controllability, and low optical loss in the optical communication wavelengths of 1.3μm and 1.55μm. One of the polymers which meet these requirements is fluorinated or perfluorinated polyimides[3-5]. Since fluorinated poly(arylene ether) has good thermal stability and low dielectric constants,[6] it may be a potential candidate for optical polymers. In this paper, we demonstrate a novel approach to designing optical polymers which exhibit good thermal stability, refractive index controllability, and low optical loss in the near-infrared wavelength region by using chloro-fluorinated poly(arylene ethers).

EXPERIMENTAL

Synthesis of Polymers and Measurements

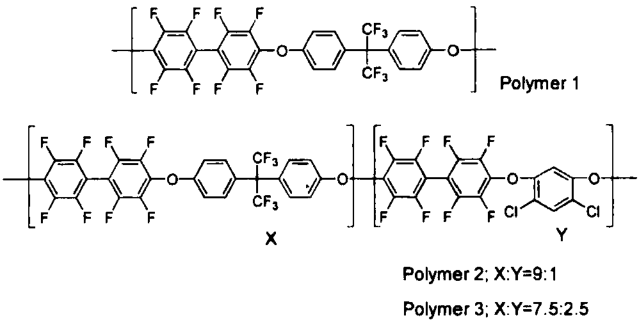

FIGURE 1 Chemical structures of polymers

Fluorinated poly(arylene ether) was synthersized from 4,4'-(hexafluoroisopropylidene)diphenol(Bisphenol AF) and decafluorobiphenyl. The copolymers were prepared by appropriate molar ratio of 4,6-dichlororesorcinol and Bisphenol AF with decafluorobiphenyl as shown in the Fig.1. The polymer solutions were prepared from a 50/50 mixture of 2-ethoxy ethyl ether and cyclohexanone, and were spin-coated onto a silicon wafer and dried for 15 minutes at 100°C, 20 minutes at 180°C, and 45 minutes at 400°C. Refractive indices of the polymer films were measured using Metricon 2010 Prism Coupler. Near infrared spectra of the samples were measured using ATI Mattson Infinity FTIR Spectrometer.

RESULTS AND DISCUSSION

The molecular weights, glass transition temperature(T_g), and TGA weight loss of the polymers are summarized in Table I. These polymers had T_g values in the range of 181~186 °C and exhibited relatively good thermal stability.

TABLE I. Characterizations of polymers

Polymer	M_nx10^{-4} (g/mole)[a]	T_g (°C)[b]	TGA weight loss onset in N_2 (°C)[c]
1	3.0	182	521
2	3.6	181	524
3	1.2	186	541

a. determined by polystyrene as a standard.
b. determined by DSC at a heating rate of 10°C/min.
c. determined by TGA at a heating rate of 10°C/min.

To investigate the effect of addition of chlorine moiety to optical loss of polymer, we compared the near-IR spectra of poly(methyl methacrylate) and carbon tetrachloride. As shown in Fig.2, there are strong absorption peaks between 1.0μm and 1.7μm in poly(methyl methacrylate) whereas these absorption peaks are not observed in carbon tetrachloride.

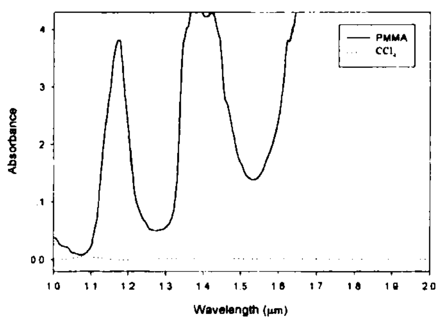

FIGURE 2 Near-IR spectra of PMMA and CCl_4.

It is known that the absorption peaks due to C-F bonds appear at longer wavelengths than C-H bonds[7]. The absence of absorption peaks due to C-Cl bonds in the near-IR region can be explained by the same reasons for the absorption behavior of C-F bonds. The effect of addition of chlorine moiety on refractive index of polymer was monitored using the prism coupler. As shown in Table. II, the refractive index of the polymer increased with chlorine moiety. This may result from the larger electronic polarizability of the C-Cl than that of C-F[8]. From above results, refractive indices of the optical polymers can be controlled by appropriate combination of chlorine and fluorine contents in the polymer, without causing further optical loss.

TABLE II. Refractive indices of polymers at TE polarization mode

Polymer	633 nm	1300 nm	1550 nm
1	1.5115	1.4935	1.4914
2	1.5170	1.4986	1.4965
3	1.5242	1.5066	1.5048

CONCLUSION

The chloro-fluorinated poly(arylene ethers) for optical application were synthesized. Optical polymers with desired refractive indices can be obtained by controlling the concentration of chlorine and fluorine in the polymers, without increased optical loss.

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