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Synthesis of New Poly(Silicate Esters) with Disperse Red 1 and Their Application as Optical Data Storage Materials

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New silicate ester monomer was synthesized by the reaction of 3-methacryloxypropylmethyldichlorosilane with disperse red 1 in methylene chloride. The monomer was polymerized with a radical initiator to produce the corresponding homopolymer and copolymers. These polymers were found to be excellent as reversible optical information recording media for data storage and retrieval through a trans-cis isomerization of the azobenzene groups by Ar laser irradiation.

Keywords: novel LC monomer; disperse red 1; optical data storage

INTRODUCTION

Since photoresponsive polymers containing azobenzene groups in the side chain have been demonstrated to be good candidates for optical

data storage and retrieval, they have been the subject of a number of papers. Azobenzene molecules in the side chain of the polymers absorb a linearly polarized light and they align perpendicular to the plane of polarization of the light. This results in the change of optical birefringence during an information recording process. The information derived from such an optical anisotropy can be erased by a circularly polarized light. These phenomena result from a trans-cis photoisomerization of azobenzene molecules [1], [2].

The present work describes the synthesis of new poly(silicate esters) with paired azobenzene units and their application to optical data storage media.

EXPERIMENTAL

As shown in Figure 1, new thermotropic liquid crystalline (LC) silicate ester monomer (MSi) was synthesized by reacting 3-methacryloxypropylmethyldichlorosilane and disperse red 1 in methylene chloride at room temperature for 48 h. Copolymers from MSi and methly methacrylate (MMA) as well as homopolymer were prepared by free-radical polymerization in THF solvent. The polymerization was carried out by using AIBN as a radical initiator at 60 ℃ for 72 h. The results for polymerization are listed in Table 1. The polymeric thin films for optical data storage were cast from the polymer solution (5 wt%) in $CHCl_3$ onto a glass plate for 30 seconds using a spin coater.

RESULTS AND DISCUSSION

Phase Transition Behavior

MSi showed monotropic behavior in which LC phase appears at 80 ℃ on cooling cycle of DSC measurement. It, however, had a typical smectic batonnet texture on both heating (76-87 ℃) and cooling cycles

(87-65 ℃) by the optical polarizing microscope. On the other hand, the resulting homopolymer and copolymers exhibited only the melting temperature on a heating cycle without any mesophases.

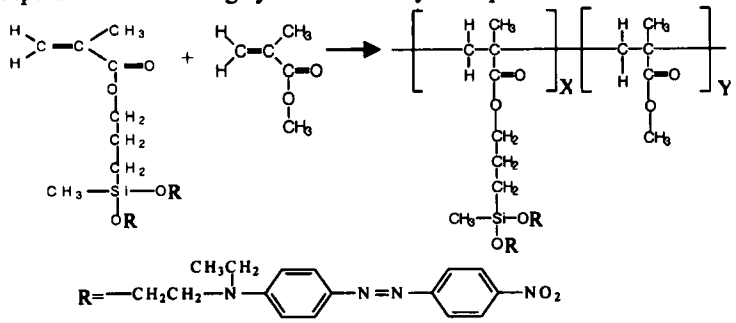

FIGURE 1. Synthesis of homopolymer and copolymer.

TABLE 1. Physical Properties of the Homopolymer and Copolymers

Polymer	Feed rato MSi :MMA	Copolymer[a] Composition MSi : MMA	Mw	Tg (℃)	Initial[b] decomposition temp (℃)
Homopsi	100 : 0	100 : 0	6500	47	195
P(Si-co-MMA)-1	75 : 25	57 : 43	11600	68	208
P(Si-co-MMA)-2	50 :50	42 : 58	13600	68	219
P(Si-co-MMA)-3	25 : 75	19 : 81	18700	76	221
P(Si-co-MMA)-4	5 : 95	3 : 97	25800	93	245

[a]caclulated from the characteristic peaks of H-NMR spectra.

[b]Temperature of 1.0 wt% loss in TGA thermogram.

Application as Information Storage Materials

The application of the prepared polymers as optical data recording media was performed according to our previous literature[3]. As a result, Figure 2 shows writing and relaxation and erasing profile on the polymeric films with the irradiation time. When the Ar laser (488 nm) is turned on, the transmitted intensity rapidly increases in a write-in process. This means that the azobenzene groups, which are randomly distributed inside the film, are aligned perpendicular to the plane of

laser polarization through a trans-cis isomerization of azobenzene groups. Such an orientation gives rise to high transmission during a read-out process. On the other hand, the recorded data rapidly decay within the first few seconds and then become retained for a long time, when the writing laser is turned off. The stored data also are erased (no transmission) by circularly polarized Ar laser. Therefore, we found that the polymers could be used as reversible optical data storage materials. Figure 3 shows the clear analog image pattern with a minimum line width of 2 μm(⟶), which is stored in the polymeric film.

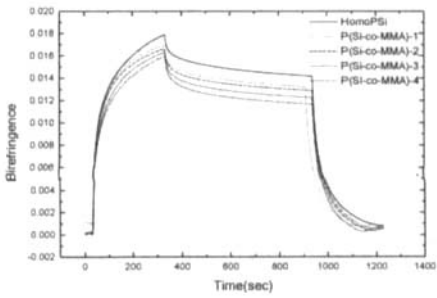

FIGURE 2. Writing, relaxation and erasing Profile.

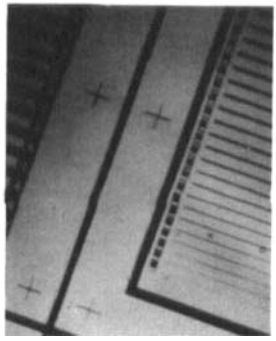

FIGURE 3. Image pattern stored in P(Si-co-MMA)-2.

Acknowledgments

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