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Synthesis of Azo Dye Containing Polymers and Application for Optical Data Storage

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Poly(malonic ester) with two symmetrical azobenzene groups (PDR1) was synthesized, and azo dye-doped polymer (ADP) thin films were prepared using PDR1 and matrix polymers such as PMMA, PC, and PVK. All the ADP thin films were found to be suitable as reversible media for data storage and retrieval. The mechanism of the optical recording was a trans-cis isomerization of the azobenzene units by the irradiation of linearly polarized Ar laser and thermal process.

Keywords: trans-cis isomerization; disperse red 1; optical data storage

INTRODUCTION

Photoresponsive polymers have attracted wide interests for their applications of the optical data storage and optical computing. The azobenzene containing polymers and ADP systems show an excellent photosensitivity. The birefringence is induced by the linearly polarized light with the mechanism of trans-cis-trans isomerization[1,2], which can be adopted for the digital data storage.

In this work, we investigated the properties of the thin film of the poly(malonic ester) with two symmetrical azobenzene groups (PDR1) in a polymer matrix (PMMA, PC, and PVK) and the possibility of their application to the media for optical data storage.

EXPERIMENTAL

The monomer and polymer (Figure 1) were synthesized and characterized according to the method[3] reported previously. The matrix polymers of the best available grade were used without further purification: poly(methyl methacrylate) (PMMA, M_w 120,000, T_g 114 ℃), poly(bisphenol A carbonate) (PC, T_g 149 ℃), and poly(9-vinylcarbazole) (PVK, M_w 1,100,000, T_g 200 ℃). The solutions with 3 wt% of PDR1 and matrix polymer in chloroform were prepared. The

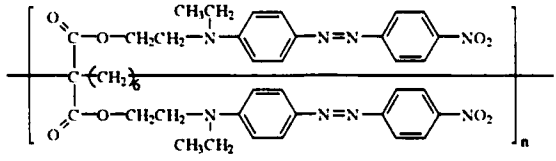


FIGURE 1. Structure of azo dye containing polymer (PDR1).

mass ratio of the PDR1 and matrix polymer was 10:90. This azo-dye doped polymer (ADP) thin films were coated onto a glass substrate by the spin coating method with rpm of 1000.

In order to induce and remove the birefringence, linearly and circularly polarized Ar^+ ion laser (488 nm) with an intensity of 10 mW/cm^2 was irradiated onto the sample, respectively. The sample was placed between two crossed polarizers and the variation of transmitted intensity from the probe beam of GaAs laser diode (847 nm) was measured.

RESULTS AND DISCUSSION

The process of writing, relaxation, and erasing which results in the change of transmitted intensity for three different samples and their repetition was shown in Figure 2. Even though the induced birefringence of ADP thin film was smaller than that of PDR1 thin film, the readout signal was large enough to be detected. In this result, PVK is a good polymer for the matrix material. PVK seems to provide a large free volume which makes the azo moiety orient easily, because

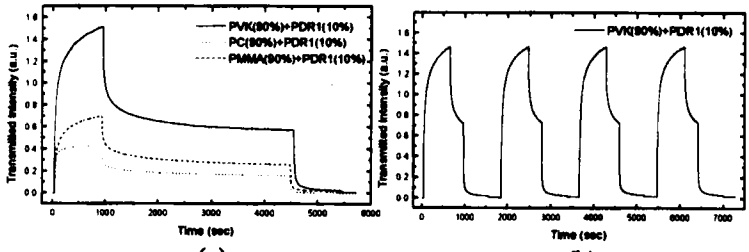
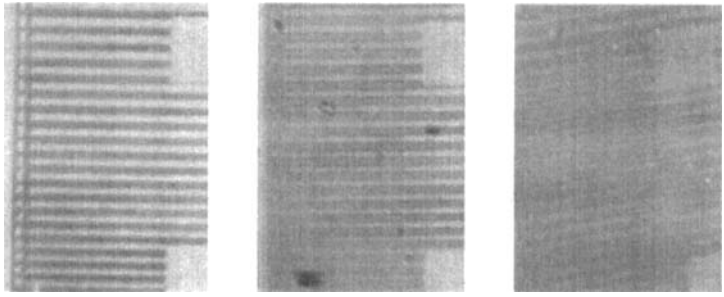


FIGURE 2. Transmitted intensity for (a) one cycle of writing, relaxation, and erasing process, and (b) five cycles of them for the films of blends.

it contains a lot of bulky groups in the side chain.

In addition, ADP thin films showed a good thermal stability. Figure 3 shows the thermal stability from an image pattern stored in a PDR1 in PVK thin film. This film was stable above 100 ℃. Other ADP thin films showed worse thermal stability than PDR1 in PVK thin film. The azo moiety in PC or PMMA seems to reorient easily, since T_g of PC and PMMA are lower than that of PVK.

In conclusion, all the ADP thin films were good media for reversible optical data storage and retrieval. Especially azo dye in PVK thin film were superior in the thermal properties to other thin films.



(a) (b) (c)

FIGURE 3. Thermal stability of image pattern stored in a blend of PVK and PDR1 film. Films were heat treated for 10 min (a) at 30 ℃, (b) at 50 ℃, and (c) at 100 ℃.

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