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Rewritable Optical Storage Effect of (Liquid Crystalline Polymer)/(Low Molecular Weight Liquid Crystal)/(Photoresponsive Molecule) Ternary Composite System

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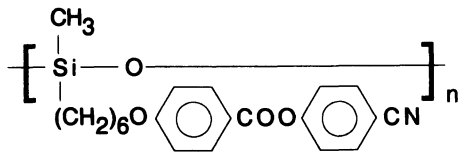
A rewritable optical storage effect induced by photoirradiation to a (liquid crystalline polymer)/(low molecular weight liquid crystal) /(photoresponsive molecule) ternary composite system was investigated. Turbid and transparent states were reversibly switched upon photoirradiation with ultraviolet and visible light, respectively, under the application of an a.c. electric field. A light-addressed optical storage of the composite film was demonstrated.

Recently, electro-optical properties of the composite system composed of side chain type liquid crystalline polymer (LCP) and low molecular weight liquid crystal (LMWLC) have been studied by the authors.[1-4] A bistable and reversible turbid-transparent switching driven by electric fields with two different frequencies was realized for the LCP/LMWLC composite system in a smectic phase. The threshold frequency f_c is defined as the critical frequency at which the composite system changes from transparent to turbid when the frequency of an imposed a.c. electric field was decreased. If the magnitude of f_c can be reversibly varied by another

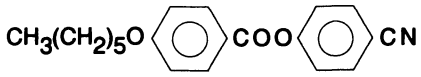
external stimulation such as photoirradiation, a rewritable optical storage effect in the composite system must be obtained by this stimulation. This paper deals with the rewritable optical storage effect induced by photoirradiation to the ternary composite system.

The chemical structures of LCP, LMWLC and photo-responsive molecule are given in Fig. 1. LCP and LMWLC used were poly(4-cyanophenyl 4'-hexyloxy benzoate methyl siloxane) (PS6EC) and 4-cyanophenyl 4'-hexyloxy benzoate (CPHOB), respectively. Also, 4,4'-dinonylazobenzene (9Az9) was used as photoisomerizable molecule. The weight ratio of LCP/LMWLC/9Az9 was 55/36/9. The ternary composite system forms a smectic phase. In order to investigate an electro-optical memory effect, the PS6EC/CPHOB/9Az9 composites were sandwiched between two ITO-coated transparent glass electrodes. The distance between the two electrodes was maintained by 10 μm thick PET film spacer. A change of the transmittance through the cell upon the application of an a.c. electric field or light irradiation was detected as a change in the output current of a photodiode. The incident light source for the light transmittance measurement was a He-Ne laser. The ultraviolet (UV) light of 365 nm and visible light (VIS) longer than 420 nm obtained by a 100 W high-pressure Hg lamp were irradiated to the composite film to photoisomerize 9Az9. The color filters (UV-D35 and L-42, Toshiba Co, Ltd.) were used to select the specific bright lines of the Hg lamp.

1. **Liquid Crystalline Polymer**
poly(4-cyanophenyl 4'-hexyloxy benzoate methyl siloxane)
K 297 S_A 421 I (Tg 260 K) (PS6EC)



2. **Low Molecular Weight Liquid Crystal**
4-cyanophenyl 4'-hexyloxy benzoate (CPHOB)
K 339 N 354 I



3. **Photo-responsive Molecule**
4,4'-dinonyl azobenzene (9Az9)
K 311 S_B 314 S_A 327 I

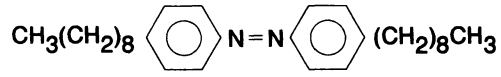


Fig. 1. Chemical structures of LCP(PS6EC), LMWLC(CPHOB), and 9Az9.

Figure 2 shows the temperature dependence of f_c for the PS6EC/CPHOB/9Az9 composite upon irradiation with UV and VIS lights. In the upper and lower regions to the f_c-temperature curve, the ternary composite became trasparent and turbid states, respectively. The irradiation time dependence of the UV absorption spectra for the ternary composite film at various temperatures upon irradiation of UV and VIS lights indicated that the trans-cis photoisomerization of 9Az9 occurred reversibly in the ternary composite film. The times required to reach photostationary states upon irradiation of UV and VIS lights at 338 K were 28 and 5.5 minutes, respectively. The magnitude of f_c increased upon irradiation with UV light (from curves 4 or 6 to curve 5 for 200 V_{p-p}), and the f_c-temperature curve (curve 5) reverted to an original one (curve 6) upon irradiation with VIS

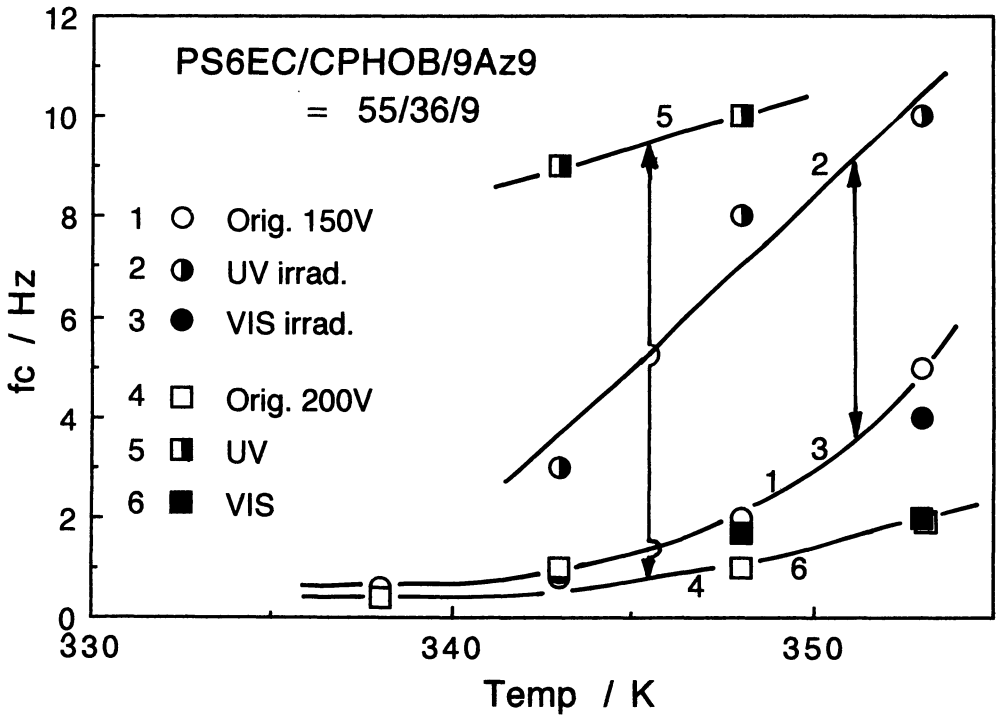


Fig. 2. Temperature dependences of critical frequency, f_c for the PS6EC/CPHOB/9Az9(55/36/9, w/w/w) composite upon irradiation with UV and VIS lights.

light as shown in Fig.2. Each turbid and transparent state remained unchanged after removing an electric field. Therefore, rewriting of optical informations is basically possible upon irradiation with UV and VIS lights to the PS6EC/CPHOB/9Az9 composite system under the application of a 200 V_{p-p} a.c. electric field with the frequency between the curves 5 and 6. It was actually confirmed that a UV-irradiated part selectively changed into a turbid state upon irradiation of UV light to the transparent composite film under the application of 1 Hz electric field of 150 V_{p-p} at 343 K. The UV-irradiated turbid part remained unchanged even if both electric field and photoirradiation were removed. The turbid state could be reversibly returned to the transparent one when a 150 V_{p-p} electric field of 1 kHz was imposed or VIS light was irradiated to the ternary composite under the application of a 150 V_{p-p} electric field with 1 Hz.

The photoresponsive electro-optical effects mentioned above indicate that the PS6EC/CPHOB/9Az9 composite system is promising as a novel photosensitive storage device to rewrite optical informations on the self-supported liquid crystalline film.

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