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Characterization of Photochromic Azobenzene Derivatives in the Liquid Crystalline Matrix

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Abstract

We investigated on the photoisomerization of azobenzene derivatives in liquid crystalline matrix that is 4-pentyl-4-bisphenyl carbonitrile (5CB) for holographic memory. In order to investigate of photoisomerization of azobenzene derivatives at the air/water interface, the azobenzene derivative having side chain monomer with alkyl chain was synthesized. The azobenzene derivatives in liquid crystalline matrix were characterized by the measurements of UV-vis spectroscopy, photorefractive index by two-beam coupling (2CB).

Keywords: Optical memory; Photorefractive effect; Two-beam coupling; Azobenzene derivatives.

INTRODUCTION

The photoisomerization of azobenzene derivatives and their derivatives have received considerable attention over the past few

years because of the potential applicability in areas such as high-density optical memory elements and molecular switching devices.[1] The derivatives of azobenzene cause photoisomerization when they are illuminates with UV light.[2] The structures are shown in Figure 1. In this paper, an amphiphlic azobenzene derivatives having side chain copolymer with Disperse Red 1 and methacrylic acid have been synthesized and studied in the liquid crystalline matrix of 4-pentyl-4-bisphenyl carbonitrile (5CB) for optical memory.

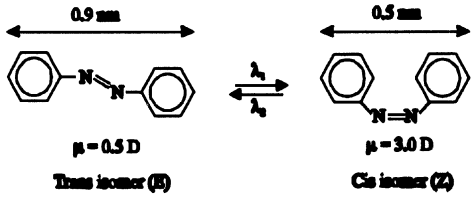

Figure 1. Characteristics of cis and trans isomers of azobenzene.

EXPERIMENT

The first step was the synthesis of 4-(N-methacryloyl)-Disperse Red 1 (DR1MA). The methacryloyl chloride (1 ml, 1 mmol) in THF (10 ml) was added dropwise to the cooled mixture of THF (20 ml), Disperse Red 1 (0.33g, 1 mmol) and triethylamine (0.1 ml, 1 mmol). The mixture was stirred at 0 ℃ for 1 h and followed by stirring at room temperature for 6 h more. The precipitated monomer was then filtered, dried and recrystallized from ethanol; Yield: 50%, TLC: R_f = 0.6 with eluent solution (ethyl acetate:hexane = 1:1, v/v). The second step was the synthesis of poly 4-(N-methacryloyl)-Disperse Red 1-methacrylic acid (pDR1MA). The mixture of methacrylic acid (3.65 g, 50 mmol), DR1MA (0.17g, 0.5 mmol) and AIBN (0.017g) as an initiator in 30 ml of acetone-water solution (v/v = 4:1) were deoxygenated by bubbling nitrogen gas for 30 min and were stirred at 50 ℃ for 24 h. The copolymers were precipitated in ethyl acetate and recrystallized from

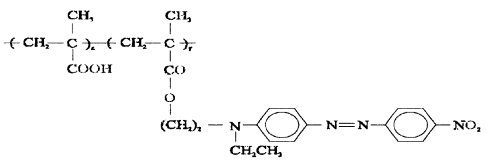

Figure 2. Chemical structure of pDR1MA.

ethanol; Yield: 25%, TLC: R_f = 0 with eluent solution (ethyl acetate:hexane=1:1, v/v). Photorefractive effect of pDR1MA in nematic liquid crystal was investigated by two-beam coupling. pDR1MA-doped nematic liquid crystal (5CB) was injected into the ITO cell which was poly(vinyacetate); PVA coated ITO glasses by 100μm of air gap. In the cell liquid crystal molecules were parallel-aligned. The polarized argon beam at 488 nm (intensity of 90 mW/cm^2) was splitted into two beam, which were crossed in the DC-voltage-biaed LC cell. The incident angle, bias DC voltage, and diffraction efficiency were measured by two-beam coupling (2BC). The 2BC system is shown in Figure 3.

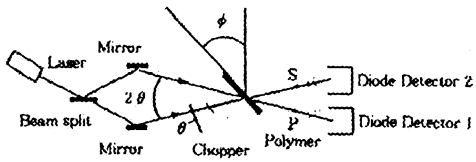

Figure 3. Experimental set-up of two-bea coupling (2BC).

RESULTS AND DISCUSSION

The photorefractive effect responded to the external DC field. Figure 4 shows the diffraction efficiency versus intensity of external DC voltage. The external DC voltage is over 3 V then the diffraction grating pattern start scattering. Because of these scattering, the diffraction index is decrease. Figure 5 shows the diffraction efficiency versus incident beam angle (external DC voltage is 2.8 V, intensity of Ar laser beam is 70 μW).

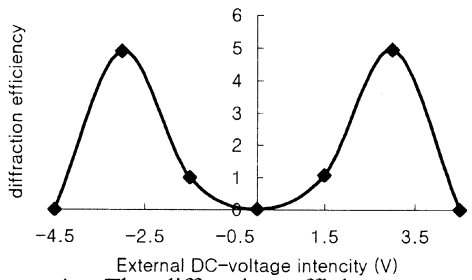

Figure 4. The diffraction efficiency grap of pDR1MA versus increasing of externa DC voltage.

Figure 6 shows the response time versus intensity of polarized Ar laser beam at 488 nm. The minimum response time was three second. And the minimum response intensity of laser beam was 155 μW (at 2.8 V of external DC voltage, 40° of incident beam angle).

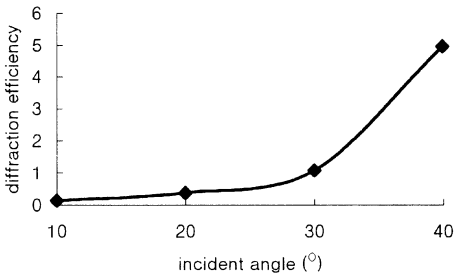

Figure 5. The diffraction efficiency versus incident beam angle (°).

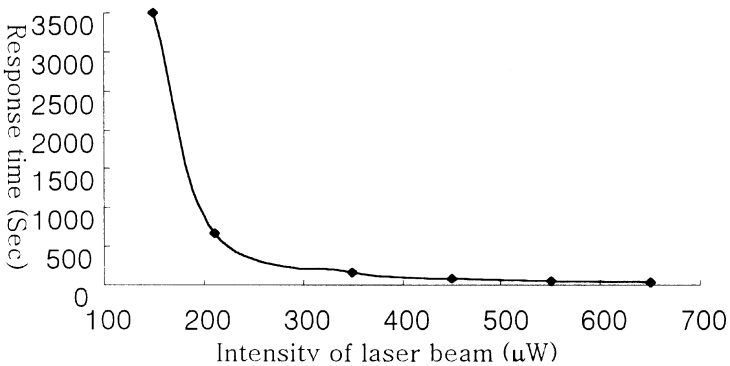

Figure 6. The photorefractive response time versus intensity of polarized argon laser beam at 488 nm.

Acknowledgments

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