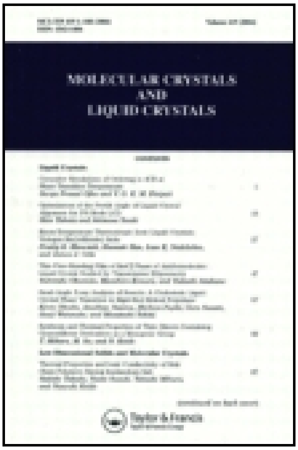

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Xerographic and Electro-Optic Studies of a Photorefractive Polymer

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XEROGRAPHIC AND ELECTRO-OPTIC STUDIES OF A PHOTOREFRACTIVE POLYMER

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Abstract We examined both photoconductive and electro-optical properties of the monolithic photorefractive polymer. The photoconductive sensitivity of $1.2\times10^{-12}(S\ cm^{-1})/(W\ cm^{-2})$ was obtained under a field strength of $5\times10^{5}V/cm$ and a wavelength of 534nm. The EO signals linearly increased with the poling electric field.

INTRODUCTION

Recently organic photorefractive materials have attracted a lot of attention both from the point of view of fundamental science and practical applications. Photoconductivity and electro-optic response are necessary processes for photorefractive effects. In order to develop efficient photorefractive materials, photoconductive properties such as carrier generation, carrier mobility, and the nature of traps should be optimized in addition to the electro-optic response. Most of the reported photorefractive polymers consist of multi-components: a carrier transporting agent, an electro-optic chromophore and a photosensitizer for photocarrier generation. Recently our group has developed "monolithic photorefractive materials" in which single component exhibits all responses necessary for photorefraction[1]. Monolithic photorefractive polymer (Figure 1) containing carbazole moiety with two acceptor groups has been synthesized by Knoevenagel polycondensation. In this polymer, carbazole chromophores lie parallel to each other in a "shoulder-to-shoulder" arrangement.

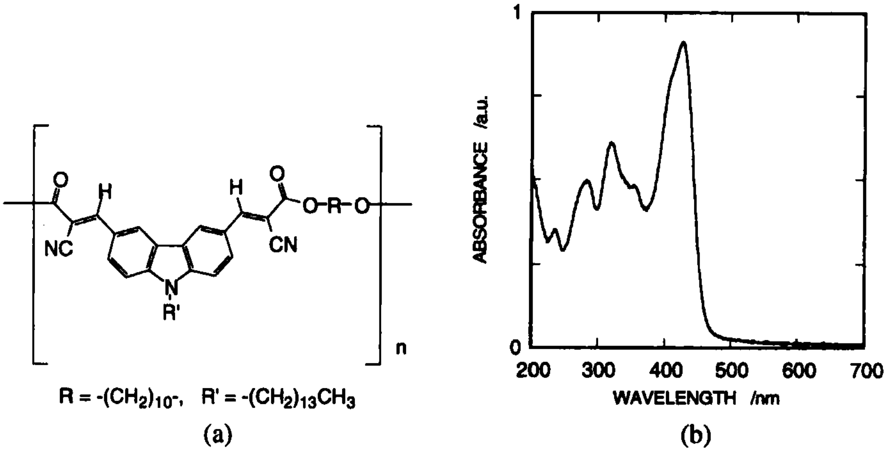


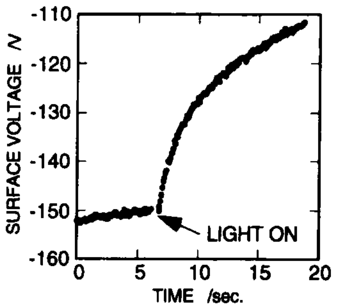
FIGURE 1 (a)Chemical structure and (b)absorption spectrum of the monolithic photorefractive polymer.

PHOTOCONDUCTIVE PROPERTIES

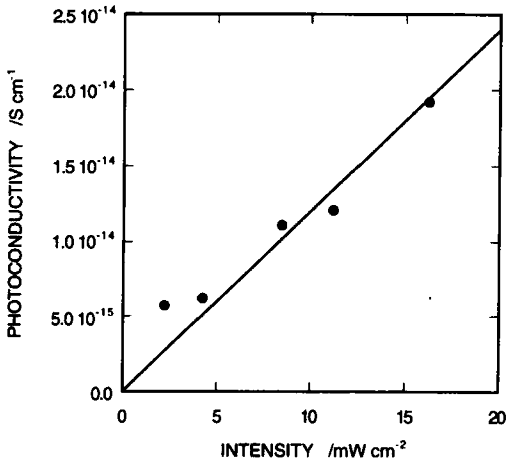
We examined the photoconductive properties of the monolithic photorefractive polymer by xerographic discharging[2,3]. Light was provided by a halogen lamp, through a bandpass(10nm) interference filter centered at 534nm. The film was prepared by spin-coating onto an ITO substrate. The thickness of the film was 3μm.

A typical discharge curve is shown in FIGURE 2(a). After corona-charging in the dark, the surface voltage was measured by an electrostatic voltmeter. On exposure to light, surface voltage decreased. This result of photo-induced discharge confirms the carrier generation in acceptor-substituted carbazole moiety at the wavelength of photorefraction which we observed[4].

FIGURE 2(b) shows the intensity dependence of the photoconductivity. The photoconductivity linearly increased with the intensity, and the photoconductive sensitivity of 1.2×10^{-12}(S cm^{-1})/(W cm^{-2}) was obtained at a field strength of 5×10^{5}V/cm. This value was comparable to other photorefractive materials. The charge generation efficiency was also calculated to be about 10^{-6} from the initial discharge rate and absorbance.



(a)



(b)

FIGURE 2 (a)Photo-induced discharge curve and (b)intensity dependence of the photoconductivity under a wavelength of 534nm and a field strength of 5×10^5V/cm.

ELECTRO-OPTICAL PROPERTIES

We examined electro-optic responses with the reflection method[5,6] at a wavelength of 532nm(frequency doubled Nd: YAG laser). Due to the low glass transition temperature of 35°C, the photorefractive polymer could be effectively poled at a room temperature by applying a dc electric field across the sample. To measure electro-optic modulation, an AC voltage of 10V rms at a frequency of 2.3kHz was applied.

The electro-optic signals linearly increased with the poling electric field (FIGURE 3). This result shows acceptor-substituted carbazole moiety was aligned and the monolithic photorefractive polymer has the electro-optic activity at this wavelength by applying a dc electric field. The typical value of r_{33} was determined to be 0.7pm/V at a electric field of 30V/μm.

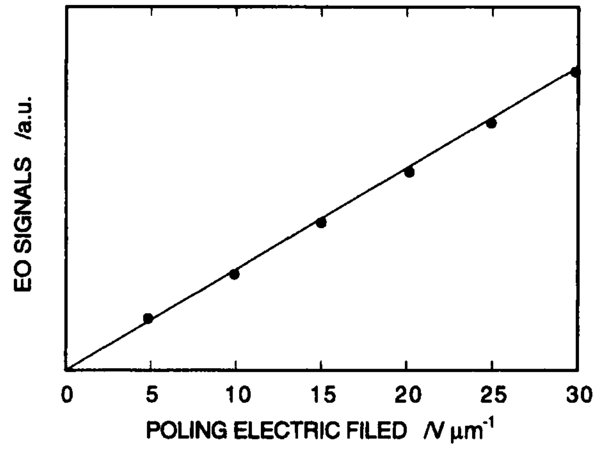


FIGURE 3 Poling electric field dependence of electro-optic responses at a wavelength of 532nm. The modulation voltage was 10V. The film was 3μm thick.

SUMMARY

We examined both photoconductive and electro-optical properties of the monolithic photorefractive polymer. A linear dependence of the photoconductivity on the intensity and the electro-optic response on the poling electric field were observed. The multifunctional carbazole moiety in this monolithic polymer with both photoconductive and electro-optical properties plays an important role for meeting the specific requirements of photorefractive effects.

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