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# Photorefractive Molecular Composite Fabricated by the Phenothiazine Derivatives

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# Photorefractive Molecular Composite Fabricated by the Phenothiazine Derivatives

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We synthesized two types of alkyloxy substituted phenothiazine dervatives containing either a nonlinear optical chromophore or a hydrazine moiety. The photorefractive properties were characterized by degenerated four wave mixing (DFWM) technique to measure the diffraction efficiency. Dynamic behavior of the diffraction efficiency was also observed to determine the response time.

Keywords: molecular composite, phenothiazine derivative, photorefractive, dynamic behavior, diffraction efficiency

## INTRODUCTION

Organic photorefractive(PR) materials have recently attracted attention not only due to their potential for practical applications, such as in optical signal processing and information storage[1-4]. The photorefractive effect of organic molecules can be defined as a multifunctional material which combines photosensitivity, photoconductivity, and electro-optic

properties. The charge carriers generated in the bright regions of a spatially modulated illumination migrate by thermal diffusion or electrical drift and become trapped in trapping centers of the dark regions, resulting in the formation of a nonuniform space charge field. The modulation of the refractive index is caused, *via* Pockels effect, by the internal electric field. In this study, we employed the phenothiazine unit to create the PR functional composite and characterize its property.

## EXPERIMENTAL

The structures of the functional compounds that were employed to prepare the PR composite were illustrated in Figure 1. Photorefractivity measurements were conducted with a degenerated four wave mixing(DFWM) technique. A 633 nm wavelength He-Ne laser was incident on the sample. For the four-wave mixing, two s-polarized beams with the 180mW/cm$^2$ were used as writing beams and a p-polarized reading beam with the intensity of 3mW/cm$^2$ counterpropagated to one of the writing beams. The normal of the sample surface was tilted 50° with respect to the symmetric axis of the two intersected beams, and the angle between the two coupled beams was set to be 20°. In the DFWM experiment, the diffraction efficiency was determined by the ratio of the intensity of the diffracted signal to that of the incident reading beam and rising and decaying behavior were also observed.

## RESULTS AND DISCUSSION

We synthesized the phenothiazine derivatives for PR composite successfully. The synthetic procedure will be described in elsewhere.

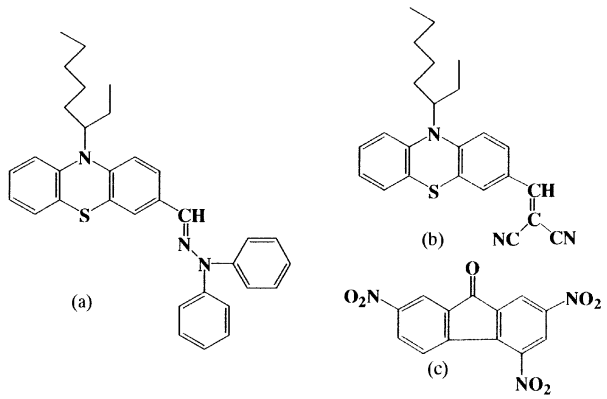


FIGURE 1 Structures of polymers used in this study; (a), charge transporting molecules bearing phenothiazine derivative; (b) phenothiazinyl bifunctional chromophore; (c) photocharge generating sensitizer, TNF.

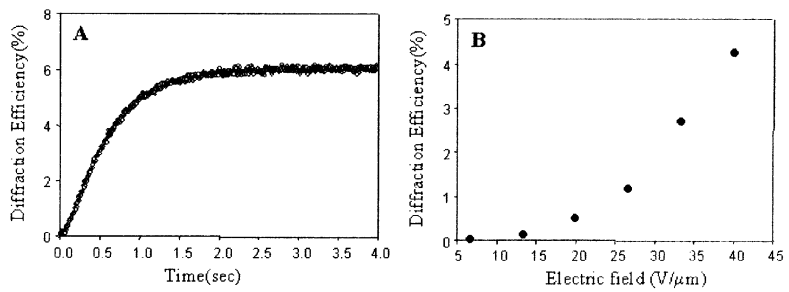


FIGURE 2 A. Dynamic behavior of the diffraction efficiency under 45 V/μm; B. Electric field dependence of the diffraction efficiency.

This molecular matrix does not need any plasticizer to control the glass transition temperature.

The dynamics of the holographic grating formation were studied by measuring the time constants of the grating formation in the DFWM

experiment. The following equation (1) fitted to the data of diffraction efficiency can be utilized for estimating the time constant.

$$\eta(t) = \eta_o [\ 1-(a \exp(-t/\tau_1)+(1-a) \exp(-t/\tau_2))]^2 \text{---(1)}$$

where a, $\tau_1$, and $\tau_2$ are the three fitting parameters. $\eta_o$ is the steady state diffraction efficiency. The fast component of the diffraction efficiency is indicated by the first term of the equation. Such a fast response time may be attributed to large charge carrier mobility and facile NLO chromophore orientation. The PR sample from molecular composite showed significantly fast response time to be around 0.39-0.4 sec. (Figure 2A) In Figure 2B, the diffraction efficiency increased with the applied electric field as is usual. Shortly, the molecular composite is also very promising material system to be applicable to the holographic information storage and signal processing.

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