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# Photofabrication of Diffraction Gratings on the Films of Polyurethane and Polymethacrylate Containing Aminonitroazobenzene Moieties

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# Photofabrication of Diffraction Gratings on the Films of Polyurethane and Polymethacrylate Containing Aminonitroazobenzene Moieties

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Polyurethane and polymethacrylate bearing an aminonitroazobenzene were synthesized for fabricating the diffraction grating on the film surface. Two beam coupling method was employed for fabricating the diffraction grating. The dynamics of diffraction grating was studied in term of the variation of the diffraction efficiency. The long-term stabilities of the diffraction efficiency was also investigated and compared in two polymers.

Keywords azobenzene; polyurethane; polymethacrylate; diffraction grating

## INTRODUCTION

Polymers containing azobenzene moieties have drawn much interest in the field of optical data storage, nonlinear optical, and holographic applications. Erasable gratings formed in the films of azobenzene-containing polymers have been studied extensively since they were first reported by Todorov et. al.[1,2]. A number of researchers also have

investigated the photo-induced anisotropic behavior through *trans-cis-trans* photoisomerization and molecular rearrangement under a linearly polarized light. Photosensitive materials like the azobenzene-containing polymers respond to variations in both the intensity and polarization state of the total electric field. Recently, surface relief gratings (SRG) have been fabricated in side chain azo polymer film through repeated *trans-cis-trans* isomerization upon exposure to the excitation light with an interference pattern[3-5].

In this work, we report on the properties of the photosensitive polyurethane and polymethacrylate for fabricating the diffraction grating controlled by a coupled linearly polarized visible light ($\lambda$=532nm). The stability of the diffraction efficiency was also investigated using the inscribed film of the two polymers.

## EXPERIMENTAL

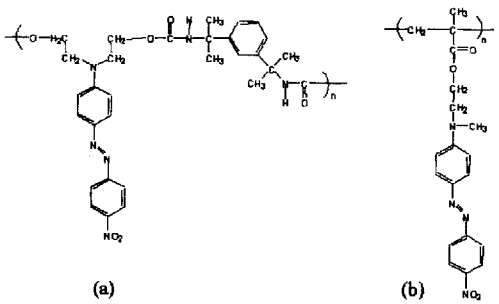
Thin films of the synthesized polyurethane and polymethacrylate were spin-coated onto glass slides using 20-wt% tetrachloroethane and cyclohexanone solution to prepare 1.5-2.0 μm thick films respectively. The thickness was measured by using the surface profilometer (Tencor P10). The spin-coated films were dried in a vacuum oven at 90°C for 48 hours.

The two linearly polarized laser beams at 532 nm fabricated diffraction gratings with an intensity of 80 mW/cm$^2$. Laser beams with s- and p-polarizations were used. The diffraction efficiency of the 1st-order diffracted beam from the gratings in transmission mode was probed with a linearly polarized low power He-Ne laser beam (5 mW) at 633 nm.

## RESULTS AND DISCUSSION

We synthesized polyurethane and polymethacrylate bearing an aminonitroazobenzene as a pendent group (See Scheme 1). The polymers were soluble in common organic solvent. The polymer has $T_g$ around

103°C and 110°C, which was determined by DSC. Optically transparent films of the polyurethane were obtained from a solution of tetrachloroethane.




SCHEME 1. Structures of the photosensitive (a) polyurethane and (b) polymethacrylate.

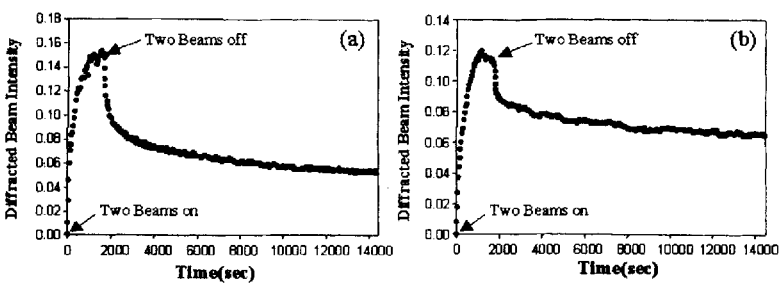



FIGURE 1 Growth of 1st-order diffracted beam intensity and its relaxation behavior. (a) Polyurethane; (b) Polymethacrylate

We have observed that growth of diffraction efficiency and its relaxation behavior at room temperature. In Figure 1, we could observe the difference of relaxation rate of diffracted beam intensity after the two pump beams were off. Under the polarizations(s-,p-) of the coupled beams we used herein, the interference patterns can be formed only under

polarization variation. Although regular grating structures with large surface modulation depth cannot be observed, the chromophores in the polymer matrix were displaced and re-distributed in the presence of the resultant polarization direction of the two pump beams. We also could observe the long-term stability of the diffracted beam intensity without the two beams. We blocked the coupled beams before tracing the relaxation of the diffracted beam intensity. The stability in polymethacrylate was observed to be higher than that in polyurethane. This is attributed to the higher glass transition temperature in part and strongly dependent of specific molecular interaction between the side chains themselves.

## CONCLUSION

In this study, we presented the long-term stability of photo-induced diffracted beam intensity of the polyurethane and polymethacrylate containing azo groups in the side chain. The stability in polymethacrylate was observed to be higher than that in polyurethane due to the higher glass transition temperature and weaker dipole interaction between the side chains.

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