

Holographic Recording and Control of Diffraction Efficiency Using Photoinduced Surface Deformation on Azo-Polymer Films

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Surface relief holograms were fabricated on azo-polymer films by the irradiation of interference laser fringes. The side-chain azo-polymer, poly-orange tom-1 isophoronediiisocyanate, was used in this study. Recording characteristics of surface relief structures were investigated; they needed no post-treatment, and could be erased by heating or irradiating a uniform laser beam. The diffraction efficiency of the recorded hologram was markedly increased by corona charging. It was also controlled by irradiation of the laser beam (488 nm) with corona charging. [DOI: 10.1143/JJAP.41.1851]

KEYWORDS: hologram, azo-polymer, photoinduced surface deformation, surface relief grating, corona charging

1. Introduction

Polymeric materials are the most promising organic materials for electrooptic devices and memory devices. The recording of polarization holographic gratings using azobenzene-containing polymer films as photoanisotropic materials has been reported.¹⁾ This photoinduced anisotropic effect is due to trans-cis-trans isomerization and the orientational effects of the azo-dye chromophore. Direct fabrication of relief structures in azo-polymers has been reported in the past several years.^{2–5)} A surface relief structure is recorded through photoisomerization and the movements of the polymer chains.^{6,7)} This is a one-step fabrication technique. A surface relief structure is fabricated by irradiation of interference laser fringes onto azobenzene functionalized polymers such as side-chain-type and main-chain-type azo-polymers. The diffraction efficiency and the surface relief depth depend on the writing energy and the polarization of the writing laser beam.⁸⁾ This structure is very stable at temperatures below the glass transition temperature T_g and can be erased by heating above T_g . This fabrication mechanism is not well understood at present, but several models have been proposed.^{9–12)}

We have recently reported that the diffraction efficiency of the surface relief structure can be markedly increased by corona charging.¹³⁾ Moreover, such a hologram exhibits non-linearity, because the orientation of the azo chromophore and the increase in the diffraction efficiency are performed concurrently by corona charging. Surface relief grating fabrication and the modulation of a surface relief electrooptic grating have been reported.¹⁴⁾

In this paper, surface relief holograms are fabricated on azo-polymer films by irradiation of interference laser fringes. The diffraction efficiency of the hologram is controlled by irradiation of the laser beam with corona charging.

2. Surface Deformation Method

The side-chain azo-polymer, poly-orange tom-1 isophoronediiisocyanate, is used in this study. Figure 1 shows the chemical structure and absorption spectrum of the mate-

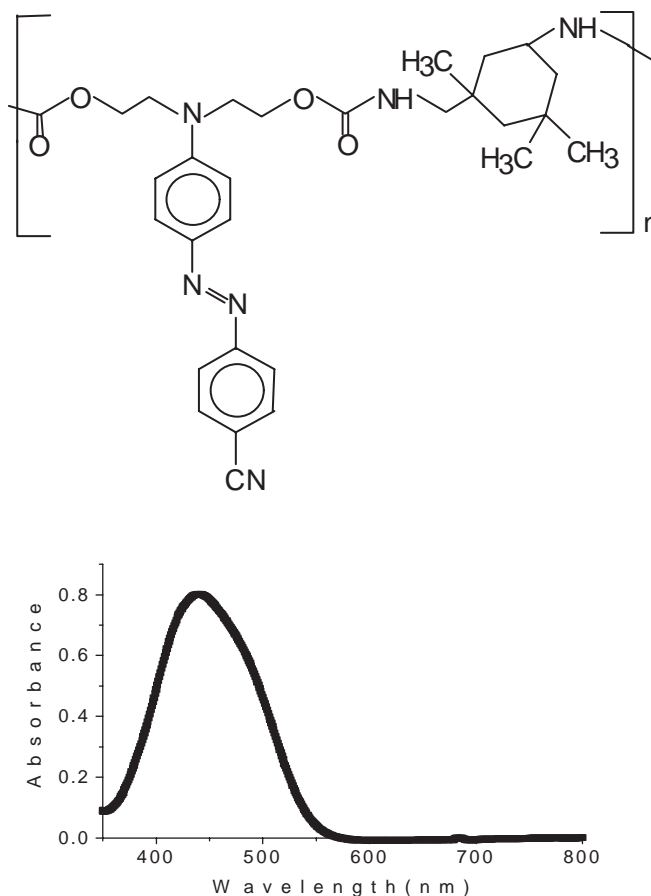


Fig. 1. Chemical structure and absorption spectrum of the material.

rial. The glass transition temperature is 136°C. The absorption peak and the cut-off wavelength of the dye are 440 nm and 560 nm, respectively. This polymer is dissolved in cyclohexanone. Samples of 1–5 μm thickness are prepared by spin-coating on a slide glass plate. The refractive index of the film is measured as 1.65 at a wavelength of 633 nm by the m-line technique.

The surface relief grating is fabricated by the irradiation of two-beam interference fringes. The experimental setup is

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