Organic Photorefractive Composites for Optical Information Processing

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1. INTRODUCTION

Polymeric photorefractive materials exhibit two attractive features, the large refractive index modulation (up to the order of 10^{-2}) and the optical erasabilility of recorded holographic information. These advantages make the organic photorefractive material to become one of the most promising candidates for optical data processing, e.g., pattern recognition and fingerprint verification.[4-6]

Spatial light modulators (SLMs) are devices that impose a given image on an optical wave by spatially modulating its intensity and/or phase distribution.[7] There are two classes of SLMs; one is electrically controlled SLMs, and the other is optically controlled SLMs. Using optically controlled SLMs, incoherent images can be converted into coherent images, and images in the infrared can be switched into images in the visible, and so forth.

In this work, we demonstrate optically controlled SLMs using photorefractive composite. An incoherent image imposed in Xe-lamp light was converted into a coherent image in He-Ne laser light.

2. EXPERIMENTS

2.1. Materials & sample preparation

Photorefractive material was prepared by doping chromophore, 2-{3-[(*E*)-2-(dibutylamino)-1-ethenyl]-5,5-dimethyl-2-cyclohexenyliden} malono-nitrile (DB-IP-DC), into photoconducting polymer matrix, poly[methyl-3-(9-carbazoly)propylsiloxane] (PSX-Cz) added by sensitizer such as fullerene (C_{60}). The chemical structures of the molecules used in this work are shown in Figure 1. PSX-Cz and DB-IP-DC chromophore were synthesized by the previously described methods[8]. Sensitizer (Kanto Chem. Co. Inc.) was used after purification. The composition of polymeric PR composite was PSX-Cz: DB-IP-DC: C_{60} in a ratio of 69: 30: 1 by wt%. The glass transition temperature (T_g) of the composite was measured by 28 °C using DSC (Perkin Elmer DSC7) at the heating rate of 10°*C/min*. For device preparation, the mixture was dissolved in dichloromethane and the solution was filtered through a 0.2μm filter. The composite was casted on an indium tin oxide (ITO) glass plate with an etched electrode pattern, dried slowly for 6hours at ambient temperature, and subsequently heated in an oven at 90° C for 24 h to completely remove the residual solvent. Then, the composite was softened by placing it on a hot plate at 100° C, followed by sandwiching between ITO-coated glasses with light pressure to yield a film with uniform thickness.

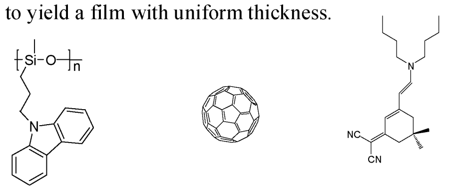


Figure 1. Chemical structures of the components

2.2. Measurements.

Schematic diagram of optically controlled SLM (OCSLM) was is shown in Figure 2. We used Xe-lamp as incoherent light source and 633 nm as coherent one. We modified the polarization states of two writing beams in two-beam coupling setup in order to simplify the OCSLM setup. One of the writing beams is s-polarized and the other is linearly polarized at 75 degree. The polarizer was placed between the sample and CCD camera to pass the only p-polarized diffracted beam, except the s-polarization components of the writing beams. Consequently, an exposure of additional reading beam was not needed for the read-out of recorded information because of the linearly polarized writing beam at 75 degree, which could simplify the experimental setup. The mask pattern was passed through by the Xe-Lamp light and was imaged on the photorefractive sample. The coherent image converted from the incoherent image was captured by the CCD camera.

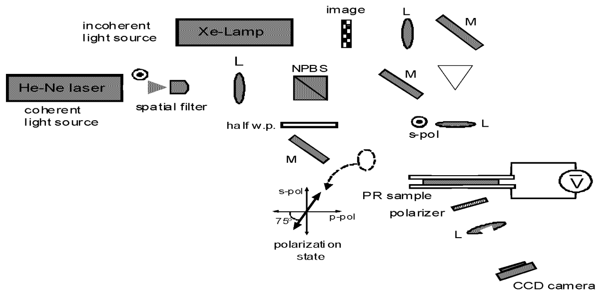
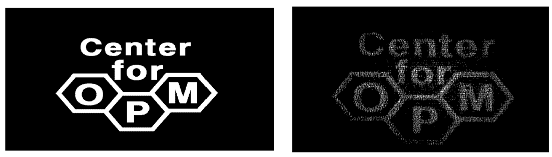


Figure 2. Schematic diagram of optical setup for optically controlled spatial light modulator. half w.p: half wave plate, PR sample: photorefractive sample, NPBS: non-polarizing beam splitter, M: mirror, L: lens, and CCD: charge-coupled-device

3. RESULTS AND DISCUSSION

Our photorefractive material shows a good performance of the high diffraction efficiency of 92% at low applied field of 30 V/μm which provided substantial advantage for the demonstration of holographic application. Figure 3 shows the optically controlled spatially modulated images which were demonstrated using our photorefractive sample. Xe-lamp were used as incoherent and coherent light source, respectively. The OCSLM setup was equipped, based on the two-beam coupling setup and its basic principle can be described as follows: Two laser beams intersected the photorefractive sample and formed the photorefractive grating in the sample. Then, incoherent light imposed with an input image illuminated on the sample and erased locally the photo-refractive grating in accordance with the input image. When the reading beam was illuminated, the diffracted beam had the same image that was imposed in the incoherent beam. Figure 3 (a) and (b) exhibited the input images and the converted coherent images, respectively. The incoherent image imposed in Xe-lamp light was successfully converted into coherent image using this OCSLM at the applied field of 30 V/ m. Also, the optical image bare in the laser beam at 785nm was perfectly converted into coherent image in 633 nm laser light. The high-contrast converted images can be obtained at relatively low applied field because of the excellent steady-state photorefractive performance of our sample.



(a) Image @ Xe-lamp **(b)Image @ 633 nm**

Figure 3. Photography images of (a) incoherent image to be input on optically controlled SLM using Xe-lamp (b) converted coherent image by 632 nm laser.

4. REFERENCES

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