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Photopolymer with nematic liquid crystals: preparation and electro-optical properties

Manuel Ortuño¹, Andrés Márquez¹, Sergi Gallego¹, Elena Fernández², Augusto Beléndez¹, Inmaculada Pascual²

¹Dpto. Física, Ingeniería de Sistemas y Teoría de la Señal, Universidad de Alicante
²Dpto. de Óptica, Farmacología y Anatomía, Universidad de Alicante
mos@ua.es

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1. Abstract

Holographic polymer dispersed liquid crystals are known as HPDLC. They are made by holographic recording in a photo-initiated polymerization-induced phase separation process in which the liquid crystal molecules diffuse to dark zones in the diffraction grating and they can be oriented by means of an electric field. The orientation of the liquid crystal produces a refraction index variation which changes the diffraction efficiency and therefore the grating develops a dynamic behavior that could be modified by means of an electronic device.

2. Experimental

Nowadays, photopolymers are used in holographic applications due to their properties: higher diffraction efficiency with an acceptable energetic sensitivity, they are made easily with a reduced cost [1]. The incorporation of liquid crystals add a special characteristic, the capacity of variation of the electro optical properties by means of an electric field. The liquid crystal molecules add optical anisotropy to the photopolymer and therefore it is possible to change the photopolymer response modifying the electric field applied [2]. In this work we use the liquid crystal licristal® BL087 from Merck. We develop a photopolymer compatible with this liquid crystal that could be used as holographic recording material. The photopolymer is composed of dipentaerythritol penta/hexa-acrylate (DHPHA) as monomer and binder. N-vinyl pirrolidone (NVP) as crosslinker [3]. Ethyl eosin (YEt) is used as dye and N-methyl diethanolamine (NMDETA) as radical generator. A mix with these components is made under red light where the material is not sensitive. The solution has these proportions (% weight) for each component: DHPHA = 54.84%, NMDETA = 15.18%, NVP 3.82%, YEt 0.37%. BL087 = 25.80%. The solution (100 mL) is sonicated in an ultrasonic bath and deposited between two conductive glass plates with 1 mm thickness and separated 15 μm using glass microspheres. This material is exposed to the laser recording (λ=532 nm) in a holographic set-up in order to record a diffraction grating. After recording, the reconstruction (λ=633 nm) of the diffraction grating in the HPDLC is made and a variable electric field is applied to check the new properties that introduces the liquid crystal in the photopolymer. We consider a bipolar square waveform, which is generated by a waveform generator connected to a voltage amplifier.

3. Results

Fig. 1 shows the diffracted intensity versus RMS voltage (Vrms). When Vrms increases the diffracted intensity (Id) decreases towards zero due to the reordering of liquid crystal molecules.
inside the non-exposed zones. The incident light is linearly polarized along the vertical of the lab and there is no analyzer at the output.

![Graph showing the electro-optical response for the HPDLC.](image)

Fig. 1. Electro-optical response for the HPDLC.

The minimum and maximum values for the diffracted intensity and their ratio is respectively $I_{\text{min}} = 0.076$, $I_{\text{max}} = 0.221$, $I_{\text{max}}/I_{\text{min}} \approx 3$ at $V_{\text{rms}} = 170$ V. The HPDLC response is reversible although the velocity of response is limited by the viscosity of the binder. At potentials higher than 100 V the material suffers a degradation process decreasing its effective impedance, which could affect to the number of effective operational cycles.

4. References


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