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ABSTRACTS

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Photopolymers comparison for see-through applications (#562)

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Abstract

We have developed a coupled waveguide system based on slanted transmission gratings recorded in photopolymers. In this work we compare the behavior of four different photopolymers for this high demanded application.

Photopolymers comparison for see-through applications

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Abstract: Nowadays augmented reality, mixed reality and see-thorough applications become one of the more interesting technologies. Holographic optical elements can apport interesting solutions for injection and extraction of the image in the waveguide. We have developed a coupled waveguide system based on slanted transmission gratings recorded in photopolymers. In this work we compare the behavior of four different photopolymers for this high demanded application. We demonstrate as we can obtain high diffraction efficiencies if we optimize the recording geometry for each recording material.

Keywords: see-through, augmented reality, holography, photopolymers

1. Introduction

The wave couplers are a key part of the see-through and augmented reality systems. Many of the solutions found for these displays are based on holographic optical elements and prims to introduce the image. In this paper we propose transmission slanted gratings recording with shorter wavelength, 532 nm, to take advantage of the higher Bragg's angle for longer wavelength. Therefore, we design our system to achieve a Bragg angle for He-Ne laser higher than critical one for the crown glass-water boundary [1]. Then the diffracted beam or image is guided along the glass to the next hologram to extract it to the observer.

It is worth noting that the grating vector, K, can be obtained easily from the two interfering wave vectors, ϱ and σ, as follows:

$$\boldsymbol{\sigma}-\boldsymbol{\rho}=\boldsymbol{K} \qquad (1)$$

Where $|\boldsymbol{K}| = \frac{2\pi}{\Lambda}$ and $|\boldsymbol{\rho}| = |\boldsymbol{\sigma}| = \boldsymbol{n}\frac{2\pi}{\lambda}$, Λ is the grating period, λ is the wavelength and n is the average refractive index of the sample. For the materials analyzed in this work, n=1.49 and the glass used as substrate has n=1.51. We design our experiment to obtain an angle propagation of θ = 41.7 º, larger than the θc.

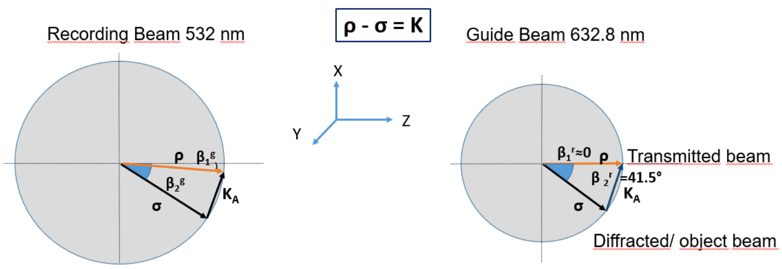

Figure 1. Ewald's sphere for two possible slanted grating geometries to be recorded by green light and to trap red spectrum. Left are the read-out geometries and right the recording ones. Left-up the designed for normal incidence of red light where the diffracted beam is trapped inside the substrate. The recording geometry used to obtain the wave vector K_A.

2. Results

In this work we present the results obtained with four different families of photopolymers, three fabricated in our laboratories: Polyvinyl alcohol acrylamide (PVA/Acrylamide), Oxide Si nanoparticles photopolymers (NPC) and Holographic dispersed liquid crystal photopolymer (HPDLC) [2], and one commercialized by Covestro, Bayfol hx 200. The diffraction efficiencies obtained for each photopolymer material are measured comparing with the incidence light, therefore about 15% of the light are reflected due to the Fresnel losses. The experimental data are presented in Table 1. In general, the effective optical thickness is like the physical one, only for the Bayfol-hx-200 the effective thickness is around 12 (μm) 4 μm thinner than the physical provided by the company.

Photopolymer	Physical thickness (μm)	% Light guided
PVA/Acrylamide	80	25
NPC	20	65
HPDLC	50	85
Bayfol hx 200	16	65

Table 1 Efficiency of the wave-couplers fabricated with different photopolymers.

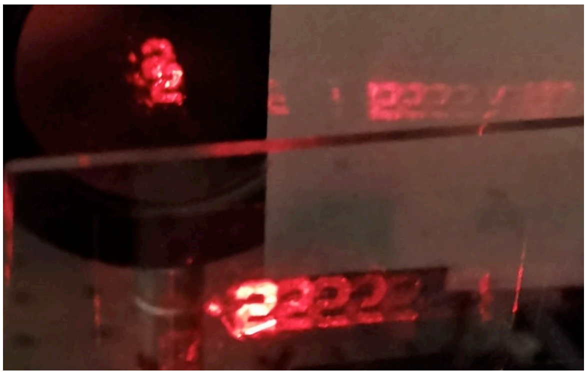

Figure 2. See-through system based on photopolymers working with red light

3. Conclusions

Summarizing we can see that good results are obtained with NPC, HPDLC and Bayfol. The advantage of HPDLC is the tunable properties of liquid crystal molecules. In addition, we are working now in the optimization of Bayfol recording to improve our results.

Acknowledgments

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