Holographic lenses stored in Biophotopol

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Summary: Innovative technologies demand versatile and environmentally compatible optical elements. In this paper we evaluated the quality of volume phase transmission lenses stored in a biocompatible photopolymer. Holographic lenses (HL) have been obtained with the same focal and diameter, for a symmetric and asymmetric experimental setups, and positive and negative focal. The quality of these lenses have been evaluated: theoretically and experimentally, from the calculation of the modulation transfer function (MTF) by capturing the point spread function (PSF) with a CCD sensor. The HLs that have shown better quality are the negative asymmetrically recorded compared with the theoretical ones.

Keywords: holographic lenses, biocompatible photopolymer, volume holography.

1. Introduction

Photonic technologies are evolving very fast the last years, in particular the technologies based in holography that use low toxicity recording materials [1,2].

In this sense, the importance of photopolymers is growing enormously due to their versatility in terms of composition and sel-processing capabilities [3]. This is a specific benefit for the creation of optical components.

In this work we fabricate and evaluate, symmetrical and asymmetrical holographic lenses for solar applications in biocompatible photopolymer Biophotopol.

2. Materials and Methods

Biophotopohol is composed of poly(vinyl alcoho) (PVA) as binder polymer, sodium acrilate (NaAO) as polymerizabe polymer, triethanolamine (TEA) as coinitiator and plasticizer and sodium salt 5'-ribofavin monophosphate (RF) as sensitizer dye. The concentrations of the components are optimized and the environmental conditions are controlled in order to obtain high diffraction efficiency.

The holographic set-up to record HL is presented in the Figure 1. HLs with positive and negative focals leghts are record using an Ar laser tuned at 488 nm at which the material is sensitive and placing a refractive len in the path of the object beam. Symmetrical and asymmetrical recording geometries are used.

Experimental values of the modulation transfer function (MTF), theorical [4] and experimental aberrations in the image plane are obtained in order to evaluate the imaging quality of the HLs using the experimental set-up shown in the Fig. 2.

Fig. 2. Holographic set-up to record HLs.

A He-Ne laser at 633 nm is used to illuminate the HLs. Experimental MTF and aberration are obtained from the point spread function (PSF), which is acquired through of the images captured with a CCD sensor.

Fig. 3. Experimental set-up to evaluation of the HL.

The focal point image is 70 mm for both geometries of recorded. The image angles (θ) are
22.4° and 0° for symmetrical and asymmetrical, respectively.

3. Results

To evaluate the quality of the Biophotopol holographic lenses the MTFs have been assessed. To obtain the MTFs we first obtained the PSF images of the HLs using the set-up explained in section 2.

The MTFs of the fabricated HLs are presented in Figure 4. The experimental results of the MTFs obtained show that asymmetric recorded HLs have a higher value of spatial frequency than its respective HLs recorded symmetrically. The negative asymmetric HL (red curve) have 15 l/mm at MTF of 0.1 versus 6 l/mm at MTF of 0.1 for its respective positive asymmetric HL (blue curve). We also included the MTFs obtained for symmetric HLs. The (positive and negative) symmetric MTF curves have lower spatial frequency than the asymmetric ones.

A simulation of the aberrations of the negative asymmetric HL, with the same parameters of the best experimental HL obtained, is shown in Fig. 6.

The shape of both diffraction spots, experimental and theoretical, is similar. However, the size of the theoretical differs from the experimental in one order of magnitude due to the aberrations present in the system.

4. Conclusions

Volume phase transmission holographic lenses has been stored in Biophotopol photopolymer. The negative asymmetrically recorded HLs obtained present the best image quality. This results show that the Biophotopol photopolymer HLs can be used for environmentally compatible applications.

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References


