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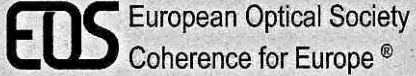

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Imaging quality evaluation of photopolymer holographic lenses

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Summary

A method to obtain holographic lenses in photopolymer is presented. The imaging quality of these lenses is evaluated by means of the modulation transfer function (MTF). Lenses of different focal lengths have been recorded. The holographic lens has higher resolution than do the refractive lens used in the recording.

Introduction

One of the most important applications of holography nowadays is the obtaining of holographic optical elements (HOEs). HOEs are frequently used in applications such as optics communications [1], information processing [2] and information storage [3]. Holographic lenses (HLs) are a typical example of HOEs; the advantages of these systems are simple recording, lightness if the support is of the acetate and multiplexing, which allows various elements to be recorded in the same plate.

There are numerous references in the literature to obtaining HLs; however, there are very few references to the use of a photopolymer as the recording material. For this reason, it is interesting to delve deeper into this aspect and study the possibilities that HLs in photopolymer can offer. Before using a HL it is necessary to analyze their imaging quality.

In this work HLs with different focal length are recorded using photopolymers as holographic recording material and its imaging quality is analyzed. An evaluation of the imaging quality is done using the point spread function (PSF) and the MTF.

Experimental Setup

The HLs were recorded with a He-Ne laser tuned at 633 nm with an incident intensity I = 4 mW/cm^2. The laser beam was split into two secondary beams and then spatially filtered. Both object (convergent) and reference (collimated) beams were recombined at the recording medium at an angle (θ) of 20.7° to the normal with an appropriate set of mirrors. To analyze the HL, it is illuminated only with the reference beam. The reconstructed wave front is captured by a CCD camera situated in the focal plane.

The photopolymer employed to store the HLs was made up of acrylamide as monomer, polyvinylalcohol as binder, triethanolamine as coinitiator, methilene blue as dye and N,N'- metilenbisacrilamide as crosslinker. This composition is the one that gives the best results in terms of diffraction efficiency and sensitivity, together with stability and solubility, when diffraction gratings are stored.

Discussion

In this study, HLs of focal length 100 mm, 150 mm and 250 mm were stored. To do this refractive lens (RL) of focal length 150 mm, 200 mm and 300 mm were placed 50 mm from the holographic plate. The imaging quality of these lenses is evaluated by means the MTF. The MTF is obtained from the intensity distribution in the focus or PSF captured by a CCD camera. A computer program to obtain the MTFs has been developed. Figure 1a shows the MTF curves for the RLs used in the fabrication of the HLs and the figure 1b the MTF curves for the HLs. The diameter of all lenses is 15 mm.

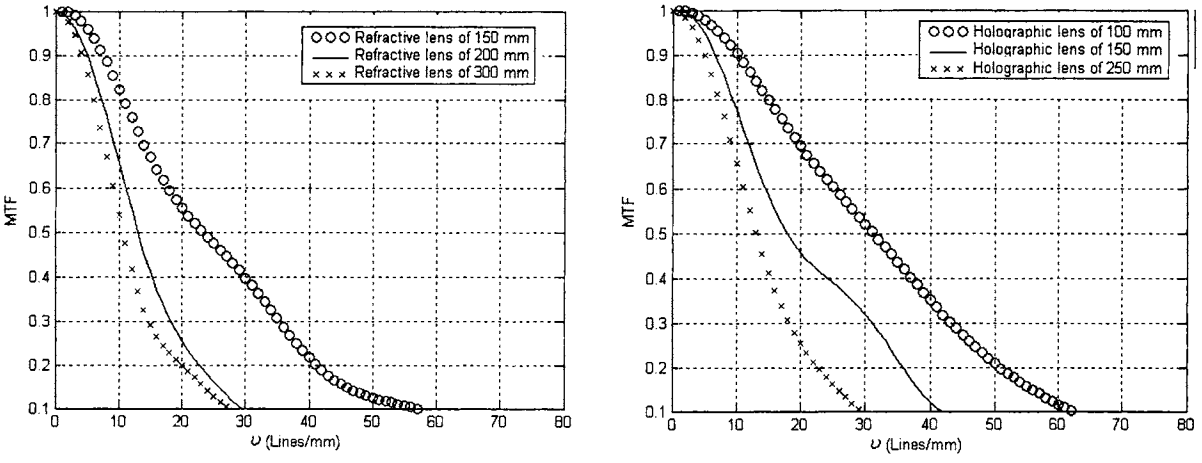

Figure 1: Experimental MTF a) Refractive lenses, b) holographic lenses.

As can be seen in figure 1 the cutoff frequency decreases when the focal length increases according to theory. HL cuttof frequency is greater than RL cutoff frequency used in its recording. This is because HL focal length is lower than RL focal length.

In conclusion, these results show that it is possible to obtain holographic lenses in photopolymers with high optical quality and resolution superior to that of the RLs used in the recording.

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References

[1] X. Ren, S. Liu, X. Zhang and S. Li, *Physics Letters A,* **354**, 243-247, 2006.
[2] M. Domingo, I. Arias and A. García, *Applied Optics*, **40(14)**, 2267-2274, 2001.
[3] T.W. Stone and B.J. Thompson, editors. *Selected papers on holographic and diffractive lenses and mirrors.* SPIE milestone series, **MS34**, Washington: SPIE Optical Engineering Press, 1991.