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EOS Conference on Trends in Optoelectronics

June 17 - 19, 2007
World of Photonics Congress 2007
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Contact:
European Optical Society (EOS)
Hollerithallee 8
30419 Hannover
Germany

Telephone: +49-511-2788-117
Fax: +49-511-2788-119
Email: munich@myeos.org
www.myeos.org/munich

ISBN 978-3-00-020991-8

Application of PVA/Acrylamide photopolymer for data page storage as a holographic memory

E. Fernández[1], C. García[1], M. Ortuño[2], S. Gallego[2], A. Beléndez[2], I. Pascual[1]

[1]Dpt. Interuniversitario de Óptica, Universidad de Alicante, Apartado 99, E-03080 Alicante, Spain

[2]Dpt. de Física, Ingeniería de Sistemas y Teoría de la Señal, Universidad de Alicante, Apartado 99, E-03080 Alicante, Spain

Email: elena.fernandez@ua.es

Summary

A holographic data pages have been stored into a PVA/acrylamide photopolymer. During storage process, some parameters like exposure time, beam ratio and intensity beam have been controlled to obtain a high quality images after reconstruction process. Bit Error Rate (BER) has been calculated fitting the histograms of the images.

Introduction

Two-dimensional memory technologies like CD-ROM's and DVD's have arrived to their limits of capacity, and the world needs new technological systems to keep more information. Thus holographic data storage (three-dimensional technology) is becoming in the new optical memory technology. These new technologies allow an important number of bits to be stored in a recording material with more capacity, more density and faster readout rates than two-dimensional technology.

Some companies as Aprilis [1] or InPhase [2-3] have already created the first prototypes of holographic optical storage systems, in which can be stored from 200 Gbyte to 1,6 Tbyte.

Discussion

To obtain a storage holographic system we have characterized a holographic material. In this work a photopolymerizable material has been used to store the holograms. The photopolymer is composed of acrylamide (AA) as the polymerizable monomer, triethanolamine (TEA) as radical generator, N,N'methylene-bis-acrylamide (BMA) as crosslinker, yellowish eosin (YE) as sensitizer and a binder of polyvinyl alcohol (PVA) [4-5]. In particular, layers about 70 µm of this material have been used to store the holograms.

Holographic data pages were recorded using the output from a diode-pumped frequency-doubled Nd:YVO_4 laser (Coherent Verdi V2) is divided into two beams and then spatially filtered and collimated to yield a plane-wave source of light at 532 nm. The material is sensitized for this wavelength. The object beam is modulated by an transparency object. The reference beam is a plane wave. Both beams are spatially overlapped at the recording medium with an angle of 17.4° (measured in air) between the two beams.

Different objects with white and black pixels have been used to simulate data page bits (ones and zeros). During the process to store the transparency some parameters have to be controlled to obtain images with greater quality. These parameters are the exposure time, the beam ratio between object beam and reference beam and reconstructed intensity beam.

In the reconstruction step we have used the same plane wave as in the recording process in order to avoid the appearance of aberrations in the reconstructed image. Since the material is sensitive to this wavelength, the intensity of the beam should be diminished to the minimum so that the image is not modified.

Using an optical system, the stored information is imaged onto a Cohu 4710 Series Monochrome CCD camera connected to personal computer where the images are analyzed and processed.

Once acquired the images, some criterion has to be considered to assess the quality of the different images, and to compare them with the original object. In order to evaluate the image quality, its histogram is used to calculate the Bit Error Rate, and the contrast between white and black pixels is measured.

Once established the work conditions that allow us to obtain images with a good quality, the storage capacity of the material is analyzed. To this goal, a larger number of images have been registered.

Acknowledgements

This work was supported by the "Ministerio de Educaci6n y Ciencia" (Spain) under projects FIS 2005-05881-C02-01 and FIS 2005-05881-C02-02 and by the "Generalitat Valenciana" under project GV06/172.

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