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# Spectral hole-burning and multiple storage of images

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ABSTRACT: A large number of images can be stored at a single spatial position making use of spectral hole-burning and holography. The storage of 25 holograms within the spectral range of 1 $cm^{-1}$ has been achieved using a polyvinylbutyral film doped with chlorin (1,2 dihydroporphyrin). This corresponds to a storage capacity of about 5000 images in the whole inhomogeneous band of the dye. Different optical setups were investigated.

## 1. INTRODUCTION

Besides its application in fundamental research, spectral hole-burning is of growing interest in technical applications, especially in view of high density optical storage systems [1]. Up to $10^4$ bits can be stored at a spot of micrometer size by encoding data bits as spectral holes. Storage densities in the order of $10^{12}$ bits/$cm^2$ seem to be possible using this frequency multiplexing. A different approach is the optical storage based on holography which allows image recording. Holographic image storage based on spectral hole-burning has been previously demonstrated. The storage of several images at a single spatial position, either at different positions of the wavelength or at different positions of an electric field applied to the sample was shown [2,3]. Using simultaneously the electric field as a further dimension for the addressing of spectral holes the storage capacity can be increased allowing the storage of 25 images within the spectral range of 1 $cm^{-1}$.

## 2. EXPERIMENTAL AND RESULTS

The experimental set up used for holographic image storage is described elsewhere [2]. A single mode dye laser was used as tunable coherent light source. The laser beam was enlarged and split into object and reference beam. Slides with an image size of 10x10 $mm^2$ could be inserted into the object beam. Object beam and reference beam were overlapped at the sample with a spot diameter of approximately 5 mm. Holograms were formed by exposing the sample with the object and the reference beam at fixed values for the laser frequency and the electric field.

Specific images were retrieved by adjusting the electric field strength and the laser frequency to the values used during recording and illuminating the sample with the reference beam. In order to prevent bleaching of the hologram the readout beam was ten times attenuated. The diffracted light was detected with a video camera followed by a video digitizer (Datacube, MaxVideo family). The digitized images were stored on a Sun-3/150 workstation. The sample was sandwiched between glass plates with transparent $SnO_2$ coatings which allowed to apply electric fields (up to 100 kV/cm) to the sample. Cooling to 1.7 K was performed in a immersion cryostat (Oxford MD-10).

Three different holographic setups were tested: a Fresnel, focused-image and Fourier hologram. The best resolution was obtained with the focused-image setup, 28 lines/mm, and was still restricted by the optical components used. The Fourier setup showed results of poor quality because the recording medium used in our experiments could not fulfill the huge dynamic range required for this type of holograms. The hologram acts as a high pass filter and thus edges are strongly overemphasized. The resolution obtainable for Fresnel holograms is diffraction limited by the spot size used on the sample. Due to the restriction by the sample size, a maximal resolution of 9 l/mm was obtained.

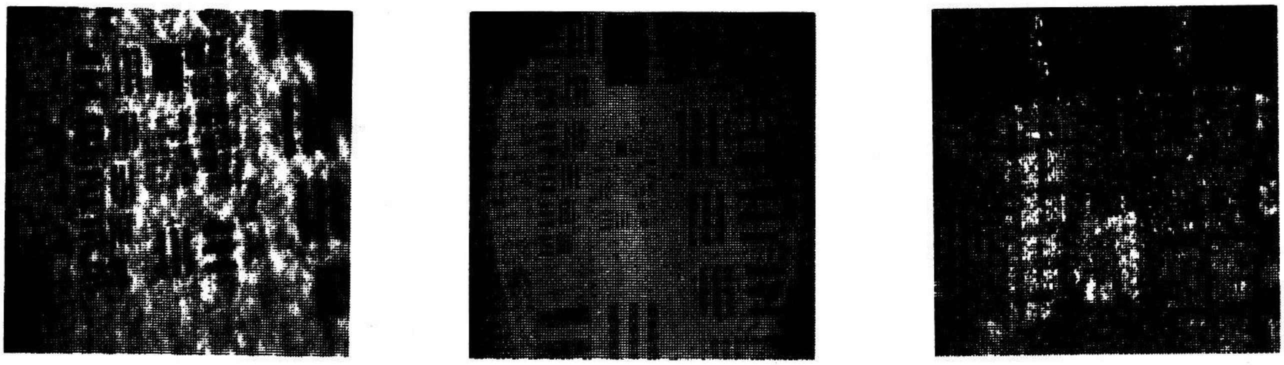

*Fig. 1: The results of the three setups investigated: Fresnel, focused-image and Fourier hologram. Best results (28 l/mm) were obtained with the focused-image type.*

## 3. CONCLUSIONS

The storage capacity of an optical image storing device based on spectral holeburning and holography has been improved using a well suited photochemical system and simultaneously addressing the two dimensions electric field and laser frequency, i.e. the Stark effect and the wavelength selectivity of photochemical transformations.

## 4. ACKNOWLEDGMENT

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