

# Two-photon-induced two-state polarisation encoding in 2,5-dimethyl-4-(p-nitrophenylazo)anisole doped polymer

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**Abstract** — In this paper we report on the application of polarisation encoding in three-dimensional (3D) bit data storage within azo dye doped polymer. Two letters are encoded in the same region of the medium by the two-photon-induced birefringence.

## I. INTRODUCTION

Due to the fast development of information technology, there is an increasing demand for higher storage capacity. In optical data storage, the proposed methods to maximise the memory density are 1) to improve optical resolution by decreasing the size of the focus spot [1], 2) to use multilayers of data planes [2], 3) to use the holographic technique [3], or 4) to use spectral or polarisation encoding [4].

It has been expected that some azo dye chromophores can undergo a trans-cis isomerisation process to induce birefringence [5,6]. In this work, we doped DMNPAA (2,5-dimethyl-4-(p-nitrophenylazo)anisole) into the polymer matrix and studied the readout contrast under two-photon excitation as a function of the polarisation direction of a reading beam. The study is then applied to 3D optical storage, in which case the memory density is increased by two-state polarisation encoding

## II. EXPERIMENTS

The experimental setup is a typical microscopy setup. A linearly polarised titanium:sapphire ultrashort pulsed laser beam (Spectra-Physics Tsunami) operating at a wavelength of 780 nm is used as a light source for two-photon excitation. A quarter wave plate and a Glan-Thompson prism are used to control the polarisation state of the recording beam. Two polarisers are used for reading, which are fixed perpendicularly to each other. We find that the contrast is the best when the angle between the recording polarisation and reading polarisation is 45 degree.

The two-state polarisation encoding technique is demonstrated in bit data storage within the DMNPAA doped polymer for the first time. The best contrast and least cross-talk between the two states is achieved with the polarisation angle of the two recording beams are at 60 degrees to each other. Fig. 1 shows the polarisation encoding results of patterns A and B, recorded in the same region at 0 and 60 degrees, respectively, and read out at the corresponding angles. Each pattern is illuminated with the given exposure time. The spacing between the neighbouring bits is 4.6  $\mu\text{m}$ .

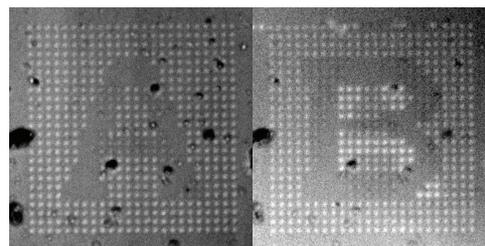


Fig. 1. Patterns A and B are recorded at 0 and 60 degrees, respectively, in the same region.

## III. DISCUSSION AND CONCLUSION

In this paper we have investigated the two-state polarisation encoding using the selective birefringence property of DMNPAA induced by two-photon excitation. The optical axis of DMNPAA molecules can be oriented to the perpendicular direction of the linearly polarised illumination beam through the photoisomerization process. Recording and reading of two patterns encoded in the same area with different polarisation states are demonstrated, which will be a promising potential for high-density 3D optical storage.

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