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Two-photon polymerization of optically active microstructures for photonic applications

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Abstract – Here we report the use of two-photon absorption polymerization to fabricate optically active microstructures. We present results on the fabrication of microstructures that exhibit optically-induced birefringence, which can be used for optical storage devices. Fluorescent microstructures with the ability of guiding its own emission were also produced. The microfabrication approach presented here opens the door for new application in data storage, waveguiding and optical circuitry.

Two-photon absorption polymerization is a powerful method to fabricate three-dimensional microstructures [1]. The multiphoton absorption confines the polymerization to the focal volume of the laser, allowing the fabrication of complex structures by moving the laser focus through the resin. In the last few years, two-photon polymerization has been used to fabricate photonic crystals and micromechanical actuators [1,2]. However, most of the structures reported so far are passive elements, whose properties cannot be externally controlled. Here we demonstrate the fabrication of optically active microstructures whose properties can be externally controlled by optical excitation.

We induce the two-photon absorption polymerization with a Ti:sapphire laser that produces 130-fs pulses at 800 nm. To fabricate structures the laser beam is focused into the sample using a 0.65 NA objective. The sample is placed on a computer-controlled *x-y-z* stage which scans the sample across the laser beam. A scanning electron micrograph of a typical three-dimensional microstructure is shown in Fig 1. The microstructure presents high definition and good integrity, besides preserving the characteristic properties of the organic compounds with which they are doped. Figure 2a shows a fluorescence microscopy image of the microstructure doped with MEH-PPV, excited at 532 nm. Guiding of the emitted light (~ 600 nm) can be seen on the edges of the structure. In Fig. 2b, a polarization microscopy of a microstructure containing DR13 is presented. In this microstructure, the birefringence was induced using an Ar^+ laser operating at 514 nm.

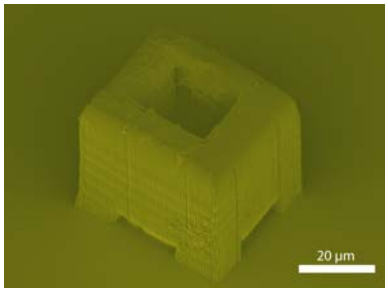

Figure 1: Scanning electron micrograph of a structure fabricated by two-photon absorption polymerization.

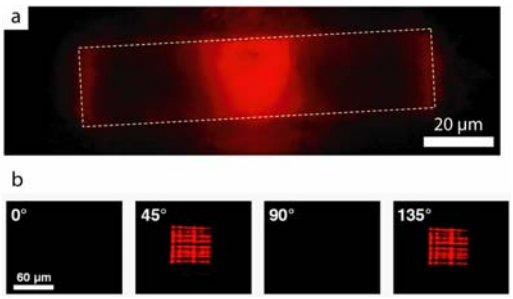

Figure 2: (a) Fluorescent image of a microstructure containing MEH-PPV. The doted line was drawn only to define the microstructure borders. (b) Polarization microscopy for a birefringent microstructure.

To summarize, we fabricate microstructures doped with organic compounds, which exhibit special optical properties. Such results open new of opportunities for the development of new photonic devices. This work was carried out with the financial support from FAPESP (Brazil), the National Science Foundation and the Army Research Office.

References

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