

Femtosecond Laser Processing of Polymers using Two-photon Photopolymerization Technique

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By laser beam focusing at diffraction limit, good quality and reproducible microstructures with sub micron resolution can be obtained on photosensitive resins. Due to the very high laser pulse power density (GW-TW/cm²), the nonlinear optical effects of multiphotonic absorption are dominating. So, laser radiation can be absorbed even in transparent materials for the fundamental wavelength (775 nm, in our case). Multiphotonic absorption took place in smaller volumes than laser focused spot size, only where the laser intensity overtakes the threshold of the nonlinear optical effect. For some photopolymerizable materials in UV (387 nm, second harmonic of our laser), 2D or 3D periodic structures with hundreds of nm in size can be made by two-photon photopolymerization technique (2PP).

In this work different photoresists such as SU-8, ORMOCER, ORMOSIL were irradiated using near-infrared femtosecond laser in order to create structures using 2PP. Between these, ORMOSIL is a new and a good candidate for creating polymer structures. It has the advantages upon other photopolymers of having relatively simple protocol for laser processing, from coating of the substrate to the laser irradiation and development. We tested its response to different laser irradiation energy, irradiation time, and adhesion to different substrates. We established the optimum laser processing protocol in order to have good structures with submicron resolution.

This polymers are very promising materials for creating structures such as photonic crystals, metamaterials, MEMS, with very broad application domains such as optic devices, medicine, telecommunications, etc.