

Non-linear optical lithography for 3D nanofabrication

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It has recently been demonstrated by several groups that non-linear optical lithography based on two-photon polymerization (2PP) of photosensitive resins allows the fabrication of true 3D nanostructures. The polymerization process can be initiated by non-linear absorption of femtosecond laser pulses tightly focused into the volume of a photosensitive resin. By moving the laser focus three-dimensionally through the resin, any 3D microstructure with a resolution down to 100 nm can be fabricated.

Photosensitive inorganic-organic hybrid polymers (ORMOCERs) are very promising materials for the fabrication of complicated 3D structures. These materials are produced by sol-gel synthesis with molecular level mixing of different chemical components at the Fraunhofer Institute for Silicate Research in the group led by R. Houbertz. ORMOCERs have negative resist behaviour and can be used as storage-stable, liquid photopolymerizable resins. When Ti:sapphire femtosecond laser pulses are tightly focused into the volume of this resin (which is transparent in the infrared) they can initiate two-photon polymerization process transferring liquid into solid state. This process is confined to a highly localized area at the focal point due to the quadratic dependence of the two-photon absorption rate on the laser intensity. When the laser focus is moved through the resin in three dimensions, 2PP occurs along the trace of the focus. This allows the fabrication of any computer-generated 3D structure by direct laser “recording” into the volume of the ORMOCER. The non-irradiated liquid resin can be dissolved in alcohol leaving the polymerized copy of the computer model (see Fig. 1). This technology can be used for the fabrication of masks and low-cost micro- and nanostructured components which are required for different applications in optics, medicine, and biology. In this presentation, numerous examples will be demonstrated and discussed.

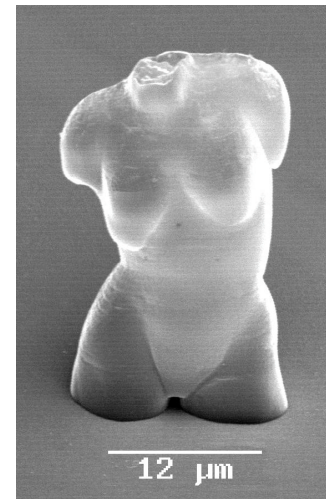


Fig. 1 SEM image of a μ -scale Venus fabricated by 2PP.

