Two Photon Lithography Written Defects in 3D Holographic Lithography Structures and Conversion to Higher Index Materials

S.E. Kooi
Institute for Soldier Nanotechnologies, Massachusetts Institute of Technology
Cambridge, MA 02139
skooi@mit.edu

3D structured polymeric materials are produced by multi-beam laser interference or holographic lithography techniques[1] using a 355 nm pulsed Nd:YAG laser and primarily SU-8 photoresist films. The number of beams, relative intensity and polarization, and the angle of intersection determine the photonic structure produced. After development and characterization of the optical properties of the structures, direct write two-photon lithography is used to introduce engineered defects to modulate optical properties such as the band gap.

We have developed techniques to write into undeveloped[2] holographic structures as well as fully developed ones. Defects are introduced either directly into the exposed but undeveloped SU8 film or the developed structure is back filled with a second liquid resin for additional writing. Defect writing is accomplished with a Ti:Sapphire femtosecond oscillator laser source and a computer controlled piezo stage.

In order to obtain more interesting and measureable optical properties, the polymeric structures produced by holographic lithography and two-photon lithography are converted into higher index of refraction materials (Si and Ge) by atomic layer deposition, chemical vapor deposition, chemical etching and ion etching techniques.

Optical properties of the photonic structures with and without added defects are calculated and measured by local reflectivity and transmission measurements as well as with near field scanning optical microscopy. The 3D structures and the defect placement and quality are also characterized by serial focused ion beam (FIB) milling and imaging.

[1] J. -H. Jang, C. K. Ullal, M. Maldovan, T. Gorishnyy, S. Kooi, C. Y. Koh, and E. L. Thomas, Adv. Funct. Mater **17**, 3027 (2007).

[2] J. P. Singer, S. E. Kooi, and E. L. Thomas, Nanoscale, **3**, 2730 (2011).