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Femtosecond Single-Pulse Absorption in Semiconductors with varying Dopant Concentration

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Abstract

The influence of dopant concentration on the absorption of femtosecond mid-IR pulses is described. The measured results are compared to a theoretical absorption model.

Summary

Bulk material modification based on focused femtosecond irradiation has attracted wide interest for the fabrication of photonics devices such as waveguides [1], Fresnel optics [2], active on-chip devices [3] or micro-fluidic structures [4]. Besides its true 3D structuring capabilities[5], simple implementation of device changes and cost-reduction for small value production are some of this technology's advantages. However, so far it has mainly been applied to dielectric host-materials, such as transparent glasses or crystals. Full integration towards silicon photonics has not been achieved. Extending 3D femtosecond laser direct write (FLDW) technology from such dielectric materials towards semiconductor materials could enable new applications for micro-electronic processing.

Adoption of 3D FLDW technology for semiconductor processing requires a fundamental understanding of the differences of the irradiation requirements, and possible modification processes in this host material. In addition, due to the two- to three-fold increase in refractive index of semiconductors compared to dielectrics, challenges regarding focusing and aberrations have to be addressed and overcome.

In this presentation we show results of our investigation of the modification threshold of crystalline silicon, and its dependence on wavelength and dopant concentration.. Differences in the absorption behavior of this new host material will be explained based on theoretical models. In addition we describe a new measurement technique to extract the material response in bulk semiconductors will be given.

1. A. Zoubir, "Femtosecond direct writing of waveguides in optical materials," Lasers and Electro-Optics, 2003. CLEO '03. Conference on (2003).
2. J. Choi, M. Ramme, and M. C. Richardson, "Femtosecond laser written 1 × N beam splitter composed of a volumetric multiplex Fresnel zone plate," Opt.Let. 1–4 (2012).

3. B. J. Eggleton, T. D. Vo, R. Pant, J. Schr, M. D. Pelusi, D. Yong Choi, S. J. Madden, and B. Luther-Davies, "Photonic chip based ultrafast optical processing based on high nonlinearity dispersion engineered chalcogenide waveguides," Laser & Photon. Rev. **6**, 97–114 (2011).
4. R. Osellame, H. J. W. M. Hoekstra, G. Cerullo, and M. Pollnau, "Femtosecond laser microstructuring: an enabling tool for optofluidic lab-on-chips," Laser & Photon. Rev. **5**, 442–463 (2011).
5. K. Sugioka and S. Nolte, "3D Fabrication of Embedded Microcomponents," Laser Precision Microfabrication (2010).