SYLM 4: Strahlführung II und Nanostrukturierung

Zeit: Donnerstag 11:00–13:00 Raum: 2B/C

Hauptvortrag SYLM 4.1 Do 11:00 2B/C

High precision refractive beam shaping: From the solution of the Maxwell equations to industrial material processing using short pulses — •Björn Gütlich, Thomas Mitra, Oliver Homburg, Dirk Hauschild, Lutz Aschke, and Vitalij Lissotschenko — LIMO Lissotschenko Mikrooptik GmbH, Bookenburgweg 4-8, 44319 Dortmund, Germany, www.limo.de

Short pulse, high power laser sources are used in a large variety of applications for material processing like cutting, drilling, annealing, micro-machining, ablation and micro-lithography. To meet the requirements of these applications the generation of appropriate beam profiles is decisive. LIMO has developed its own software based on the Maxwell equations to realize the best result for the beam shaping task. Various beam shaping principles, e.g. phase shifting for single mode lasers, beam mixing for multi-mode lasers are discussed here. Widely used geometries are square, rectangular light fields or light lines. For these or other customized solutions the advantages of novel micro-lens arrays with asymmetric lens profiles are demonstrated. Based on LIMO's unique production technology with computer-aided design, free-form micro-lens surfaces can be structured cost-effectively on wafer-basis into any kind material for high power short pulse lasers. Particular emphasis is put on refractive Gaussian-to-tophat converters for single mode lasers and their advantages in micro-machining. Patterning results in plastics (polyamide) and ceramics (Al_2O_3) are presented and improved redevelopments of the beam shaping system for industrial applications are introduced.

Hauptvortrag SYLM 4.2 Do 11:30 2B/C

Towards nanostructuring with femtosecond lasers — •Boris Chichkov — Laser Zentrum Hannover e.V.

I will report on our progress in the development of laser-based nanotechnologies. In particular, three-dimensional microstructuring by multiphoton illumination technique will be discussed. Taking its origin from multiphoton microscopy, it is now becoming an important microfabrication tool. Two-photon polymerization (2PP) and a more general version of this technology, two-photon activated laser processing, are considered as enabling technologies for the fabrication of 3D photonic crystals and photonic crystal templates. 2PP is very promising technique for the fabrication of drug delivery systems and medical implants. These and other applications in nanophotonics and biomedicine will be discussed.

Hauptvortrag SYLM 4.3 Do 12:00 2B/C

Near infrared 80 MHz femtosecond laser nanoprocessing — Karsten Koenig[1,2], Aisada Uchugonova[2], Iris Riemann[2], Ronan LeHarzic[1,2], and •Jens Müller[3] — [1]Saarland University, Faculty of Mechatronics&Physics, Campus, 66123 Saarbruecken — [2]Fraunhofer IBMT, Ensheimer Strasse 48, 66386 St. Ingbert — [3]JenLab GmbH, Schillerstrasse 1, 07745 Jena

Intense near infrared MHz femtosecond laser pulses at transient TW/cm2 intensities and low pJ/nJ pulse energies can be used to perform material processing based on multiphoton ionization and plasma formation. Cut sizes of sub-wavelength, sub-100 nm which is far beyond the Abbe diffraction limit can be realized without any collateral damage effect. This technology has been used for nanodissection of human chromosomes, targeted transfection of human stem cells due to the formation of nanoholes in the cellular membrane and for intraocular surgery. In addition, single cells within living tumor spheroids and 3D stem cell clusters were knocked out without destructive effects to the surrounding cells. Genomic regions of 40 nm size have been inactivated by a combination with metallic nanobeads. Sub-100nm nanprocessing with 1 -2 nJ femtosecond laser pulses at 800 nm was also performed in metal films and silicon wafers. The femtoseond laser induced nanotopography in silicon and SU-8 photoresist was used to engineer particular morphologies of stem cells. As conclusion, femtoseond laser multiphoton microscopes can be considered as novel nanoprocessing tools in nanomedicine, nanobiotechnology and material science.

Hauptvortrag SYLM 4.4 Do 12:30 2B/C

Nanostructuring by Optical Near Fields — •Paul Leiderer — University of Konstanz, 78457 Konstanz, Germany

Whereas the focusing of light in the optical far field is limited to a length of about half a wavelength due to diffraction, this restriction does not hold for the optical near fields in the vicinity of small objects. We have utilized this fact for structuring surfaces by means of local laser ablation on length scales far below the wavelength of the applied laser pulses. Both dielectric and metallic nanoparticles served as "nanoantennas" for structuring Si and glass surfaces as well as thin metal films. In order to avoid smearing out of the generated structures due to heat flow effects we have used femtosecond pulses (pulse duration 150 fs, wavelength 800nm) for our experiments. The smallest features achieved in this way had a scale of 10 nm.