Micromachining with Femtosecond Lasers

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Laser sources have been used for machining for some time now. With conventional continuously emitting or long pulsed laser sources in the nanosecond regime, however, limited precision in the range of some micrometers is possible. The heat deposited in the material during the absorption also makes the machining of delicate materials impossible. The shockwaves associated with the absorption of the pulse may also cause damage.

The mechanism of the ablation changes drastically when going from the nanosecond to the femtosecond pulse duration regime. Some background of the mechanism of the essentially cold ablation is given, explaining how the fascinating precise results have become possible. The difference in the mechanism for metals and dielectrics will be explained. Since with short pulses, less energy is needed for ablation than with long pulses, also the shock waves are reduced.

Among other things, shape memory alloys, delicate polymers and structured thin films will be shown as well as results from two photon polymerization

Also, using ultrashort pulses, it has become possible to create structure sizes below the diffraction limit of the beam, which is in the range of one micrometer for a laser operating in the near infrared region. By operating the laser close to the ablation threshold, only the central part of the beam initiates ablation, which is thus below the diffraction limit.

Machined samples will be shown providing some insight into possibilities of processing with ultrashort pulses.

Up to now, amplified femtosecond laser systems were necessary to do micro machining. A roadmap of possible developments is laid out and discussed. A new category of oscillator is introduced filling the gap of conventional oscillators and amplified systems to address the needs of micromachining. First experimental results of machined samples with this oscillator will be shown.