Picosecond thin disk laser platform Perla for micromachining

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Adoption of picosecond lasers for micromachining has recently accelerated. They are an ideal candidate for surface structuring, highly precise cutting, drilling, etc. There are two ways leading towards large size micro- and nano-structures. First, moderate pulse energy at high repetition rate, ideally several MHz, and very fast galvo scanners can be used. This is demanding for both laser construction, and process control with synchronization. Alternatively, multi-beam processing can employed. This approach is interesting especially for high energy high beam quality thin-disk regenerative amplifiers with multi-kHz repetition rate. Integration of such lasers with diffractive optical elements or other elements generating multi-beam interference patterns allows for fast patterning even with kHz pulse trains. The most important prerequisity for multi-beam processing is excellent beam quality, ideally close to diffraction limited Gaussian beam. Thin disk laser platform Perla developed at Hilase centre which is working at pulse repetition rate of 1 – 100 kHz, pulse energy > 40 mJ, and beam quality M^2 < 1.1 is an ideal tool for such application as it was already demonstrated (see figure bellow).

A versatile diode-pumped solid-state laser platform Perla based on thin disk technology uses an extremely thin (100 – 200 um) gain medium fixed to a water-cooled high thermal conductivity carrier. The HR coated gain medium acts like an active mirror. Low thickness of the large size gain medium allows for efficient heat extraction in axial direction. Thin gain medium also reduces accumulated nonlinear effects. The Perla platform is a CPA (chirped pulse amplification) system. It consists of a fiber-based front-end including a pulse stretcher reducing pulse peak power by stretching it to sub-ns pulse duration. Stretched pre-amplified pulses with sub-uJ pulse energy are seeded to an Yb:YAG thin-disk regenerative amplifier. Perla platform reaching average power up to 500 W and pulse energy up to 40 mJ is based on a ring or standing-wave cavity containing a thin disk and a BBO Pockels cell for coupling/de-coupling the signal pulse. Regenerative amplifiers allow for keeping high quality output beams given by M^2 parameters <1.1 thanks to optical resonator. Yb:YAG Perla lasers are pumped by fiber-coupled laser diodes emitting at 969 nm. This wavelength generate less heat in laser gain media unlike more frequent of 940 nm, which has higher quantum defect. Amplified pulses are finally compressed to pulse duration < 1.5 ps. High power frequency conversion to 2nd, 3rd, 4th, and 5th harmonic frequency as well as parametric generator tunable from 1.6 to 3.2 µm were developed. Therefore is the platform a versatile tool for high-tech micromachining. Latest achievements will be presented at the conference.