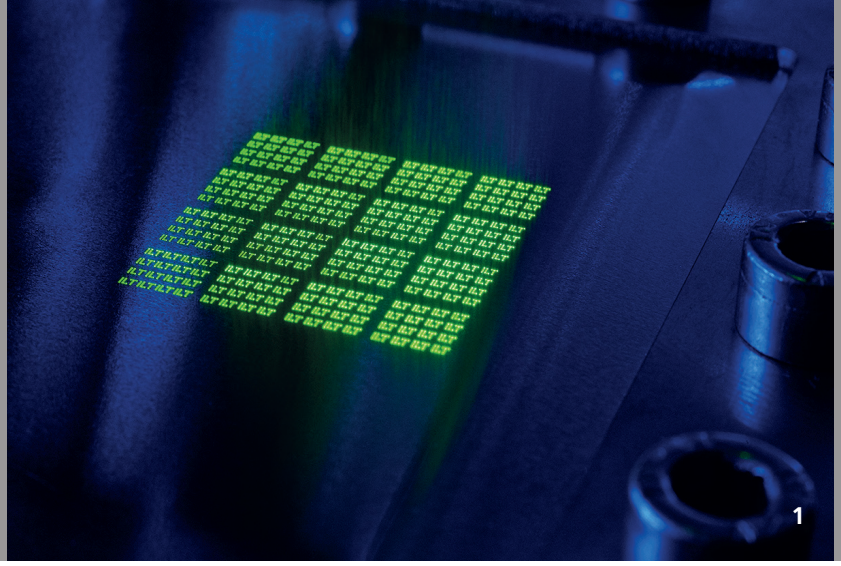

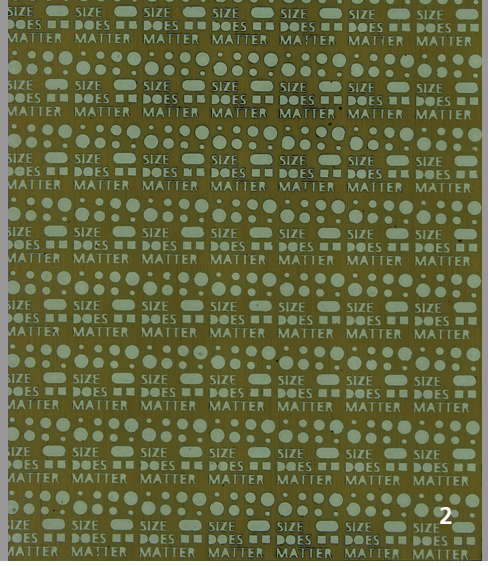

HIGHLY PRODUCTIVE USP LASER PROCESSING WITH MULTI-BEAM OPTICS

Task

The productivity of industrial laser processes essentially depends on how well the average power can be transferred to the workpiece. This principle also applies to material ablation and cutting processes with ultrashort pulsed lasers, which provide the highest machining accuracies achievable in the nanometer range. In the meantime, in the ultrashort pulsed (USP) region, beam sources with outputs from 100 to 1000 W have become available. In order to meet the high standards of quality and accuracy even at very low beam diameters, intensities are needed near the ablation threshold to prevent undesired, thermally induced losses in quality. Thus, the power per single beam is generally limited to a few watts. Nevertheless, in order to implement the high available power, a new technological approach shall be used, in which the laser beam is split into several partial beams. Thus, a parallelization of the processing can be implemented and the ablation process accelerated. Through the use of diffractive optical elements, the beam can be split with high efficiency, uniformity and stability.

Method

Fraunhofer ILT has developed industrially applicable multi-beam optical systems, which, based on diffractive optical elements, produce any number of arrays of partial beams. To ensure high process stability and reproducibility, the multi-beam module is monitored in real time by means of sensors and is adaptively stabilized. Thanks to a tailor-made design, the multi-beam optical systems can be used for many applications in the field of laser precision machining. In addition to classical surface structuring, this includes drilling and cutting applications.

Result

Figure 1 shows an ablation process with 16 partial beams, with each beam marking the lettering ILT 16 times. The variable deflection with a scanning system makes it possible to generate any ablation contour in multibeam operation. Figure 2 shows a microstructured 20 µm steel foil which has been processed by means of a multi-beam optical system. The smallest structure shown is 15 µm with an accuracy of 2 µm. The multi-beam optical system used generates 196 partial beams, allowing processing speeds of several hundred structures per second. Here, only an average power of 15 W was used at a wavelength of 515 nm, which illustrates that the productivity of the laser process is scalable with great potential.

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1 Ablation process with 16 partial beams.
2 Microstructured steel sheet produced with 196 partial beams.

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