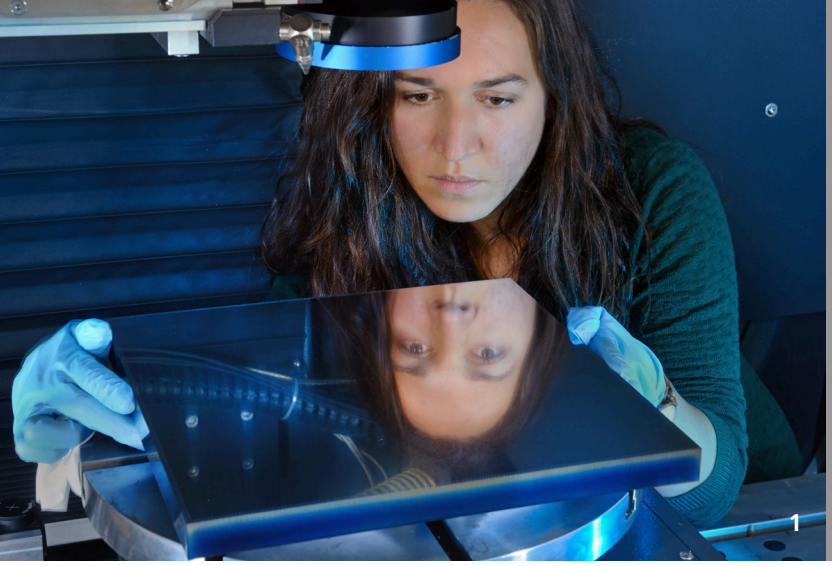

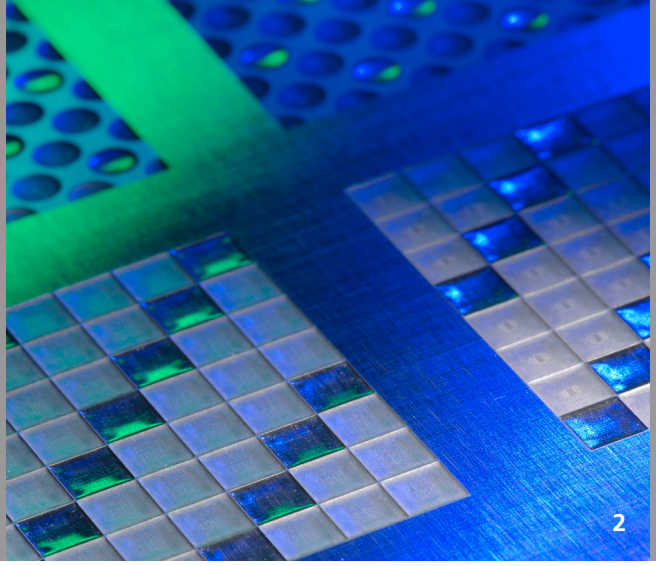

SELECTIVE POLISHING USING ULTRASHORT PULSED LASER RADIATION

Task

High-quality surfaces with sub-µm roughness and locally adapted design and functional structures are becoming increasingly important in a wide range of industrial applications. To produce e.g. micro-holes and micro-structures, ultrashort pulsed (USP) laser radiation is used since it is so precise. Often a downstream polishing step as a surface finishing, however, is necessary for the surfaces to reach corresponding gloss levels. Laser polishing has proven to be suitable for complex structures, but also because it offers ecological and automation advantages. Currently, industrially used laser polishing processes are based on the use of cw or short pulsed laser radiation. By developing a USP polishing process, Fraunhofer ILT aims to integrate a polishing step into a fully digital photonic USP process chain, thus enabling users to polish new design and functional surfaces at high spatial resolution.

Method

Various process strategies for polishing using USP laser radiation have been developed to generate a roughness < 100 nm. By using a high pulse repetition rate of 50 MHz with correspondingly low pulse energy, Fraunhofer ILT has developed a process that can generate targeted melt film and prevented material evaporation. Tailored pulse bursts with repetition rates in the 100 kHz range enable a controlled melting and solidification process. The high feed rates of up to 8 m/s result in high cooling rates, reducing oxidation of the melt and make an inert gas atmosphere during USP polishing unnecessary.

1 Large-area USP polishing of a vacuum huck plate with microholes.

2 Selective polishing of three-dimensional USP structures.

Results

Different melt depths and surface qualities can be flexibly combined on one workpiece surface with a combination of different process strategies. Common melt depths in USP polishing are < 15 µm. A roughness of Ra < 80 nm can be produced at area rates of 7–15 cm²/min. Moreover, the system can polish locally at high-precision and selectively, in addition to processing large areas in a normal ambient atmosphere.

Applications

USP polishing is particularly relevant as a sub-process in a USP-based photonic process chain to produce different functional surfaces, especially in tool making for the automotive and consumer goods industries.

The R&D project underlying this report was carried out on behalf of the German Federal Ministry for Economic Affairs and Energy BMWi under the grant number ZF4328108LT9.

Contact

Astrid Saßmannshausen M. Sc., Ext: -638
astrid.sassmannshausen@ilt.fraunhofer.de

Dipl.-Phys. Martin Reininghaus, Ext: -627
martin.reininghaus@ilt.fraunhofer.de

Fraunhofer Institute for Laser Technology ILT, www.ilt.fraunhofer.de
DQS certified by DIN EN ISO 9001, Reg.-No.: DE-69572-01