



POLISHING WITH ULTRASHORT PULSE LASER RADIATION

Task

Ultra-short pulsed (USP) laser beam sources are opening up more and more areas of application since they allow flexibility in the design of components and miniaturization up to structure sizes $< 10 \mu\text{m}$. After USP laser ablation, 3D structures have a surface roughness of $0.4 \mu\text{m}$ to $2 \mu\text{m}$ depending on the process parameters used. If this does not meet the requirements, as is the case when transparent plastics are molded, the structures have to be polished downstream, thus placing the highest demands on the surface quality of the molding tool. Since the structure sizes are in the range of a few micrometers, manual polishing cannot be used for the subsequent process step. Machine-assisted polishing processes are also not suitable for the sometimes very complex and small structure sizes.

Method

Fraunhofer ILT has developed a process using USP laser radiation to polish three-dimensional microstructures in the same machine after USP laser ablation. Actually, the advantage of USP processing consists of an ablation process dominated by evaporation and without melt formation. However, a molten phase is required to smooth roughness peaks and polish workpieces. A locally limited melt film can also be produced

with USP laser radiation thanks to the extremely high pulse repetition rate of several 10 MHz and a pulse picker, which separates individual pulse groups in the kHz range at a controlled frequency.

Results

Thanks to its spatial and temporal energy deposition, Fraunhofer's process can achieve remelting depths in the range of a view 100 nm up to $10 \mu\text{m}$ depending on the application. Above all, USP polishing can significantly lower the micro-roughness, which means surface roughness is reduced by up to a factor of four, and the process has a surface rate of $12.2 \text{ cm}^2/\text{min}$. In combination with the USP-based production of three-dimensional microstructures, gloss effects can be selectively generated and quality improved.

Applications

In addition to applications involving molding tools, polishing with USP laser radiation is also attractive to the automotive, consumer goods and electronics industries.

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- 1 *Metal tool with three-dimensional structures made and polished with USP lasers.*
- 2 *Process for selective USP polishing after USP structure generation and laser cleaning.*