



4

## EFFICIENT PROCESSING OF 3D TOOLS WITH THE COMBINED USE OF SHORT AND ULTRASHORT LASER PULSES

### Task

Thanks to their functionality, structured surfaces can reduce friction in, for example, combustion engines. Such surface textures are also becoming more and more a sign of a product's quality due to their optical and haptic properties. Processes currently used to structure components, such as photochemical etching, are limited not only in their precision (manual process) but also in their flexibility to design the grain structures. For the production of optically and haptically functional structures with high productivity, the industry requires methods that enable the desired structures to be generated on a purely digital basis.

### Method

Ultrashort pulsed laser radiation in the ps ( $10^{-12}$  s) to fs range ( $10^{-15}$  s) is characterized by high intensities ( $> 10^{12}$  W/cm<sup>2</sup>), which lead to a direct evaporation of the material and, therefore, to the highest precision. However, a long processing time may create disadvantages. For efficient processing, short ns pulses ( $10^{-9}$  s) will be used to insert a coarse structure into the workpiece in an upstream process step. In contrast to material ablation with ultrashort pulsed laser radiation, the ablation process with ns pulses is dominated by the melt, which results in higher ablation depths with, however, lower surface quality.

### Results

Similar to the strategy of roughing and finishing in machining processes, an initial laser process with ns pulses ablates the largest volume before a second laser process with ps pulses enhances the surface. This combination joins the advantages of each individual process into one: a short processing time (ns pulses) with the highest accuracy (ps pulses).

### Applications

In automotive interiors, a trend is moving from the classic leather grains to functional, technically appealing surfaces. For this purpose, tool inserts for the production of plastic molded parts (e.g. dashboards, airbag covers, trim strips) shall be provided with a technical structure (e.g. pyramids).

The R&D project underlying this report was carried out on behalf of the Federal Ministry of Education and Research (BMBF) under grant number 02P14A145.

### Contact

Andreas Brenner M.Sc.  
Telephone +49 241 8906-8365  
andreas.brenner@ilt.fraunhofer.de

Dipl.-Phys. Martin Reininghaus  
Telephone +49 241 8906-627  
martin.reininghaus@ilt.fraunhofer.de

3 Pyramid structure generated in tool steel with ps laser radiation.

4 Chromatically confocal 3D image of pyramid structure enhanced with ps-laser radiation.