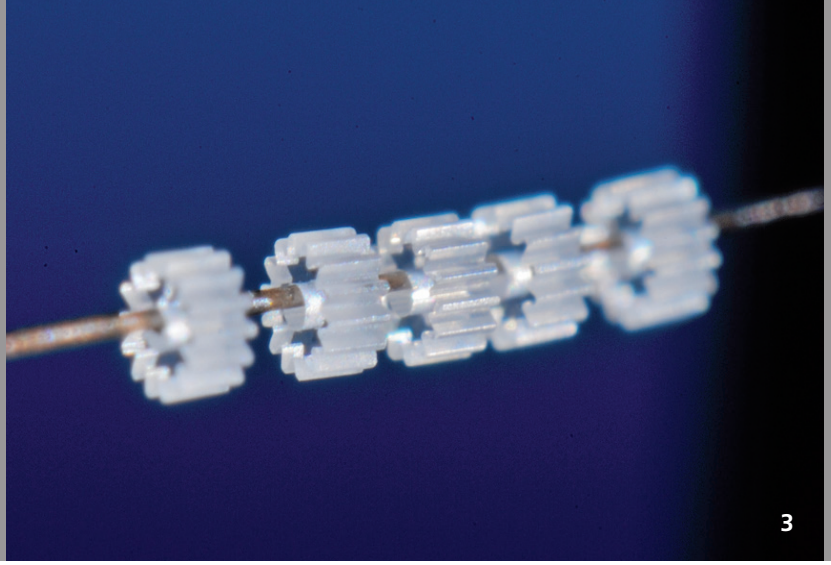

# SAPPHIRE PROCESSING BY SELECTIVE LASER-INDUCED ETCHING

## Task

Selective Laser-induced Etching (SLE) is an innovative laser-based manufacturing process for the production of micro and macro components and micro complete assemblies from transparent materials. It also allows complex parts to be manufactured directly from digital data (CAD) and is, therefore, particularly suitable for the production of small series, prototypes and individual pieces. As part of a project funded by the DFG, the SLE-handling mechanism for sapphire has been studied in collaboration with the Chair for Laser Technology at the RWTH Aachen University. The high-precision machining of sapphire and ruby opens up many new applications for these materials, among others, in the field of microsystems technology as well as in medical and chemical industries.

## Method

Selective Laser-induced Etching is a two-step process. In a first step, the inside of the transparent material is modified by the laser radiation. For this, ultra-short pulsed laser radiation (500 fs - 5 ps) is focused (1 - 2 µm). By moving the focus, a contiguous volume is modified, which has contact with the outer surface of the workpiece. In a second step, the modified material is selectively removed by wet chemical etching. For digital photonic production of complex components, the path data for the laser focus are created from digital CAD data and, by means of the CAM software, the micro scanner system is controlled synchronously.

## Result and Applications

Holes, cuts or complete components were produced in sapphire. The diameter of the gears shown in the figures is 300 or 500 µm. The microstructures produced can also be used as molding tools due to very high hardness of the base material. The process is characterized by very small kerf widths of < 5 µm. By using a specially developed micro scanner, Fraunhofer ILT can cut any form desired down at accuracy of 1 µm. Such microstructured components are mainly used in microsystems technology, precision engineering, medical, chemical and biotechnology.

By optimizing and adjusting the parameters to the requirements of customers, Fraunhofer ILT can provide feasibility studies for specific shapes and geometries, production of samples and small series as well as the further development of this technology.

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*3 Gears (d = 500 µm) of sapphire on a hair.*

*4 Gears made of sapphire (500 µm and 300 µm).*