# Laser Beam Figuring – Laser-based shape correction of fused silica optics

Optical components made of glass are usually produced in small to medium quantities by grinding and polishing in increasingly fine ablative steps. This process, which determines the surface quality, is supplemented by zonal or local corrective polishing for high-precision optics. Particularly in the case of geometrically complex optics with aspherical or free-form surfaces, corrective polishing using conventional production methods requires very long processing times and incurs high process costs.

## High process speeds and surface qualities independent of shape

Current approaches to laser-based processing of optical surfaces promise high process speeds and surface qualities independent of shape. Research has demonstrated that such a process can be applied for corrective polishing of flat surfaces, a process that is based on material ablation close to the evaporation temperature. The aim of this so-called laser beam figuring is to develop a fast and cost-effective laser-based corrective polishing process for high-precision aspheres and free-form optics made of fused silica. To correct shape as well as low and medium frequency defects, a targeted local glass ablation of less than 10 nm ablation depth with a lateral resolution of approx. 50 µm must be achieved without significantly increasing the roughness in the process. Power-stabilized $CO_2$ laser radiation is modulated into µs pulses using acousto-optic modulators (AOM). The ablation depth is a function of the pulse duration. As each pulse can be assigned an individual pulse duration via the control software, the ablation depth can be adjusted locally and at high precision.

## Prospects for the laser-based manufacturing process

With the developed test setup, Fraunhofer ILT could achieve reproducible ablation depths from a few nanometers up to several 100 nm with a lateral resolution of approx. 50 µm on flat fused silica surfaces. At a repetition rate of 8 kHz and a pulse duration of 42 µs, an ablation rate of up to 97 $mm^3/h$ could be reached. As an example, it was shown that the medium-frequency error of a flat sample can be reduced from a surface roughness of 0.647 nm to 0.388 nm (field size 16 x 16 $mm^2$). The institute is conducting further investigations into reducing shape as well as low and medium frequency defects; they show the prospect of establishing a new laser-based manufacturing process for the production of glass optics.
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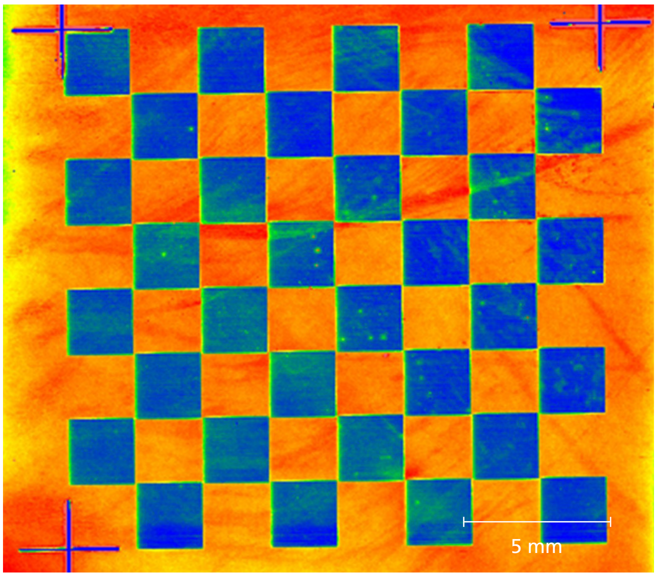


*1 White light interferometry image of parameter and reference fields (chessboard) in false color representation. Average ablation depth of the blue fields compared to the orange fields: 11.0 nm ± 0.9 nm.*