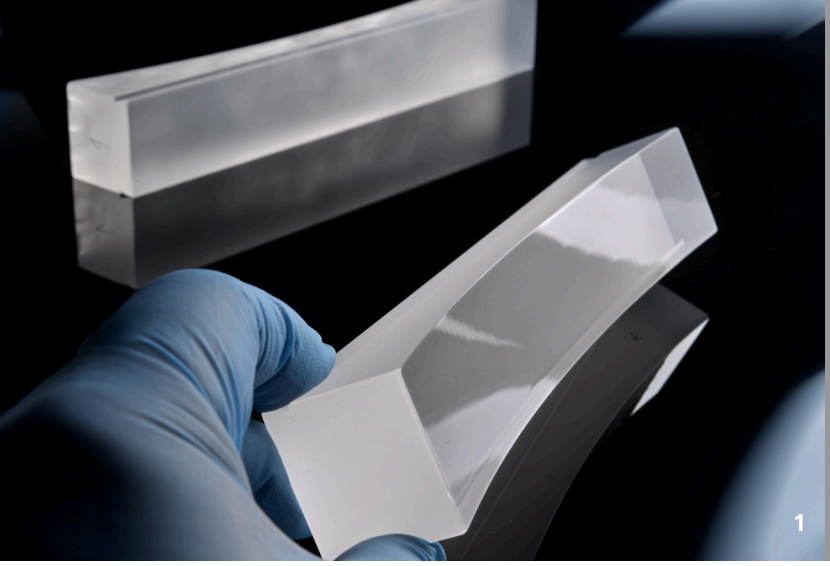

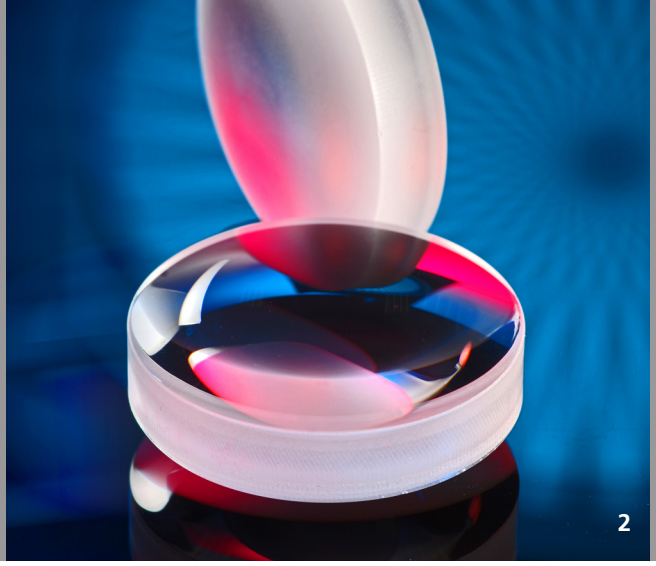

INCREASING THE SHAPE ACCURACY OF LASER POLISHING OF GLASS LENSES

Task

Laser polishing of optical glass such as N-BK7 is a thermal process: By interacting with the laser radiation, the surface of the glass is heated in a thin edge layer and thus softened. Thanks to the surface tension, the glass surface is smoothed without material being removed. However, the high local temperature gradients lead to thermal stresses in the glass, which can result in permanent deformation of the glass substrate. For example, the shape in lenses made of N-BK7 (center thickness 15 mm, diameter 30 mm) can deviate in peak to valley by up to 30 µm.

Method

In addition to looking at strategies such as polishing on both sides with adapted process parameters, Fraunhofer ILT is investigating whether shape defects can already be corrected in the preceding machining step. The institute aims to achieve improved shape accuracy after laser polishing by adjusting the initial shape prior to laser polishing. For this purpose, the shape distortion of the target geometry after laser polishing is systematically recorded in a first development step, and then characterized in order to subsequently be able to grind blanks with a deliberate shape offset. The spherical component, which dominates the shape distortion after laser polishing, can thereby be adjusted without additional time or machine expenditure.

Results

When the N-BK7 lenses (diameter 30 mm, radius of curvature 100 mm) are ground as R 98 mm lenses, a radius of curvature of R 99.6 ± 0.5 mm can be achieved after laser polishing. Thereby, the sagitta error is reduced from over 22 µm to below 4 µm compared to the non-adjusted initial geometry. Thus, the shape deviations after laser polishing on these lenses lie in an order of magnitude comparable to fused silica for the first time.

Applications

The results shown here demonstrate that laser polishing of optical glass is technically feasible. This can reduce the complexity of the process chains in optics manufacturing and thus cut throughput times and unit costs.

The R&D project HyoptO underlying this report was carried out on behalf of the German Federal Ministry for Economic Affairs and Energy BMWi under the grant number IGF-20308 N.

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1 Laser-polished freeform mirror blank 230 x 35 mm².
2 Laser polished lens Ø 30 mm with initial state.

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DQS certified by DIN EN ISO 9001, Reg.-No.: DE-69572-01