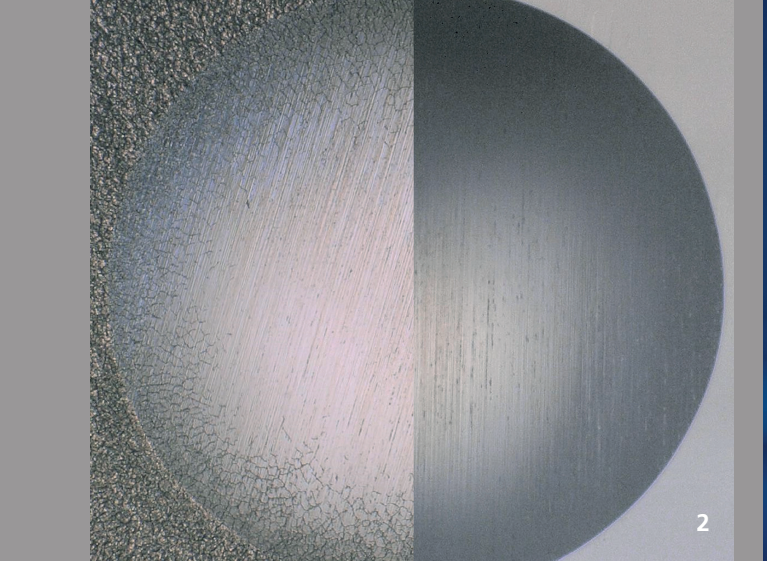

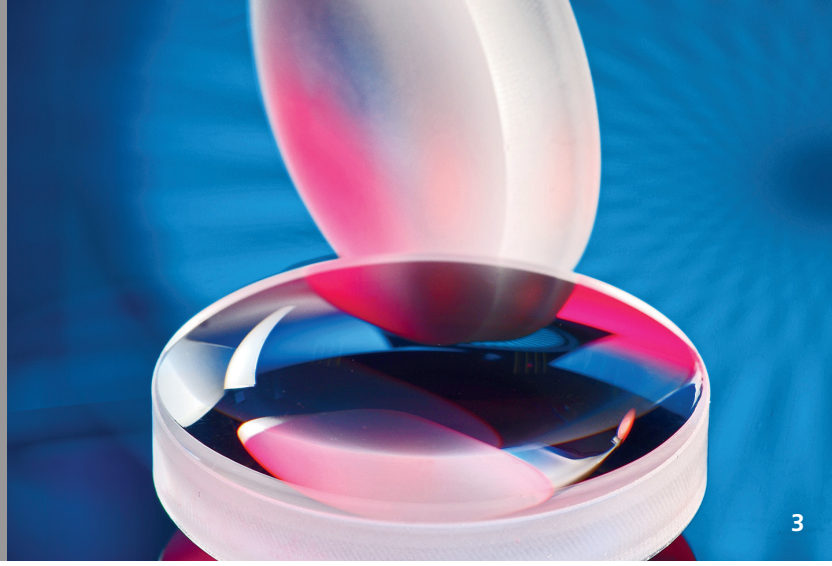

HYBRID PROCESS CHAIN FOR THE PRODUCTION OF GLASS OPTICS

Task

Optical components made of glass are usually produced in complex process chains consisting of multiple grinding and polishing steps. The brittle fracture behavior of the glass materials is the main reason this staggered manufacturing process is needed since the forces acting during mechanical processing cause tiny subsurface damage (SSD) below the machined surface layer. The SSD depth during mechanical processing is usually < 100 µm and it can only be removed mechanically by ablation. In this process, the applied force and, thus, the depth of new SSD are successively reduced at the expense of the removal rate. As a consequence of this iterative process, the highest quality optics can only be produced at slow throughput times and, therefore, high costs.

Method

The virtually ablation-free healing of SSD by laser polishing at depths of up to 1000 µm has already been successfully demonstrated. A single laser polishing step replaces several grinding and pre-polishing steps and can, thus, reduce process time and increase material yield. For this purpose, Fraunhofer ILT integrated laser polishing into the process chain, consisting of rough grinding, laser polishing and corrective polishing. Then, it compared the process time to achieve optical standard quality for N-BK7 and fused silica optics with that of a conventional process chain. The result was a trade-off between smoothing and thermal distortion at the laser polishing/corrective polishing interface.

Results

When laser polishing at process times of a few seconds is used, the material removal required for fused silica can be reduced from 40 µm (SSD depth) to 5 µm (thermal deformation), thus reducing the duration of post-processing by about 70 percent. Due to higher thermal deformation, the remaining removal depth for N-BK7 is currently 16 µm (from 25 µm SSD depth), resulting in a reduction in polishing time of about 30 percent.

Applications

The hybrid process chain for manufacturing optics can be used to reduce the complexity of process chains and, thus, lower lead times and unit costs. In particular, this applies to the production of aspheres and free-form surfaces.

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2 Ground (left) and laser polished (right) fused silica surface with etched dome cut for SSD detection.

3 Laser-polished glass optics.