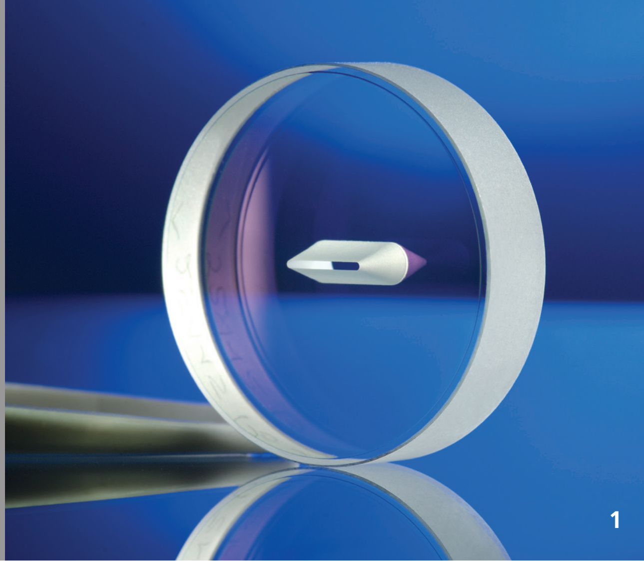

Subject to alterations in specifications and other technical information. 04/2018.

LASER PROCESSING OF GLASS FOR HIGH ASPECT RATIO STRUCTURES

Task

Classical precision-mechanical processing or ultrasonic drilling are not well suited for machining very fine structures or high aspect ratio bore holes into glass or other dielectric materials. For example, while preforms for fibers with hollow structures are manufactured with the laborious stack-and-draw process, a massive glass rod with bored out hollow structures would, in principle, be simpler. However, in this case, drillings of about 1 mm diameter and several 10 cm length are required.

Lossless geometric separation of ray bundles or spatial filtering, however, demands small openings in the order of magnitude of 100 µm in mirror substrates. The mirror surface needs to remain undamaged around the hole and the edges as sharp as possible. These geometrical forms can hardly be machined with present-day classical manufacturing processes.

Method

As an alternative to classical processes, Inverse Laser Drilling focuses the laser beam on the underside of the glass bulk. The workpiece is moved along the beam propagation axis and, by means of a scanner, the desired geometry is ablated layer by layer. To avoid chipping and to protect the surface, a glass substrate can be contact bonded to the work piece prior to machining and removed afterwards.

Result

This process has been used to structure the geometric shape of a photonic crystal fiber preform (60 bore holes, 750 µm diameter, 20 cm length) into a BK7 bulk. For spatial filters and geometric separators, undercut holes and slits with the order of magnitude of 100 µm have been structured into fused silica mirror substrates without chipping. Other materials like sapphire, ULE^{TM} or YAG can be machined with this method as well.

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1 Undercut and chip-free slit in a ULE mirror substrate with a diameter of 25 mm and thickness of 6.35 mm.

2 Preforms for photonic fibers.

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