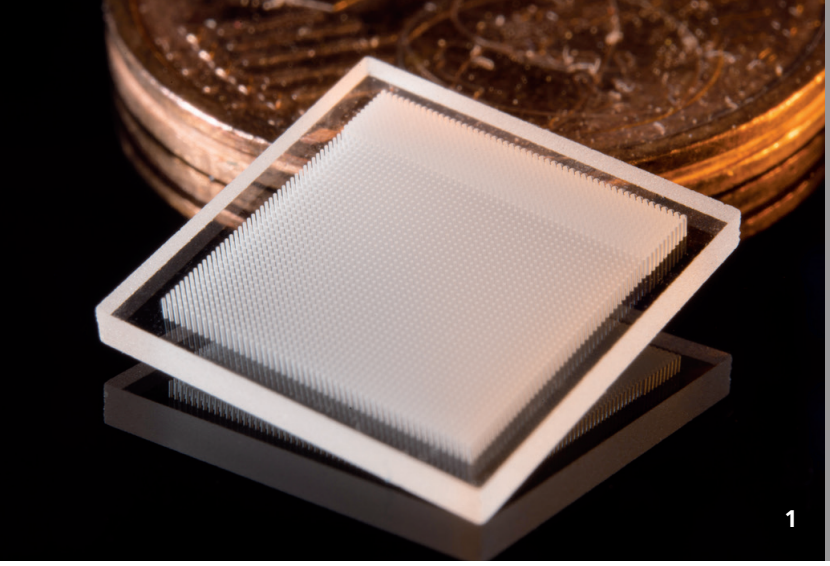

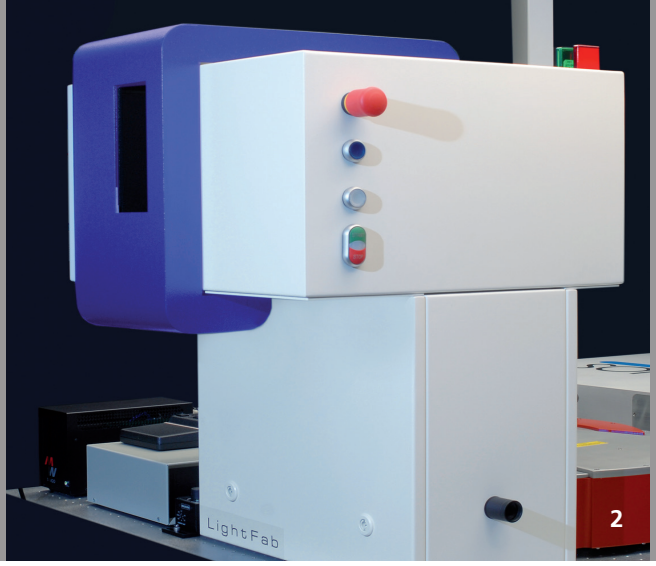

GLASS DRILLING: SCALING THE SLE PROCESS

Task

When combined with new high-speed scanners, high-power, ultra-short pulsed lasers (50 to 500 W) with pulse repetition rates from 4 to 40 MHz can increase productivity for processing transparent materials. In particular, with the new laser manufacturing process Selective Laser-Induced Etching (SLE), efficiency increases can be expected since the material is not vaporized, but rather melted into a 3D contour, which is selectively removed in a subsequent wet-chemical etching process.

Method

A newly developed 3D high-speed scanner achieves process speeds of up to 200 m/s with an optical focal length of f = 160 mm or 12 m/s at f = 10 mm or 2 m/s at f = 1.6 mm when a microscope objective is used for two-photon polymerization. The scanner is used with fs and ps laser beam sources to expose fused silica and create through holes with SLE. For this purpose, the focus is moved along a circular path and simultaneously guided through the 1 mm thick workpiece. Fraunhofer ILT has examined whether hole diameter and machining speed can be scaled with the laser power.

Result

A minimal hole diameter < 25 µm in fused silica with a thickness of 1 mm has been drilled using fs-laser radiation starting at a laser power of 0.5 W. When ps-laser radiation is used, holes can be made with a diameter of 100 µm at 6 to 12 W, 200 µm at 11 to 30 W and 400 µm at 23 to 80 W. The SLE process can be scaled very well to large process speeds with larger USP laser power.

Fifty drill holes per second can be made in 1 mm thick fused silica with diameters from 25 to 500 µm. On average, for example, this corresponds to an ablation rate of 370 mm^3/min and a maximum efficiency of 16 mm^3/min per watt of applied ps-laser power for a hole diameter of 400 µm after etching.

Applications

The drill holes and microchannels can be used for microfluidics, for example in medical diagnostics, for filter applications in the food industry and as vias in the electronics industry.

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1 Drill holes of 120 µm diameter in 1 mm thick fused silica.

2 A high-speed scanner.

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