LASER POLISHING OF GLASS COMPONENTS MANUFACTURED WITH SLE

Task

Thanks to its almost unlimited design freedom, the laser-based manufacturing process Selective Laser Etching (SLE) makes it possible to manufacture complex and individualized components made of fused silica. However, the surfaces produced with SLE have a micro-roughness of Sa = 400 nm (measuring field 100 × 100 µm2) due to the laser patterning in the bulk material and the subsequent etching process. Polishing the surfaces, in particular of complex geometries and internal surfaces of microfluidics, is very costly with the present state-of-the-art processing.

Method

The Fraunhofer ILT, in collaboration with LightFab GmbH, is developing a laser-polishing process for the post-machining of components made of fused silica manufactured with SLE. Here, the glass of the SLE surfaces is melted in a thin surface layer by means of laser radiation and smoothed by the surface tension with almost no material loss. If the heat penetration depth is sufficiently large, the laser-based polishing process can also be used to heat inner surfaces so that the micro-roughness is reduced. For the laser polishing of fused silica, both continuous and modulated CO_2 laser radiation ($\lambda = 10.6$ µm) is used. Since the process operates without contacting the component, complex surface geometries such as free-form lenses can also be polished.

Results

Initial results of the laser polishing of fused silica surfaces show that the micro-roughness of the SLE surface can be reduced from Sa = 400 nm to Sa = 0.5 nm (measuring field 100 × 100 µm²). In addition to the laser polishing of free-form lenses, the method has also been tested on complex 3D geometries that have been manufactured using SLE. In the case of the laser polishing of internal micro-channels, the roughness of the inner surface could be reduced to such an extent that flow processes inside the micro-channel could be observed with a microscope.

Applications

The SLE-based production of components made of quartz glass is commonly used, in particular, in microfluidics, micro-mechanics and micro-optics.

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1 Microfluidics made of fused silica (height: 7 mm) manufactured by SLE (left) and laser-polished (right).

2 Chess piece made of quartz glass (left: after SLE, right: after laser polishing).

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