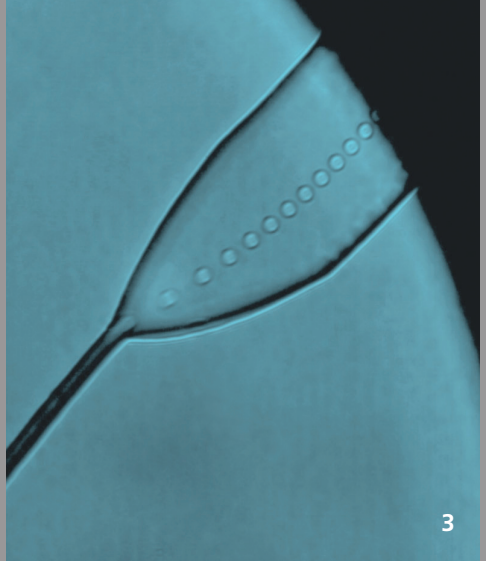

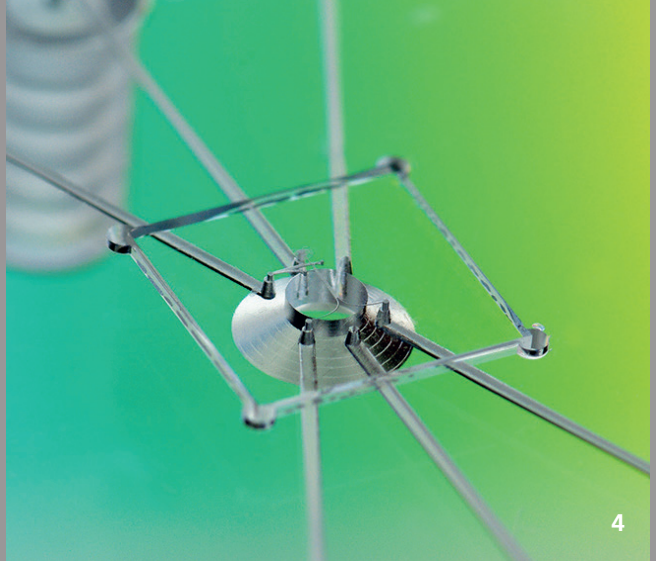

PROTOTYPING AND MANUFACTURING 3D MICROFLUIDIC CHIPS IN FUSED SILICA

Task

The range of applications of microfluidic systems is diverse and often specific to a customer. Conventional manufacturing processes for microfluidic chips use molding or lithographic methods; however, both of these limit the designs to planar structures. Creating free-form, three-dimensional microstructures directly from the digital design is fast and cost effective when prototypes need to be developed, and it significantly shortens innovation cycles for new designs. In addition, the 3D process makes it possible to implement completely new functionalities in a microfluidic system.

Method

Fraunhofer ILT has developed a laser process for the production of 3D channel structures in fused silica. In this process, complex structures from the digital design data with ultrafast laser pulses are written directly into fused silica. The process locally changes the physical and chemical properties of the glass. The irradiated structures can, therefore, be etched wet-chemically selectively with micrometer precision so that cavities are formed inside the glass substrate as written channel structures (selective laser etching). The CAD-based design and precise volume fabrication make it possible to design fluidic channels as well as interfaces for the positioning of optical components in a single opto-fluidic system in a very compact and cost-effective manner.

Results

Currently, microfluidic chips can be produced with channel structures of 10 µm in width and several centimeters in length. The roughness of R_z = 2 µm can be reduced by thermal remelting processes so strongly that the surfaces attain optical quality; this way, diagnostic laser measurement methods can be used in the microfluidic chip.

Applications

For high-throughput screening, microfluidic glass chips were developed for the generation and screening of segmented flows of smallest droplets with a diameter of 5 µm and used for the cell-free biosynthesis of enzymes. In addition, the 3D microfluidic chips are used in multispectral screening systems with scattered and fluorescent light detection, in which three-dimensional structures are used for the highly accurate hydrodynamic focusing of cells and particles.

Contact

Dipl.-Phys. Georg Meineke
Telephone +49 241 8906-8084
georg.meineke@ilt.fraunhofer.de

Dr. Achim Lenenbach
Telephone +49 241 8906-124
achim.lenenbach@ilt.fraunhofer.de

3 Generation of droplets with Ø 10 µm.

4 Carrier structure for plug and play connection of microfluidic chips via plug connectors made of fused silica.