Fraunhofer
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FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT

LASER STRUCTURING OF MICROREACTORS

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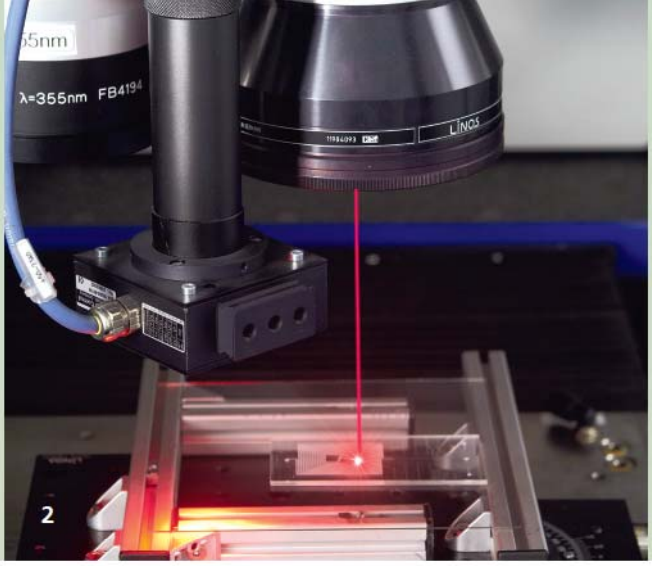

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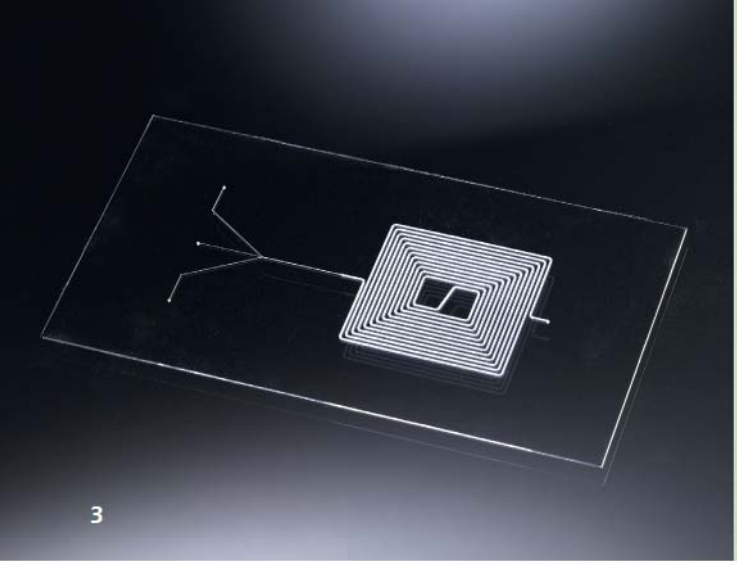
Glass is frequently used in microreaction technology due to its chemical inertness and biological compatibility. Conventional processes for generating microfluidic structures in glass substrates, such as wet etching or sandblasting, require the use of masks. New masks must consequently be fabricated when new microreactors are designed, making the development of microreaction processes costly, particularly in terms of time. More flexible and faster micro-structuring techniques are therefore needed for a modern process design in microreaction technology.

LASER ABLATION

Laser ablation is a powerful technique for the rapid generation of microstructures in glass substrates. Focused picosecond laser pulses allow controlled and well-defined material removal on a micro-scale. An optical mirror/lense system guides the laser beam over the glass wafer according to a 3D-CAD drawing and pre-defined laser parameter settings. The microfluidic structure is thus directly written onto the glass substrate with high precision. Due to minimal thermal stress, no strain and micro-cracks occur during the micro-structuring process. The re-design of a microfluidic structure can be quickly executed by simply adjusting the 3D-CAD data according to the new specifications. This allows a fast, iterative optimization of various microfluidic structures and a tailor-made microreactor design.

Owing to its dynamic beam guidance and a huge variety of machining parameters, picosecond laser ablation offers significant flexibility in realizing diverse microfluidic structures. In addition to the two-dimensional layout of microchannels, the depth and shape can also be controlled accurately. For instance, sloping microchannels and various channel cross-sections (rectangular, trapezoid, and circular) can be precisely structured on the basis of corresponding 3D-CAD data. All microfluidic structures exhibit an excellent geometric precision and can be obtained with high aspect ratios. In addition to glass, many other substrates such as metals, ceramics, Teflon and other stable polymers can be processed by the same laser system.



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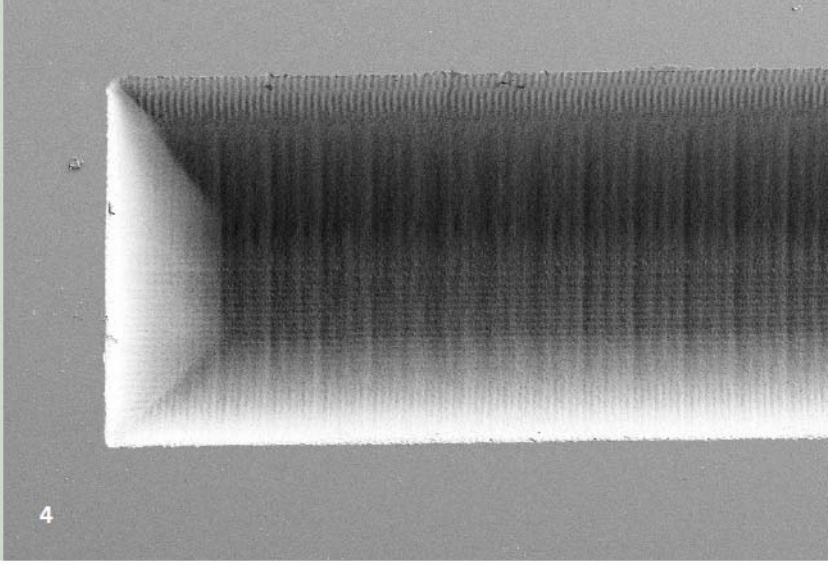

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OUR OFFER

On behalf of its customers the Fraunhofer ICT develops and optimizes chemical processes using microreaction technology. The design of tailor-made microreactors forms a key part of our R&D services. Laser structuring is used to fabricate and test microfluidic structures on site. Iterative improvement and re-design of the microfluidic structures guarantees a rapid optimization of the reactor performance.

Our offer includes

- Design and laser structuring of microfluidic components
- Fabrication of microfluidic prototypes
- Micro-structuring of casting or molding tools
- Feasibility studies on the micro-structuring of various materials

Processing parameters

– Laser wavelength:	1064, 532 and 355 nm
– Power:	12 W @ 1064 nm
– Pulse duration:	10 ps
– Repetition rate:	10 to 1000 kHz
– Pulse energy:	up to 200 µJ
– Scan velocity:	up to 2500 mm/s

1 *Digital microscope for 3D characterization of generated microstructures.*
2 *Optical mirror/lense systems guide the laser beam onto the glass wafer.*
3 *Laser-structured micro-reactor for segmented flow processing.*
4 *SEM image of a micro-channel in a glass wafer (channel width: 200 µm).*

COVER PHOTOGRAPH:
Laser micro-structuring at the Fraunhofer ICT: positioning of the glass wafer.

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