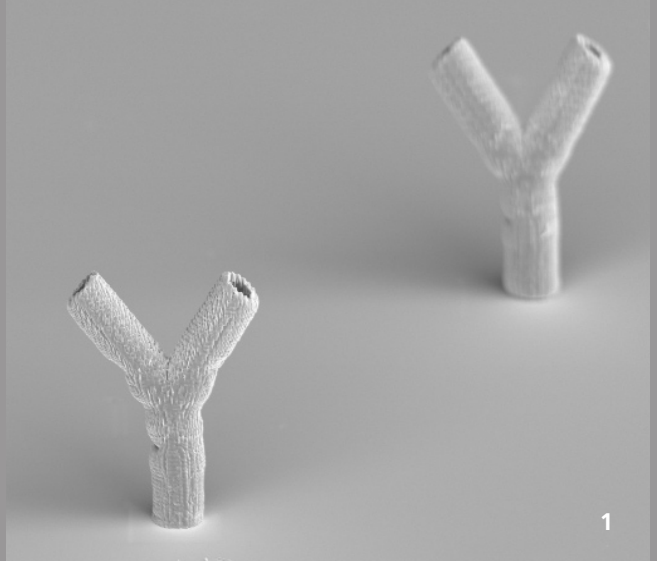
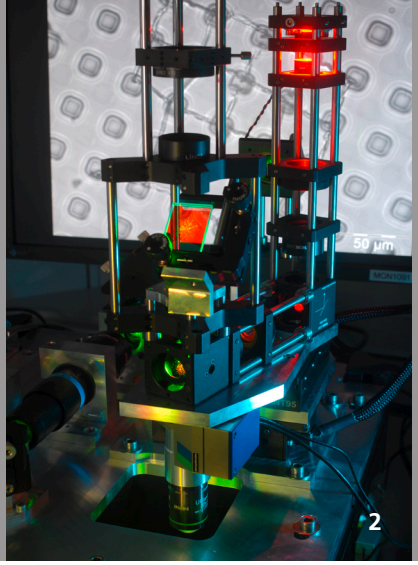


1



2

HIGH RESOLUTION BIOFABRICATION

Task

Biofabrication methods are employed in biomedical applications in order to mimic the nature of living tissue as it is often most beneficial. Cells in a natural environment are subjected to specific chemical and geometrical stimuli, with such features ranging from the nano- to the millimeter range. Two photon polymerization (TPP) is a laser based freeform fabrication method able to generate structures with a resolution smaller than 1 µm of materials such as elastic or inelastic biocompatible polymers or proteins. However, machines capable of performing TPP are often large and expensive, which hinders widespread use of the technique and bring up certain drawbacks of biofabrication, such as non-compatibility to sterile processing.

Method

In order to overcome the shortcomings of current TPP, the Fraunhofer ILT developed an inexpensive and compact TPP-module. A prototype was developed based on a frequency doubled microchip-laser, which combines high accuracy with flexibility. The module can be easily integrated into larger processing tools since the beam guidance is independent from sample handling. The high accuracy of TPP-processing can be obtained within a relatively large working field.

2 Sample capillary with an inner diameter of 20 µm.

1 Stand-alone table-top module for TPP.

Results

The prototype is small enough to fit within a standard clean bench to exclude contaminations, a prerequisite for many sensitive biological applications. In contrast to other TPP setups, the focused laser beam can be moved freely in all three directions and encompasses a working field of 25 x 25 x 0.5 mm^3. Since the sample and the built structure are at rest, the structuring method is very sensitive and well suited for highly flexible materials. Furthermore this decoupling allows for an easy combination of pre- and post-fabrication steps in a closed processing unit. As a stand-alone table-top solution, the prototype facilitates full beam manipulation and optical inspection via real time monitoring. Various materials, such as common photosensitive polymers and native proteins were successfully tested with the aim of high resolution microstructures.

Applications

The TPP module can be fitted to specific needs within bio-medical research. It can also be operated in ambient air or be included in any non-corrosive gas environment. Two main applications are developed at Fraunhofer ILT. The combina-tion of TPP with inkjet printing to realize macroscopic, high resolution biomimetic scaffolds and the generation of tailored structures on biochips to foster research in in vitro diagnostic devices.

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