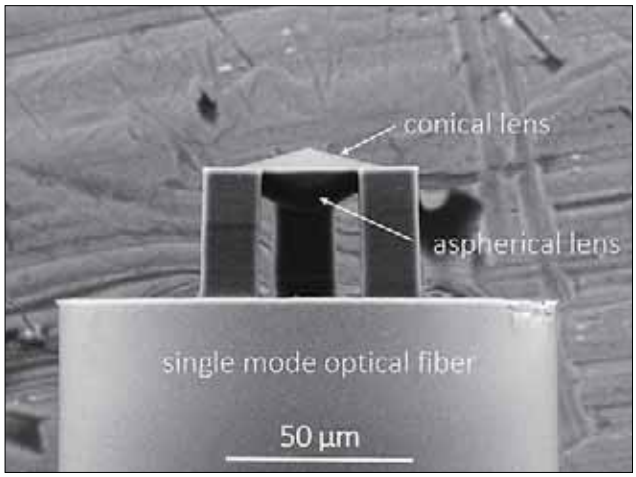
MULTI-PHOTON POLYMERIZATION

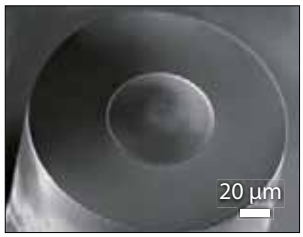
Multi-photon polymerization (MPP) is a unique method allowing the fabrication of 3D microstructures with a spatial resolution of the order of 100 nm. MPP technology is based on non-linear absorption at the focal spot of a tightly focused femtosecond laser beam, which induces well confined photopolymerization reactions. <290 fs pulses at >100 kHz repetition rates are advantageous for material modification via avalanche ionization – enabling fabrication of materials ranging from hybrid composites to pure proteins.

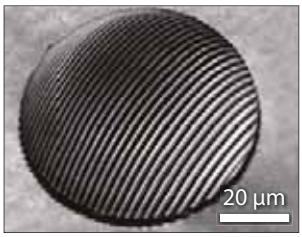
APPLICATION IN MICRO-OPTICS

Most of the photopolymers used in MPP technology are transparent in the visible range and could be directly applied in various micro-optical applications. Various mechanical as well as optical properties can be tuned.

Examples: prisms, aspherical lenses, lenses on the tip of an optical fiber, multi-lens arrays, vortex beam generators, diffractive optical elements, etc.







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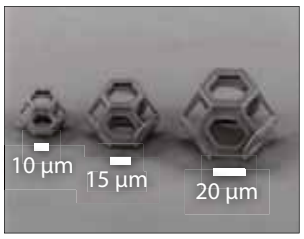
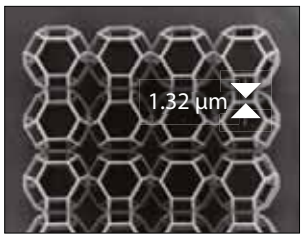
M. Oubaha et al. Novel tantalum based photocurable hybrid sol-gel material employed inthe fabrication of channel optical waveguides and three-dimensionalstructures, Appl. Surf. Sci. 257(7), 2995–2999 (2011).

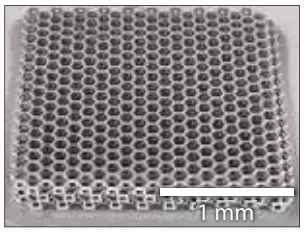
APPLICATION IN BIOTECHNOLOGY AND REGENERATIVE MEDICINE

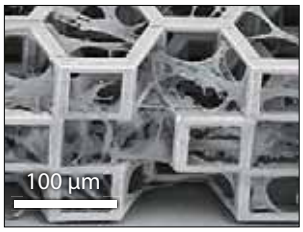
MPP technique can be realized in biocompatible and even biodegradable materials, thus it is a perfect platform for regenerative medicine research and applications.

Examples: 3D polymeric scaffolds for cell growth and tissue engineering, drug delivery devices, micro-fluidic devices, cytotoxic elements.







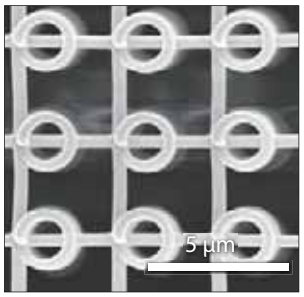


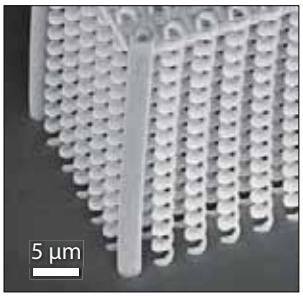
M. Malinauskas et al. 3D artificial polymeric scaffolds for stem cell growth fabricated by femtosecond laser. Lithuanian J. Phys., 50 (1), 75-82, (2010).

APPLICATION IN PHOTONICS

Highly repeatable and stable technological process enables the fabrication of various photonic crystal devices for controlling spatial and temporal properties of light at micrometer distances.

Examples: photonic crystal spatial filters, supercollimators, structural colours, etc.





L. Maigyte et al. Flat lensing in the visible frequency range by woodpile photonic crystals, Opt. Lett.38(14), 2376 (2013).

V. Purlys et al. Spatial filtering by chirped photonic crystals, Phys. Rev. A 87(3), 033805 (2013).

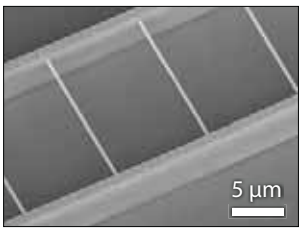
V. Purlys et al. Super-collimation by axisymmetric photonic crystals,Appl. Phys. Lett. 104(22), 221108 (2014).

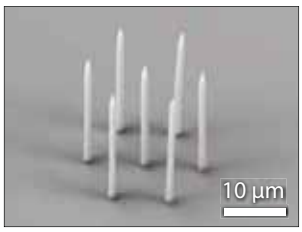
V. Mizeikis et al. Realization of Structural Colour by Direct Laser Write Technique in Photoresist, J. Laser Micro Nanoen. 9(1), 42 (2014).

APPLICATION IN MICROMECHANICS

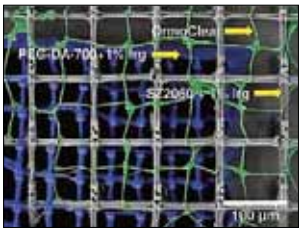
MPP technology gives the user ability to create multiscale and multimaterial 3D objects out of substances with various physical, chemical, and biological properties.

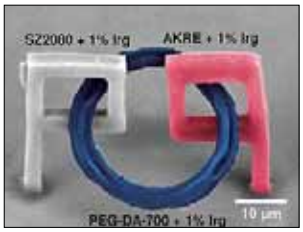
Examples: cantilevers, valves, micro-pore filters with controllable pore sizes, mechanical switches. [1)]





Examples of multicomponent structures. [2)]



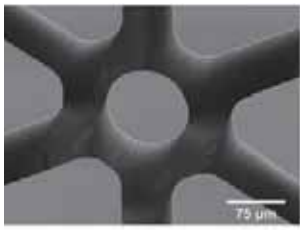


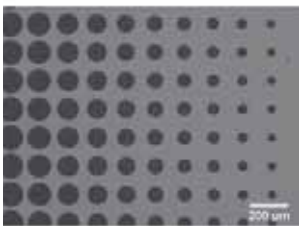
[1)] V. Purlys, Three-dimensional photonic crystals: fabrication and applications for controlof chromatic and spatial light properties, Ph.D. Thesis. Vilnius University: Lithuania (2015).

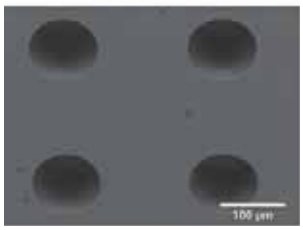
[2)] M. Malinauskas et al. Ultrafast laser processing of materials: from science to industry, Light: Sci. Appl., to be published, (2015).

LASER ASSISTED SELECTIVE ETCHING

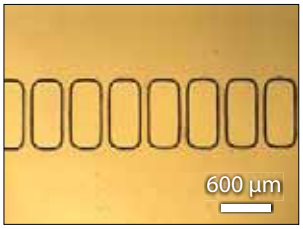
Can be applied in microoptics, micromechanics, medical engineering, etc.

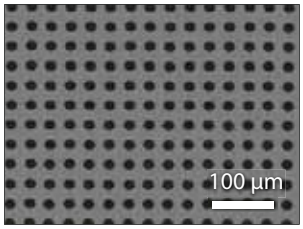






LASER ABLATION

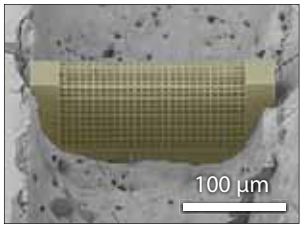


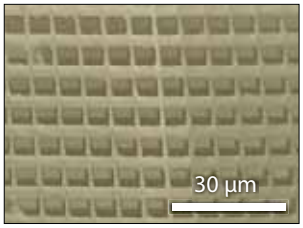


Hybrid microfabrication

ABLATION AND LITHOGRAPHY

Laser ablation allows a rapid production of glass channels while 3D laser lithography is used to integrate fine-mesh filters inside the channels. Then whole system is then sealed by laser welding.





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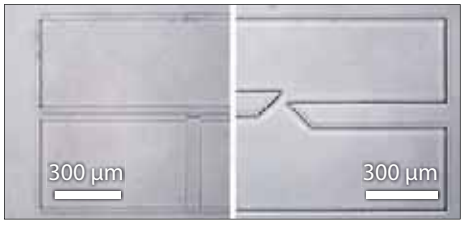
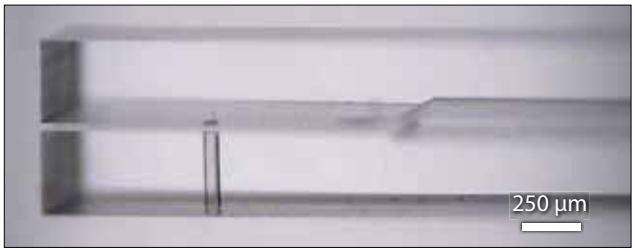
ETCHING AND POLYMERIZATION

Combining selective laser etching and photopolymerization allows manufacturing of cantilevers for sensing applications.





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