ULTRAFAST LASER WORKSTATIONS

3D MICROFABRICATION SERVICES

femtika

WWW.FEMTIKA.COM

ABOUT FEMTIKA

FEMTIKA is a leading provider of advanced laser technology solutions in selective laser etching, multiphoton polymerization and additional femtosecond-driven techniques. Our cutting-edge technology allows for precise and efficient processing in a wide range of industries, including microelectronics, medical devices, and semiconductor sector.

Founded in 2013, our team of experienced scientists and engineers has been at the forefront of laser technology research and development. Our commitment to innovation and excellence has led to the development of unique and highly effective laser solutions that deliver superior results.

Our state-of-the-art facility is equipped with the latest equipment and technology, allowing us to provide our clients with the highest level of service and support. We also offer comprehensive training and technical support to ensure that our clients have the knowledge and tools they need to achieve their goals.

At FEMTIKA, we are dedicated to providing our clients with the best laser technology solutions available on the market. We strive to exceed our clients' expectations and help them achieve success in their industries.

The company belongs to the European Photonics Industry Consortium (EPIC), the TOOLAS cluster, and the Lithuanian Laser Association.

FEMTIKA PRODUCTS & SERVICES

CONTRACT DEVELOPMENT AND MANUFACTURING SERVICES

Feasibility Study

- Research of micro-structure fabrication method
- Fabrication of microstructure prototype
- Iterative development and prototyping services
- Measurement and alignment with technical requirements
- Study report preparation

Small Scale Production

- Evaluation of repeatability
- Optimization of fabrication process
- Fabrication quality assurance

Scalability Solution Development

- Development of micro-structure fabrication process
- Development of mass production fabrication design
- Development of needed machinery and automation

ULTRAFAST LASER WORKSTATIONS – LASER NANOFACTORY SERIES

Selective Laser Etching Workstation

- Development and production of Microfluidic chip
- Micromechanics for watch industry and medical applications, microoptics
- TGV and fiber alignment holes

Multi-Photon Polymerization Workstation

- Material engineering and development
- Scaffolds, lab-on-chip devices
- Medical device development and prototyping
- Microoptics and optical systems

Hybrid Laser Processing Workstation

- Universal tool for multiple processes
- Ablation, dicing, surface structuring, colouring, functional processing
- FBG, waveguides, photonic wire bonding
- Custom system integration

ULTRAFAST LASER WORKSTATIONS

GLASS LASER WORKSTATION

A dedicated solution for your glass micro-processing tasks

FEATURES

- Dual-objective head for effortless fabrication mode transition
- Multi-scale glass processing: achieve precision from μm to cm scales
- Autofocus
- Self-aligning optical system for reduced maintenance requirements
- High-sensitivity camera for real-time process monitoring

PROCESS SPECIFICATIONS

- Technology: selective laser etching, ablation, welding, refractive index modification
- Materials: fussed silica, borosilicate glass and other transparent materials
- Smallest feature size: > 1 μm
- Minimum surface roughness: < 200 nm
- Maximum object height: 20 mm
- Aspect ratio: > 1 : 200
- Minimum micro hole diameter: 5 μm

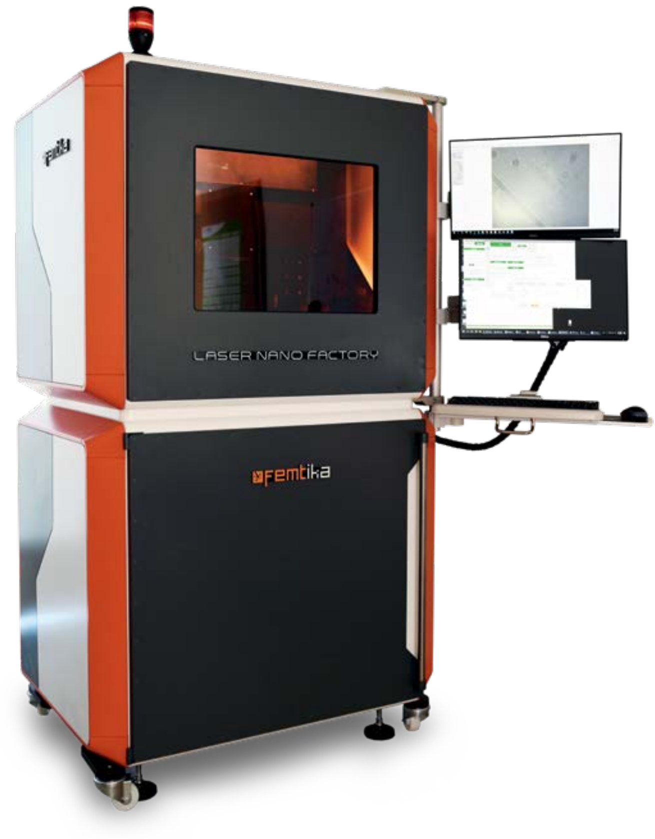
TECHNICAL SPECIFICATIONS

Femtosecond laser source	Wavelength	1030 ± 10 nm		
	Max. average power	10 W		
	Pulse duration	400 fs – 4 ps		
	Repetition rate	100 kHz – 1 MHz		
	Max. pulse energy	> 100 uJ		
Positioning stages (XYZ)	Axis	X	Y	Z
	Travel *	120 mm	120 mm	60 mm
	Accuracy	± 0.5 μm	± 0.5 μm	± 0.5 μm
	Bi-Directional Repeatability	± 0.15 μm	± 0.15 μm	± 0.15 μm
	Maximum speed (no load)	350 mm/s	350 mm/s	200 mm/s
Galvano scanners	Scan angle	± 0.35 rad		
	Repeatability	0.4 μrad RMS		

* Custom travel range options: 160x160, 300x300, 600x600.

FBG WRITING WORKSTATION

A dedicated solution for writing fiber bragg grating



FEATURES

- Fiber core detection using camera or autofocus
- Fiber bragg grating (FBG) writing using PbP, LbL methods with an option for phase mask writing
- 4 core fiber writing
- Cladding removal via laser ablation
- Comprehensive laser control capabilities for the precise optimization of specialized tasks.
- Automation possibility with a roll-to-roll solution (also available with an imersive objective)

TECHNICAL SPECIFICATIONS

Femtosecond laser source	Wavelength	1030 ± 10 nm and 515 ± 10 nm		
	Max. average power	10 W		
	Pulse duration	250 fs – 10 ps (tunable)		
	Repetition rate	Single-shot – 1 MHz		
	Long-term power stability	< 0.5% RMS over 100 h		
Positioning stages (XYZ)	Axis	X	Y	Z
	Travel	150 mm	100 mm	60 mm
	Accuracy	± 200 nm	± 200 nm	± 275 nm
	Resolution	0.5 nm	0.5 nm	2 nm
	Maximum speed	350 mm/s	350 mm/s	200 mm/s

LASER NANOFACTORY WORKSTATIONS

FEATURES

- Combine additive and subtractive manufacturing in one system
- Wide tunability enables efficient fabrication of micro-nano structures using a wide range of materials
- Stitching-error-free manufacturing
- User friendly, wizard-guided software for model preparation and system operation
- Modular and customizable system
- Integratable into production lines

TECHNICAL SPECIFICATIONS

Technology		Selective Laser Etching	Multiphoton Polymerization	Hybrid
LASER SOURCE				
Femtosecond laser	Wavelength	1030 ± 10 nm	780 ± 10 nm	1030 ± 10 nm and 515 ± 10 nm
	Repetition rate	Single-shot – 1 MHz	> 80 MHz	Single-shot – 1 MHz
	Pulse duration	250 fs (450 fs) – 10 ps (tunable)	< 150 fs	190 fs – 10 ps (tunable)
	Max. average power	5 W	> 250 mW	from 5 W to 20 W*
	Long-term power stability	< 0.5% RMS over 100 h	< 0.5% RMS over 24 h	< 0.5% RMS over 100 h
POSITIONING				
Linear stages with synchronized Galvano scanners	XYZ POSITIONING STAGES MOUNTED ON GRANITE BASE WITH BRIDGE			
	Travel (XYZ)	160 mm × 160 mm × 60 mm *		
	Accuracy (XYZ)	± 300 nm		
	Resolution (XYZ)	1 nm		
	Maximum speed (XY)	200 mm/s		
	GALVANO SCANNERS			
	Accuracy	50 μrad		
	Repeatability	0.4 μrad RMS		

Technology	**Selective Laser Etching**	**Multiphoton Polymerization**	**Hybrid**

OTHER PARAMETERS

Monitoring on time	The fabrication process is monitored by an integrated machine vision system		
Stitching	Stitchless fabrication using Infinite Field of View (IFoV)		
Focusing optics	Objectives – from 0.25 to 0.45 NA *	Objectives – from 0.4 to 1.4 NA *	Objectives – from 0.25 to 1.4 NA *
Autofocus system	Automatic glass/polymer or glass/air interface optical detection		
Self-Align-System (SAS)	Automatic laser beam path alignment system		
Substrate	Universal vacuum sample holder with computer-controlled, position synchronized illumination for transparent samples		

Beam delivery & control	Motorized attenuator, polarization rotator, beam expander. Integrated power meter enables real-time power monitoring
Software	Convenient control of all necessary process parameters and machine settings. The software handles standard formats of 3D designs created by popular CAD programs, like STL
Laser safety	Ergonomic housing to ensure laser safety class 1 and environment stability conditions for laser microfabrication process

* Customizable.

PHYSICAL DIMENSIONS

Dimensions when all doors are closed (W × L × H)	1790 mm × 920 mm × 2270 mm
Dimensions when doors are opened (W × L × H)	2680 mm × 1900 mm × 2300 mm
Weight	870 kg

ENVIRONMENTAL & UTILITY REQUIREMENTS

Operating temperature	20 °C ± 2 °C
Relative humidity	≤ 60%
Electrical requirements	110 V AC, 20 A – 230 V AC , 10 A
AC power (normal operation)	typical 2 kW

The conditions of the environment are preferred to be as stable as possible.

CUSTOM LASER SYSTEM INTEGRATION

UNIVERSITY OF DUISBURG-ESSEN

Complex multi process Laser Workstation Integration, employing multiphoton polymerization, ink-jet printing, time resolved photoluminescence, Raman spectroscopy based diagnostics, laser processing in gas environment. All controlled by the Femtika software with semi-automatic switching between laser processes, work areas and modes. System used in academia for semiconductor solar cell prototyping and characterization.

MESOMORPH

EU funded Horizon-2020 project Mesomorph brought up together a dozen or partners for integration of atomic layer deposition, multi-photon polymerization, laser ablation, selective laser etching, and machine vision / diagnostics system into single machine for development and production of optoelectronic components.

https://mesomorph-h2020project.eu/

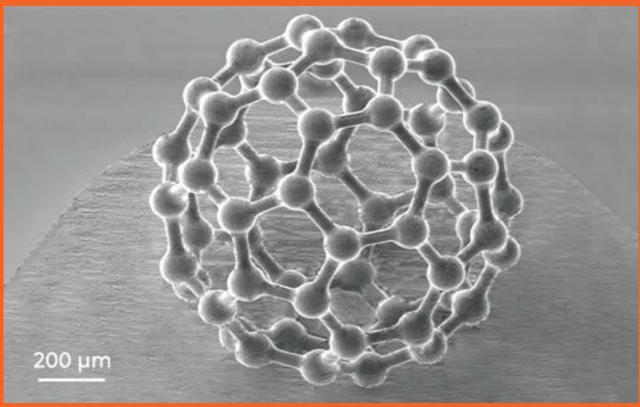
FEMTOSURF

The FemtoSurf Project has received funding from the European Union's Horizon 2020 Research and Innovation Program. The main objective of FemtoSurf project was to develop, test and demonstrate industrial-grade solid state 2-3 kW-level fs laser with parameters suitable for metal surface patterning applicable in industrial settings.

https://www.femtosurf.eu/

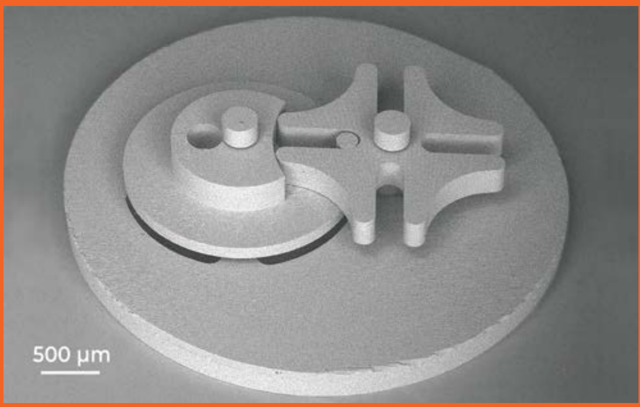
CONTRACT DEVELOPMENT AND MANUFACTURING SERVICES

SELECTIVE LASER ETCHING

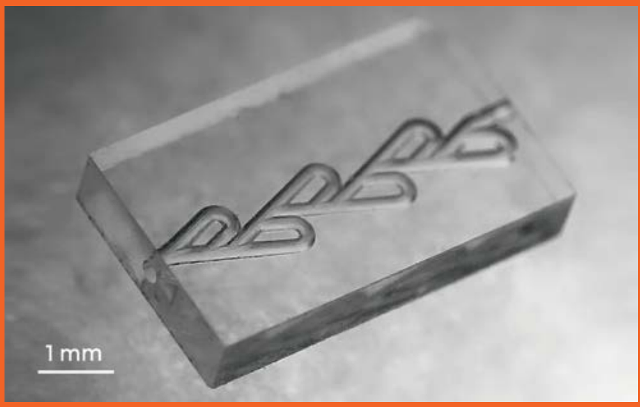


3D glass structures

3D nozzle



Geneva mechanism



Tesla valve

Microchannels

Fiber array

SELECTIVE LASER ETCHING

APPLICATIONS

- Micro-mechanics
- Micro-fluidics
- Lab-on-chip
- Microoptics

FEATURES

- Subtractive manufacturing technique
- Arbitrary-shaped 3D structures from glass µm to cm scale
- Various glasses applicable
- Self-alignment system for automatic laser beam alignment
- Micrometer feature resolution

Selective laser etching (SLE) is a subtractive laser technology allowing fabrication of complex-shape 3D glass parts with micrometer precision. This technology consists of two fabrications steps: femtosecond laser irradiation and subsequent chemical etching. Tightly focused the femtosecond laser beam induces modifications of transparent material within the focal point of laser beam. By spatially moving the laser focus well-defined structure is written in point-by-point fashion up to substrate surface. Afterward, the sample is immersed in etchant solution, which etches out laser modified areas.

SLE is often used in the manufacturing of electronic devices and other precision components ensuring high accuracy and detail in etched patterns. Moreover, the highly focused light enables the creation of complex 3D shapes and intricate designs.

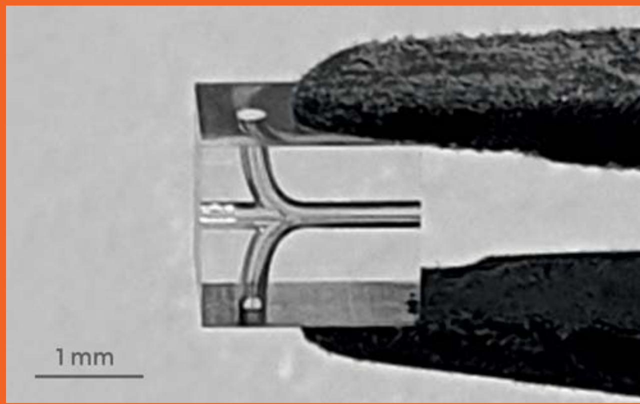
SPECIFICATIONS

Technology	Substractive manufacturing
Materials	Fused silica, borosilicate
Smallest feature size	> 1 µm
Minimum surface roughness	50* – 200 nm
Maximum object height	1 cm
Aspect ratio	> 1 : 200
Minimum micro hole diameter	5 µm
Writing speed	50 mm/s

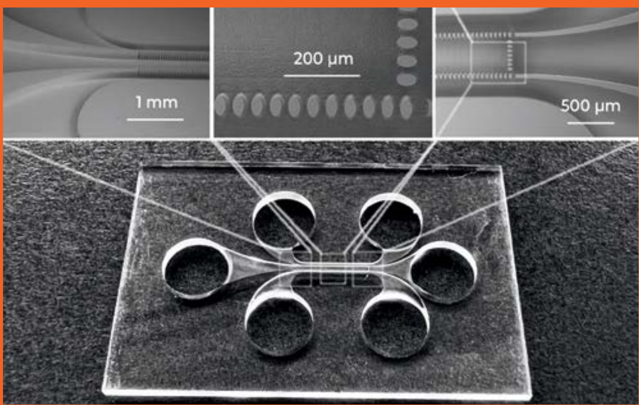
* Applying additional polishing.

SELECTIVE LASER ETCHING

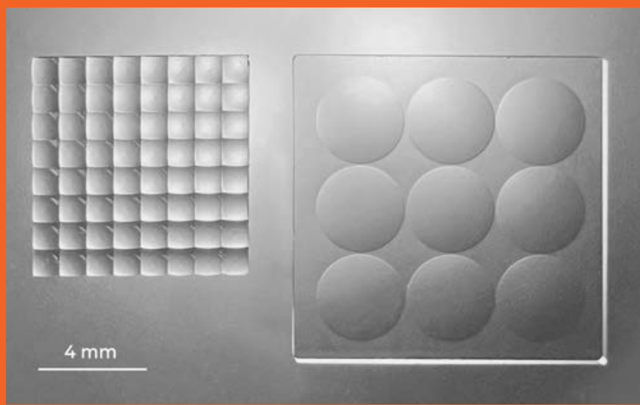
Gears system



3D interconnect channels

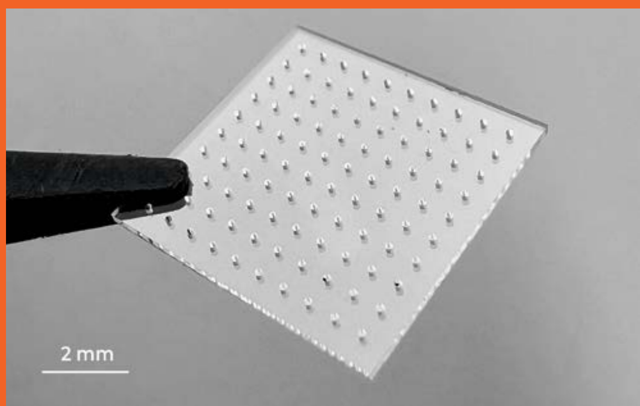


Microfluidics



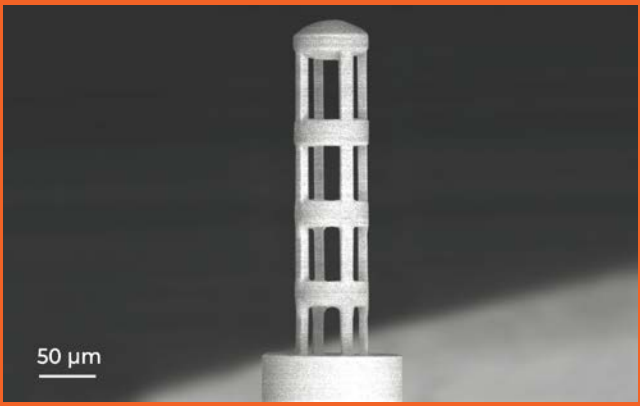
Microoptics, microlenses

Threads for screw

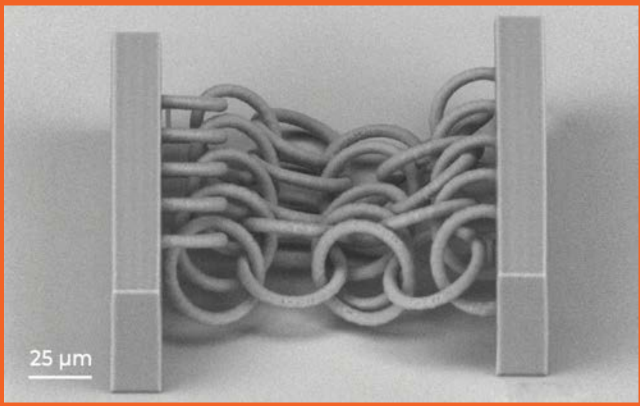


Quantum computing / TGV

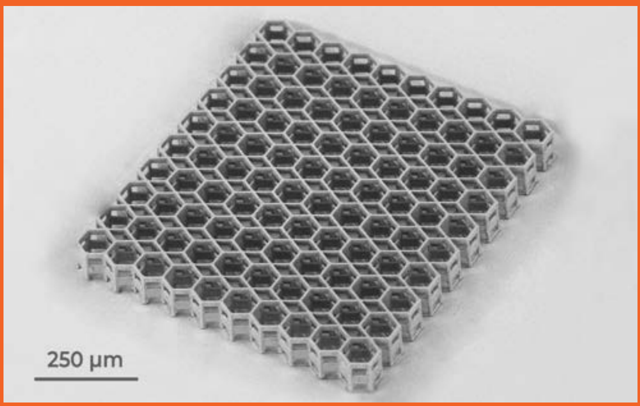
MULTIPHOTON POLYMERIZATION



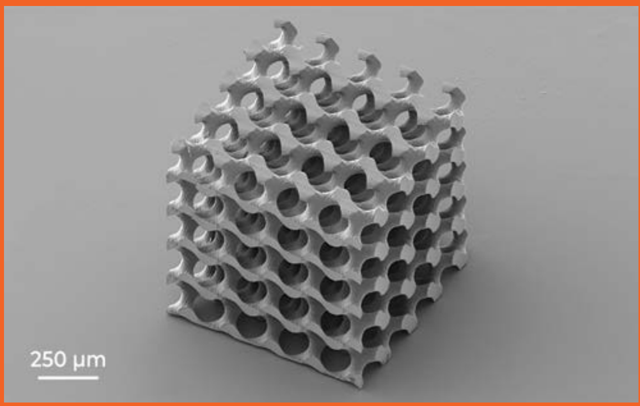
3D structures on fiber tip



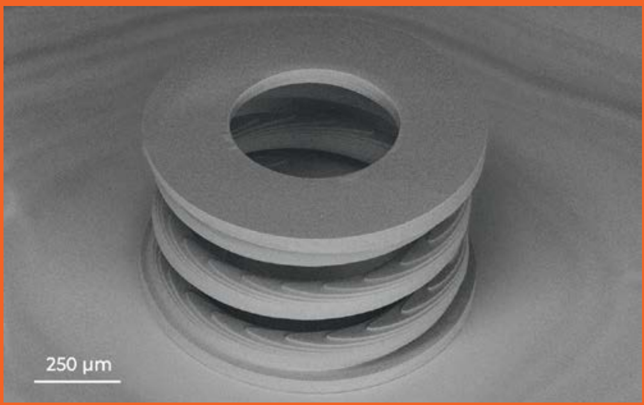
3D chain-mail structure



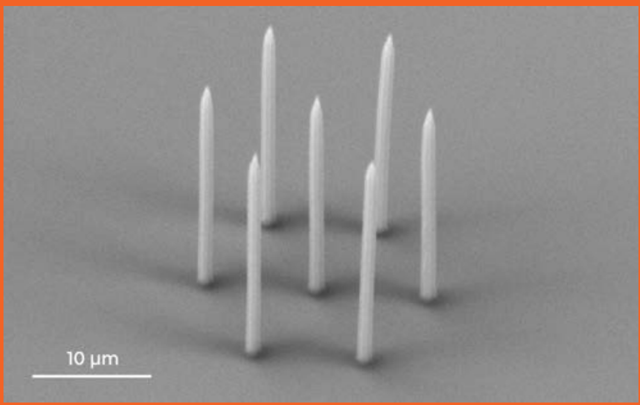
3D scaffold



3D gyroid structure

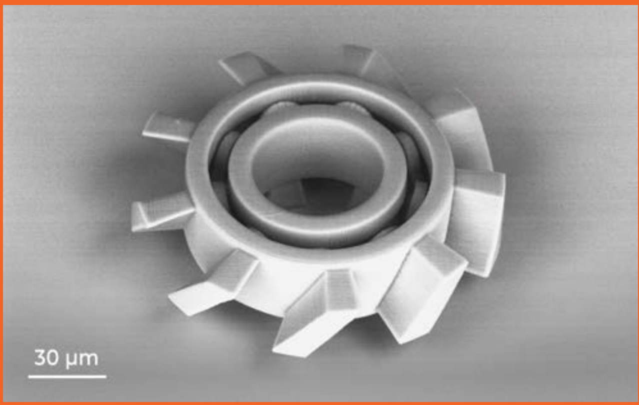


3D meso-spring

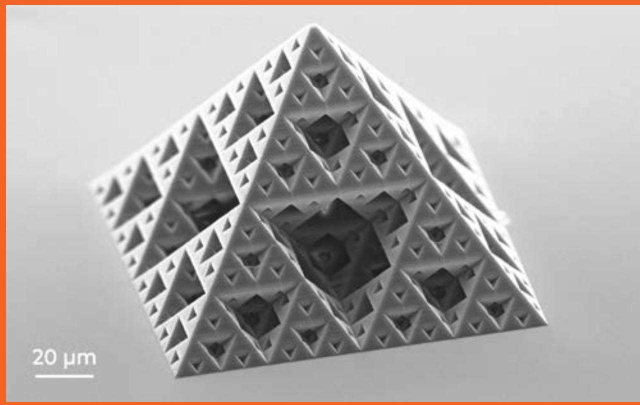


Microneedles

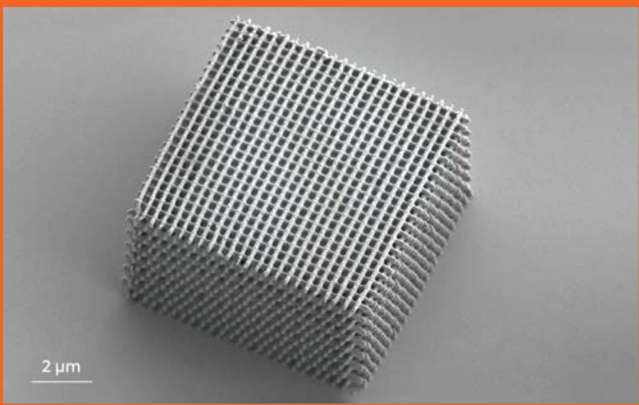
MULTIPHOTON POLYMERIZATION



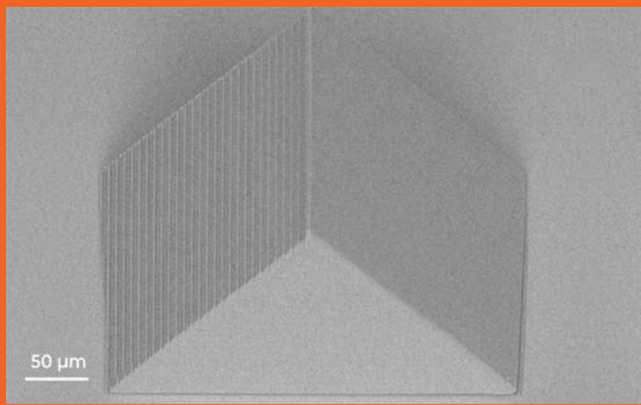
Mechanical bearing



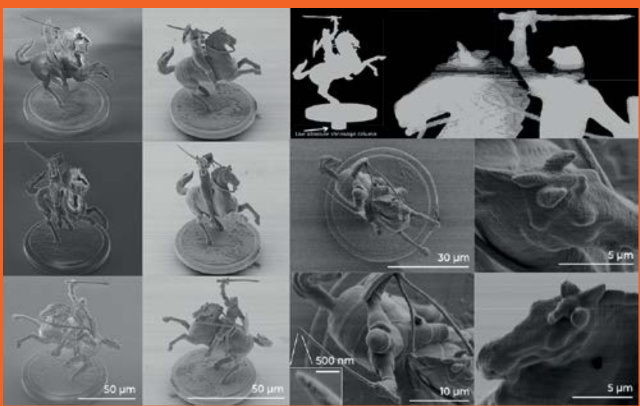
3D pyramid structure



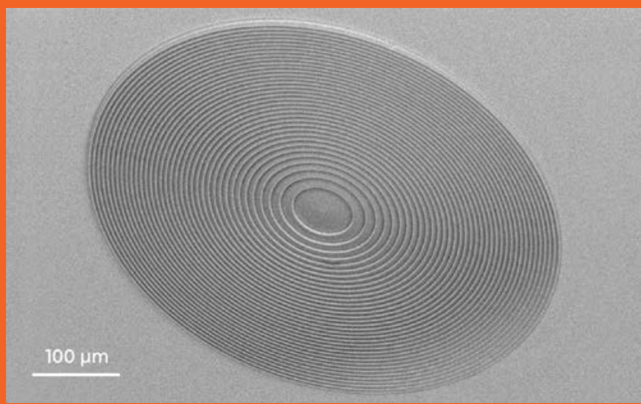
Photonic crystal



Prism for ellipsometry



Ceramic structures



Fresnel lens

MULTIPHOTON POLYMERIZATION

APPLICATIONS

- Micro-optics
- Micro-mechanics
- Scaffolds
- Sensors
- Interconnects

FEATURES

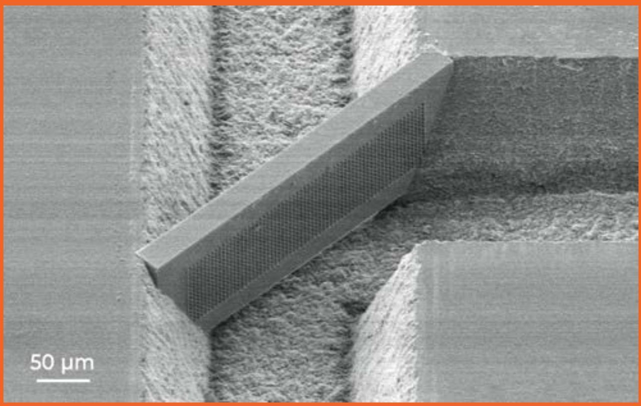
- Sub-micrometer resolution additive manufacturing technique
- True 3D structures in micrometer scale
- Various polymers available
- Stitching error-free manufacturing

Multiphoton polymerization (MPP) is a technology that enables the production of arbitrary shape polymeric structures within sub-micrometer resolution. First, a photoresist sample is prepared by drop-casting polymer material mixed with a photoinitiator on the glass slide and then pre-baking. Afterward, the 3D microstructure is fabricated using a direct laser writing technique. Consequently, the polymer hardens in places of drop where it is affected by laser radiation due to a process called photopolymerization. Finally, the microstructure is immersed in an organic solvent to develop an unpolymerized photoresist.

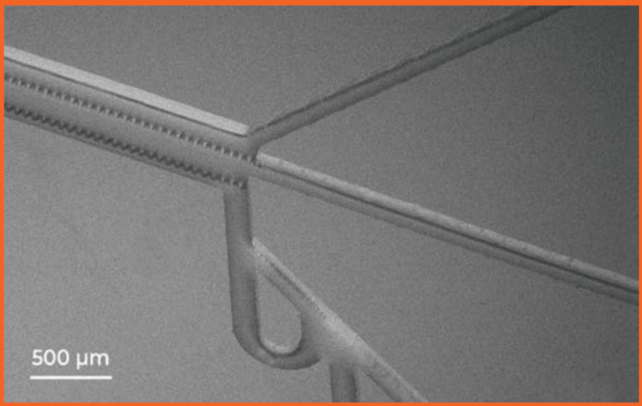
MPP is often used in the manufacturing of microelectronic devices, as it allows for the creation of very small and detailed structures with high levels of precision. Additionally, because the light is highly focused, it can be used to create complex 3D shapes.

SPECIFICATIONS

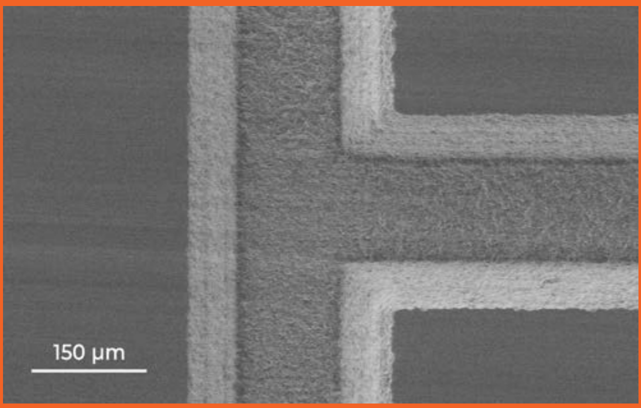
Technology	Additive manufacturing
Materials	Hybrid organic inorganic polymer, hydrogels, epoxy-based photoresist, elastomers, proteins, glassomers (SZ2080, Ormocers, PEG-DA, SU-8, PDMS and others)
Minimum XY feature size	150 nm
Minimum surface roughness Ra	≤ 20 nm
Maximum fabrication speed	30 mm/s



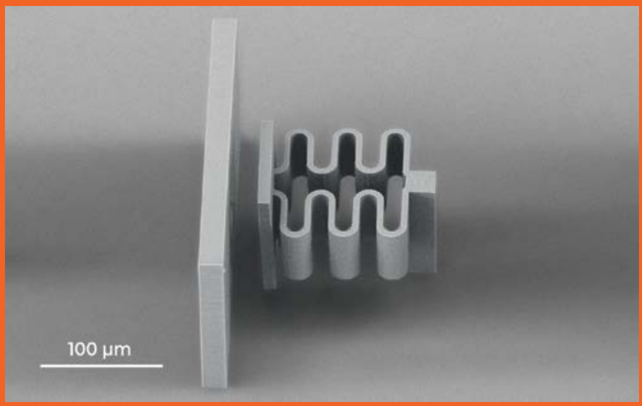
Lab-on-chip device



Liver-on-chip

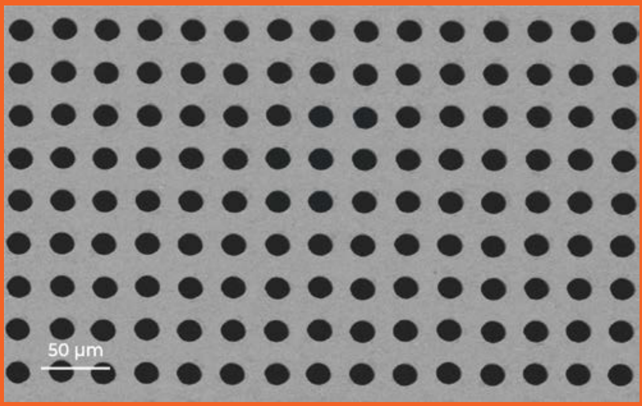


Lab-on-chip device

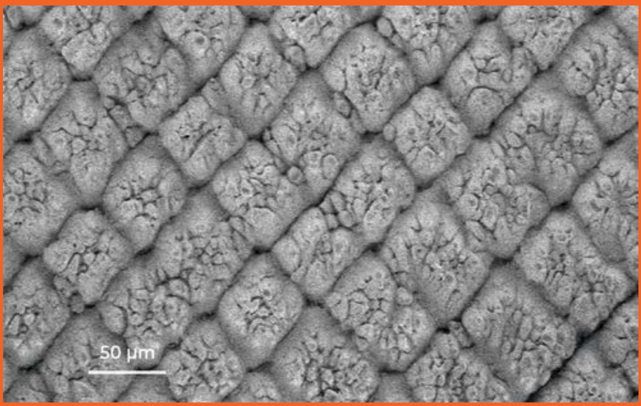


Micromechanical sensor

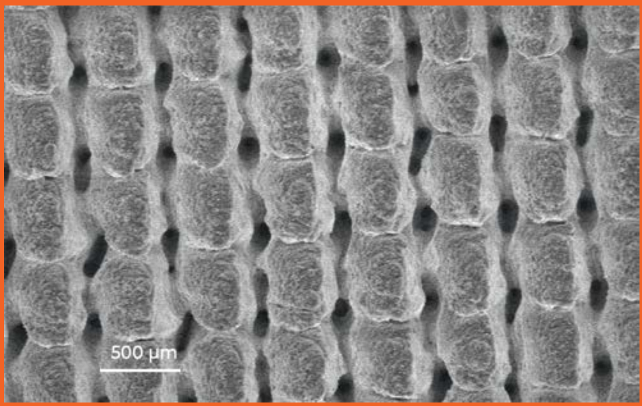
Laser surface texturing



Holes in hard metal

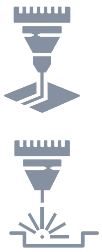


Hydrophobic surface



Hydrophilic surface

HYBRID FABRICATION



APPLICATIONS

- Micromechanics
- Lab-on-chip
- Microfluidics
- Sensors

FEATURES

- Additive and subtractive techniques combined in one Laser Nanofactory system
- Arbitrary-shaped 3D structures from micrometers to centimeters scale
- Fast switch from additive to subtractive microfabrication
- Customizable configuration – integrate additional devices

Femtosecond lasers are extremely versatile tools allowing a great variety of different microfabrication processes. Each process has its own requirements for laser, beam delivery or material parameters. Our Laser Nanofactory workstation allows **hybrid fabrication**, meaning that various processes are supported by the same equipment. The two of our most frequently used processes are multiphoton polymerization and selective glass etching, however, that is far from all! By precisely tuning its parameters the same machine is capable to perform more processes including:

- Refractive index modification of transparent materials
- Micro-ablation
- Surface structuring
- Micro-welding

In addition, Laser Nanofactory is a modular system, allowing further adaptation to your application. It supports various sample holders (e.g. for microscope slides, wafers, fibers) and different fabrication heads, optimized for your desired laser applications.

INDUSTRIES

BIOTECHNOLOGIES

Biomedical 3D manufacturing is an ever growing topic. Femtosecond laser-based 3D multiphoton polymerization is a superb tool for fabrication of micro-scaffolds with complex functional architectures, wide-scaled and out of any relevant material.

OPTICS AND PHOTONICS

Producing of photonic devices based on high-resolution (up to hundreds of nm) single features for applications in visible and IR part of the spectrum. Fabrication of microoptics of any desirable shape as the optimized surface geometries allow minimising aberrations or creating exotic light distributions, like, for instance, Bessel beams or optical vortexes.

MEDICINE

Objects with controllable feature sizes that can be smaller, bigger or at the cell size can be produced. This enables the production of next-generation medical devices, such as cell perforators and micro-robots. They combine extremely small size and unmatched functionality, paving the way for completely new outlook to medical device design and fabrication.

MICROFLUIDICS

Amplified femtosecond lasers were shown to be extremely capable in producing microfluidical components. As they can be realized for both additive and subtractive manufacturing channels, arbitrary free form integrated elements and bonding can be realized with only one laser micromachining setup. This opens an array of new possibilities which can enrich this active research area with new set of capabilities.

MICROMECHANICS

3D femtosecond micro-manufacturing provides the steppingstone for downsizing mechanical elements down to sub-micrometer scale. What is more, due to diverse light-matter interaction regimes achievable with fs pulses it is possible to produce these elements from wide range of materials, starting with polymers and ending with glasses, dielectric crystals or metals. Gears, springs, cantilevers and other classical mechanical elements can be produced in micro-scale using this method.

SURFACE STRUCTURING

Functional surfaces are incredibly important in the fields ranging from medicine to space exploration. The surfaces created with fs pulses can be easily made both repelling and adhering, playing into needs of basically any application, including tool manufacturing, aviation, maritime and medicine.

PUBLICATION LIST

[1] Butkutė, Agnė, et al. “Combined femtosecond laser glass microprocessing for liver-on-chip device fabrication.” Materials 16.6 (2023): 2174.

[2] Merkininkaite, Greta, et al. “Additive manufacturing of SiOC, SiC, and Si3N4 ceramic 3D microstructures.” Advanced Engineering Materials 25.17 (2023): 2300639.

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[10] D. Andriukaitis, A. Butkutė, T. Baravykas, R. Vargalis, J. Stančikas, T. Tičkūnas, V. Sirutkaitis, and L. Jonušauskas, “Femtosecond Fabrication of 3D Free-Form Functional Glass Microdevices: Burst-Mode Ablation and Selective Etching Solutions”, 2021 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference, (2021).

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