femtika

3D MICRO-FABRICATION

WORKSTATIONS AND SERVICES

ABOUT FEMTIKA

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Founded in 2013 by the group of enthusiastic scientists and business managers. Femtika is a spin-off company from Vilnius University Laser Research Centre.

Femtika's goal - to supply growing worldwide demands of available tools and technologies enabling hybrid 3D laser fabrication, with custom design components in micro- and submicro-scale.

Company is proud of its world class specialists with deep working knowledge in the area of laser micro-machining, polymerization and optical solutions.

Over 30 diligent and curious employees, 4 of them - PhD, 3 - PhD students.

Femtika is a member of Lithuanian Laser Association and European Photonics Industry Consortium (EPIC).

Proudly based in Vilnius, Lithuania.

The main Femtika working areas:

- Desing and production of custom 3D laser precision processing systems.
- Fabrication services of 3D micro- and nano-structures using femtosecond laser.

LASER NANOFACTORY

System dimensions: 1.1m x 0.9m x 1.9m
(all doors closed, excl. accessories)

Specifications: standard system for hybrid micro-fabrication

Implemented technologies: multiphoton-polymerization, selective laser etching, laser ablation

Femtosecond laser source*

Wavelengths	1030 nm ± 10 nm and 515 nm ± 10 nm
Pulse duration	<290 fs - 10 ps
Pulse energy	>200 μJ
Max average power	10 W
Repetition rate	Single-shot - 1 MHz

*For specific requirements another laser source could be provided, suitable only for multiphoton-polymerization (wavelength 780 nm ± 10 nm, average power >250 mW, pulse duration <100 fs, repetition rate 100 MHz).

Nanopositioning

Travel (XY)	160 mm x 160 mm
Travel (Z)	60 mm
Accuracy	± 300 nm (XY), ± 275 nm (Z)
Resolution	1 nm (XY), 2 nm (Z)

linear stages synchronized with galvanoscanners:
stitching-error free fabrication

Universal vacuum sample holder

With computer-controlled illumination
14 mm x 66 mm illuminated area
Capability of more than 5 kg load
Easily changeable plates for chucking the wafers

Beam power control

The optical modulator and motorized attenuator is used for beam power control

Integrated powermeter enables real-time power monitoring

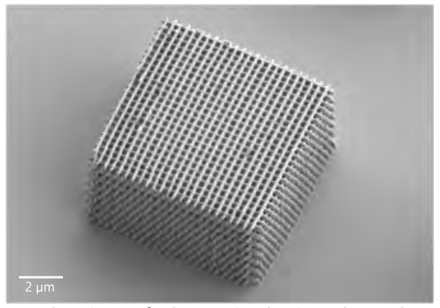
- Highest resolution 3D printing: down to 150nm
- Self Alignment System integrated for automatic beam alignment
- Hybrid fabrication: additive and subtractive techniques in one system
- High sensibility camera for real-time process management
- Workstation is protected against environmental vibrations
- Possibility to integrate additional devices

MULTI-PHOTON POLYMERIZATION

Microfabrication by multi-photon polymerization is a direct laser-write technique which allows 3D structuring of photopolymers at the micro- and nano-scale. This can be achieved through combination of various nonlinear effects, careful consideration of laser radiation parameters and precise focusing conditions. For this reason 3D laser lithography was used for creation of functional devices in fields of nanophotonics, microoptics, microfluidics, micromechanics, tissue engineering and much more. It is important to note, that there is huge variety of materials that can be processed by applying 3D laser lithography, including hybrid organic-inorganic photopolymers, biodegradable polymers, elastomers, proteins and so on.

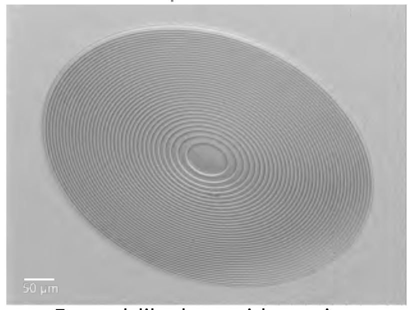
3D gyroid structure - mechanically rigid, but light. The overall size of this structure - 1 mm x 1 mm x 1 mm. The structure height is much bigger than the working distance of the used objective (0.19 mm).

photonics



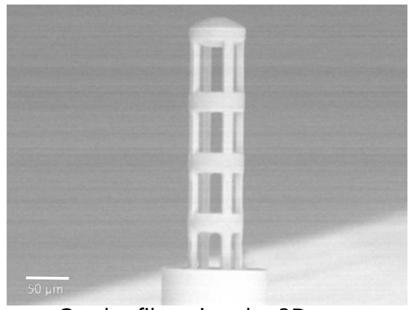
Production of photonic devices based on high resolution (up to hundreds of nm) single features. The line width of this photonics crystal - 200 nm.

micro-optics



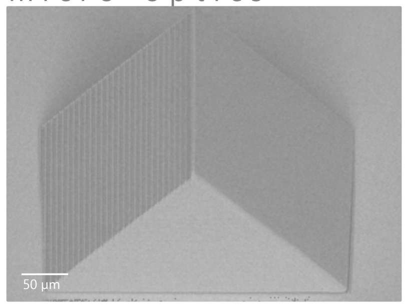
Fresnel-like lens with varying aspherical profile in each Fresnel zone for superb nearly spherical aberration-free focusing.

fibers



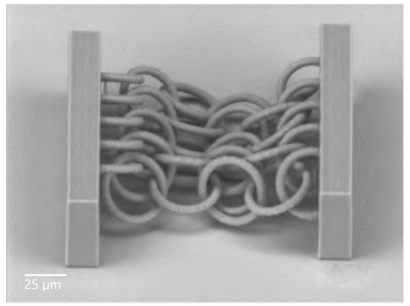
On the fiber tip: the 3D supports ensuring a required distance to the lens, fabricated on the top of the structure.

micro-optics



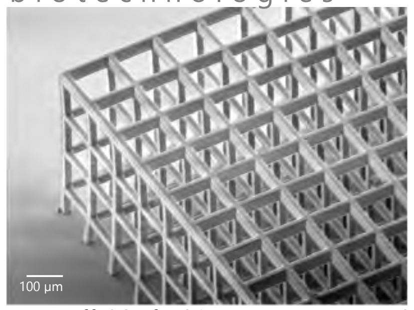
Prism for elipsometry. Only one optical surface is needed - dynamic slicing and hatching ca be used to increase throughput.

micro-mechanics



Functional intertwined geometries such as chain-mail allow creating flexible structures out of hard material.

biotechnologies



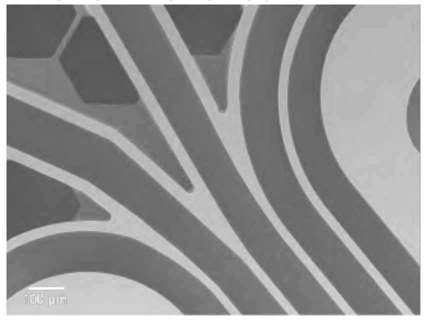
3D scaffold of arbitrary geometry and micro pores out of biocompatible material.

Smallest feature size - 150 nm
Fabrication speed on highest resolution - 30 mm/s
Accessible writing area - 160 mm x 160 mm

depends on the structure, material and focusing optics

SELECTIVE LASER ETCHING OF GLASS

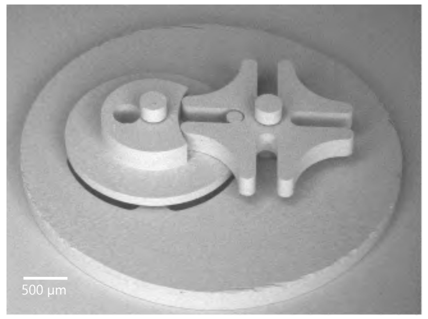
micro-fluidics

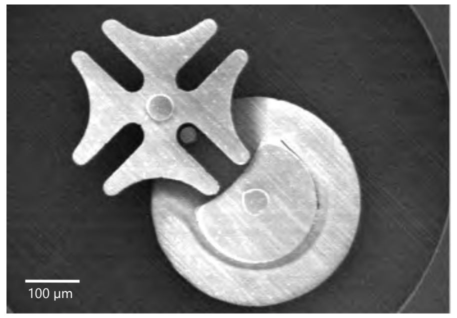


Micro channels on the surface of glass.

Micro channels in the volume of glass forming a Tesla valve - the device to control the flow of the liquid. The surface roughness (RMS) of this channel ~270 nm.

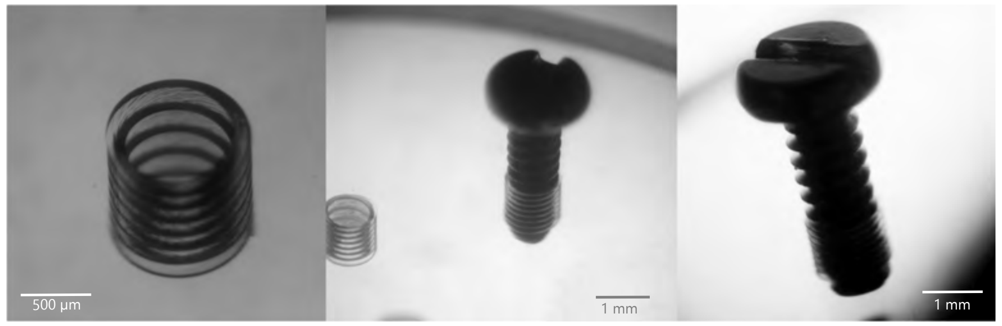
micro-mechanics



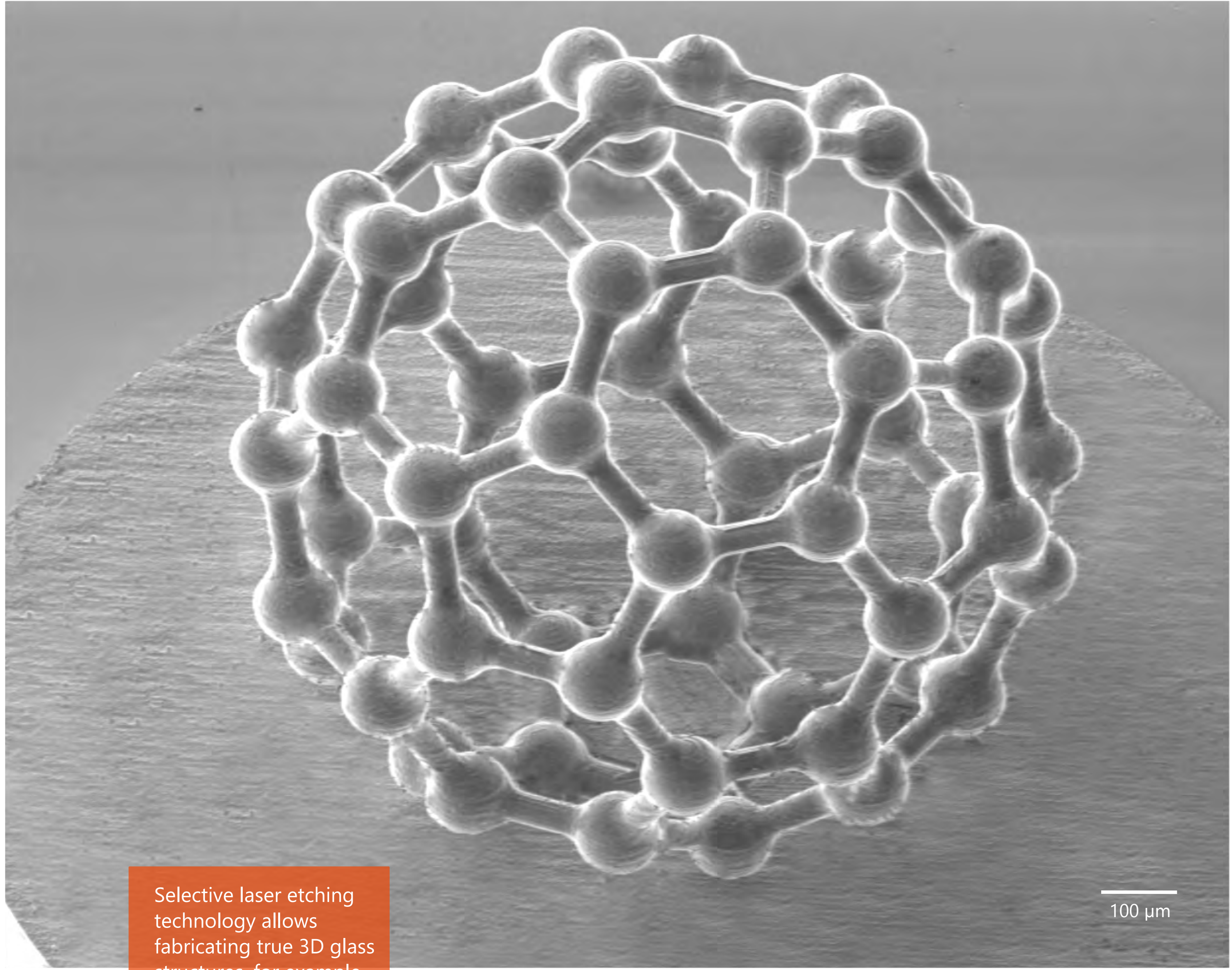


One of the most commonly used devices for producing intermittent rotary motion - Geneva mechanism - fabricated of glass. It can be easily scaled while maintaining the same fabrication parameters - the sizes of these structures differ 5 times.

micro-mechanics



Relatively large structure with precise features - thread for screw - is hard to fabricate due to its spiral shape and requirements for high precision and low surface roughness. Without fulfilling mentioned requirements it would be impossible to insert the screw inside the structure without damaging the structure itself.



Selective laser etching technology allows fabricating true 3D glass structures, for example, the model of fullerene molecule.

Selective laser etching is a two-step process. First, the volume of fused silica is modified by ultra-short radiation, then the material is chemically etched away. In this way, mechanically stable and durable 3D structures can be created of glass or in the volume of glass.

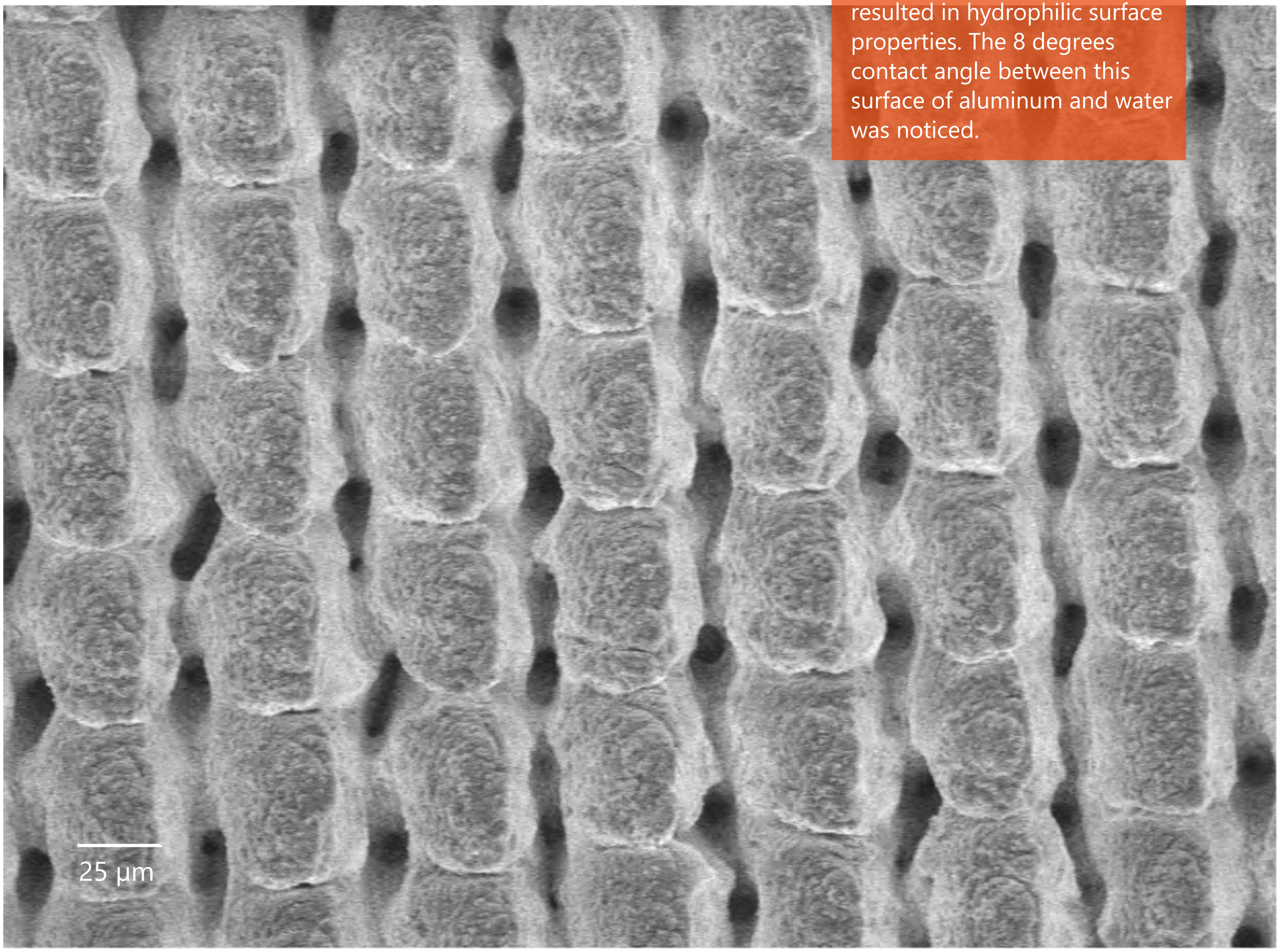
Finest surface roughness (RMS) at the bottom of the groove ~ 200-300 nm
Finest surface roughness (RMS) on the sides of the groove ~ 100 nm
Smallest feature size ~1-2 µm

depends on the structure and material

LASER ABLATION

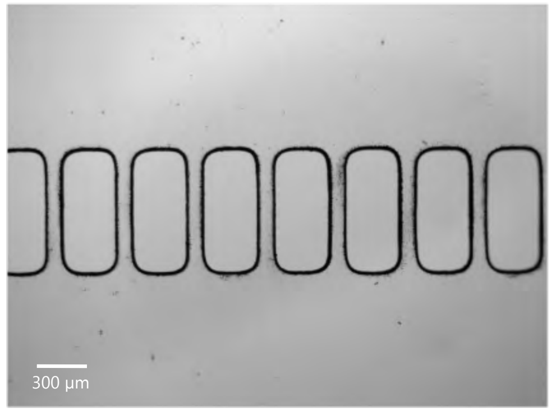
Laser ablation is based on ultra-fast interaction between material and femtosecond laser irradiation and allows "cold processing" with minimal thermal effects and superb cut quality without damaging the surrounding material. Almost any material can be processed: metals, polymers, glass, even paper (banknotes, for example). What is more, surface micro-texturing is possible for surface functionalization (for example, creating hydrophobic/hydrophilic surfaces, friction manipulation, etc.).

The smallest hole diameter in metal ~3µm
Possible aspect ratio up to 1:10
The max thickness that can be drilled - 1mm (metals), 0.5mm (glass), 2mm (polymers)
Ablation speed examples - 5ms per hole (polymers), 50ms per hole (tungsten)



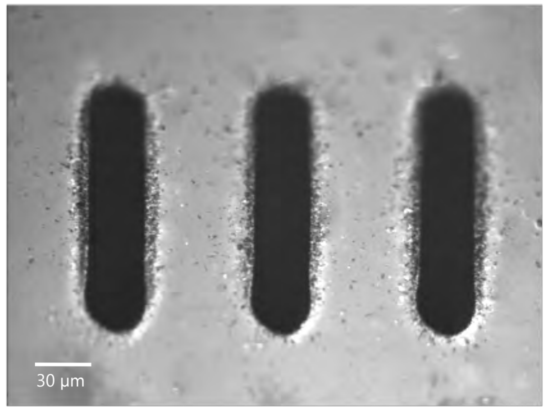
Metal surface micro-texturing resulted in hydrophilic surface properties. The 8 degrees contact angle between this surface of aluminum and water was noticed.

micro-cutting



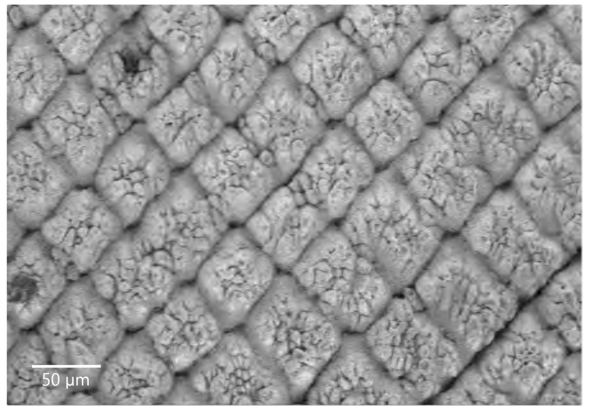
Square holes with rounded corners in a polymer. Pitch between holes is substantially smaller that the size of the hole. Spaces are thin and straight, ablation edges are clear, minimal thermal influence.

micro-cutting



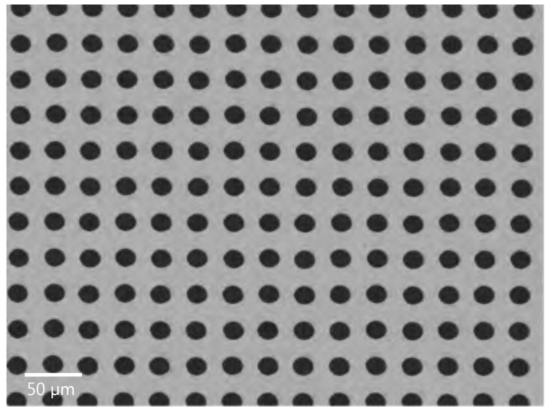
Arbitrary shaped cutouts in a polymer. Sample thickness 50 µm, cutting speed - 100 mm/s.

surface texturing



Hydrophobic surface achieved on a copper alloy sample. The contact angle between this surface and water drop - 150 degrees.

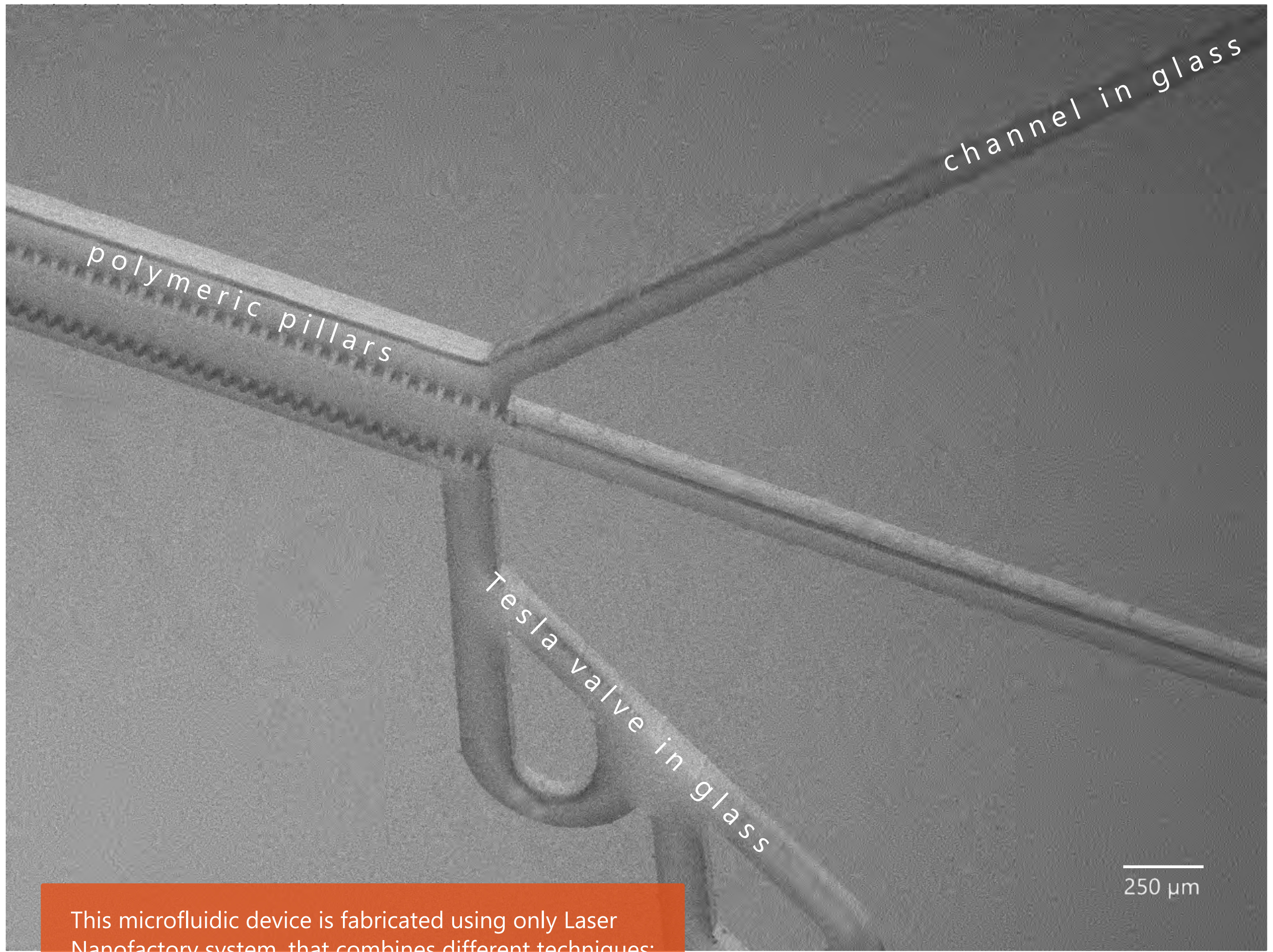
micro-drilling



Holes drilled in a hard metal. Ablation speed – up to one hole of 30 µm in-diameter and 18µm out-diameter in 50 ms.

HYBRID FABRICATION

Hybrid fabrication is a unique technique presented by Femtika. It allows combination of several different technologies (and materials as well) in one micro-device. Hybrid fabrication allows manufacturing of complex functional structures – lab on chip devices.



This microfluidic device is fabricated using only Laser Nanofactory system, that combines different techniques: subtractive manufacturing for the formation of the arbitrary-shaped channels in glass; additive manufacturing - for micropillars. The whole microfluidic system is sealed with glass substrate via welding process - also done with the same Laser Nanofactory workstation.

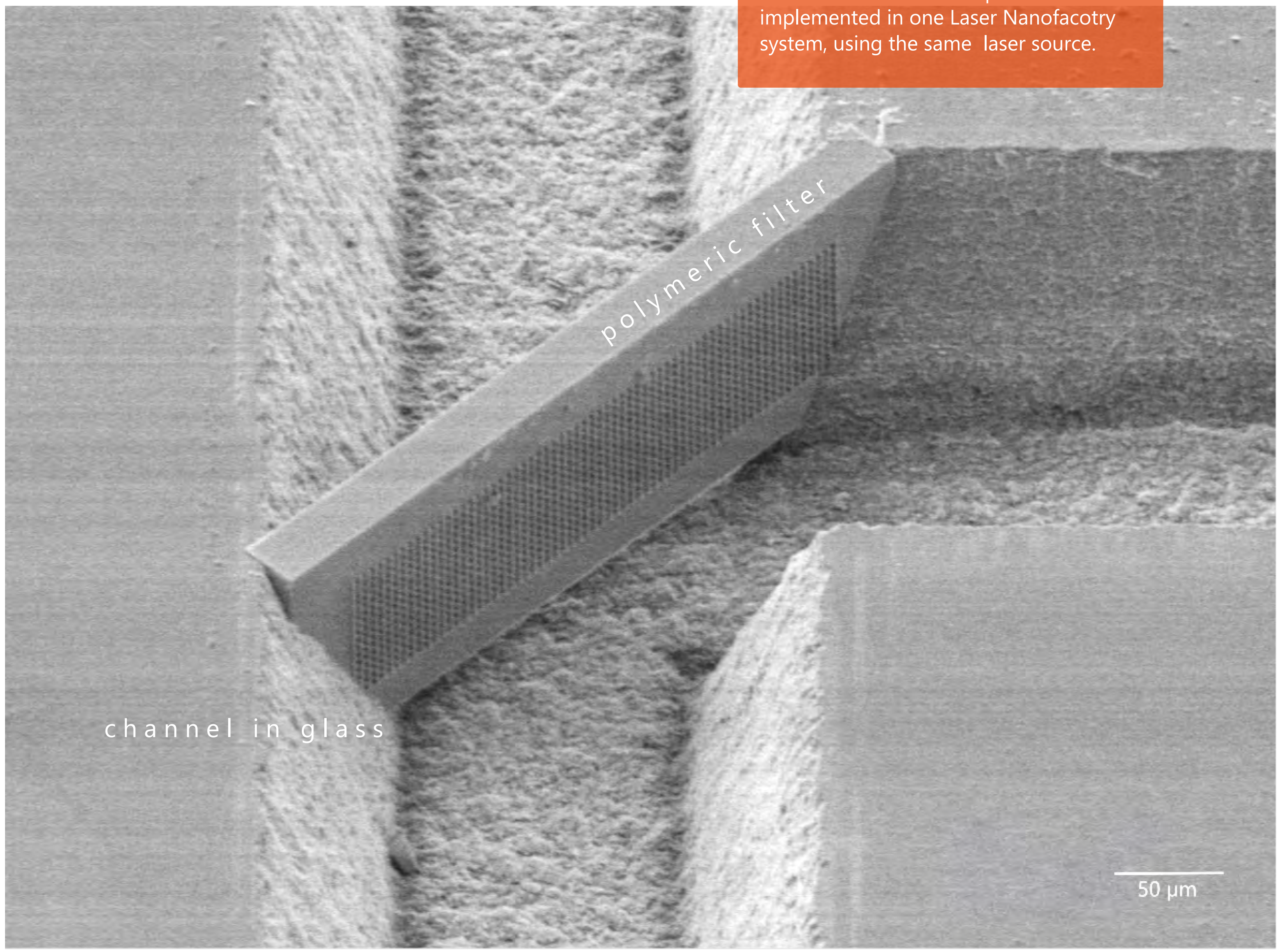
In the example above, the liver-on-chip as in vitro liver model is shown. In vitro liver models are critical for hepatology studies and drug development for liver diseases.
The channels in glass with polymeric micropillars form a microfluidic device where different types of inserted cells can form a complex cellular architecture, manipulate cell-to-cell interactions. Microfluidic device can easily generate a concentration gradient, control cellular spatial distribution, and provide a flow environment.

The channel in glass was made using laser ablation technology.

The filter with micro-pores was fabricated by multiphoton polymerization technique.

The whole device was sealed with another part of welded glass.

All the abovementioned processes were implemented in one Laser Nanofacotry system, using the same laser source.



Laser Nanofactory system is controlled by Femtika own flexible and easily controllable software, dedicated for science and research.
The main purpose of the software is to control the equipment used for 3D direct laser writing setups, such as multiphoton polymerization, 3D glass inscription and others.
The software is divided into the two applications: Compiler and Fabrication.
The Compiler is used for defining the structures (motion profiles). It does not require the system connected and can be easily copied to other computers (e.g. home computer) for convenience.
The Fabrication part works only on a licensed computer with all the devices connected. It receives the compiled data from the Compiler and performs the structure fabrication.

The software allows direct power tunability through the laser and position-based pulse picker control.

Precise control of several devices (positioning stages, galvanoscanner, power attenuator, laser shutter, etc.).

The whole writing process is automated.

Internal programming language.

Sample coordinate system alignment (tilting and rotation).

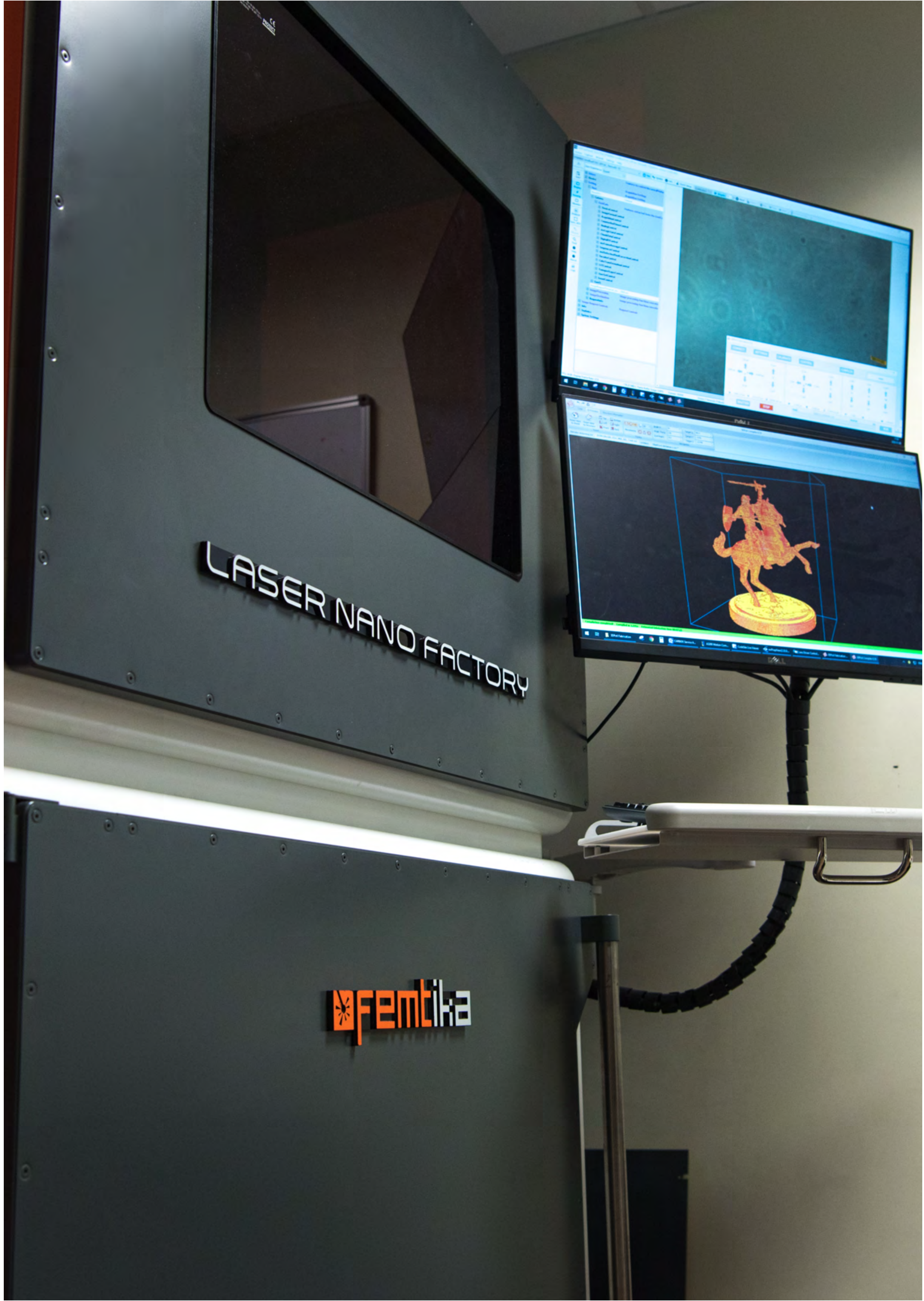
Automatic calculation of various structure parameters and estimated fabrication time.

3D fabrication trajectory preview window.

An easy-to-use graphical user interface.

The software handles standard formats of 3D designs created by popular CAD programs, like STL.

SOFTWARE



APPLICATIONS

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 leads to capability to produce new generation medical devices, such as cell perforators, micro-robots and similar. 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 micro-machining 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.

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Femtosecond laser hybrid (additive and subtractive)
micro-fabrication tools and services