Femtosecond Laser-Induced Selective Etching of Transparent Materials: From Glasses to Crystals

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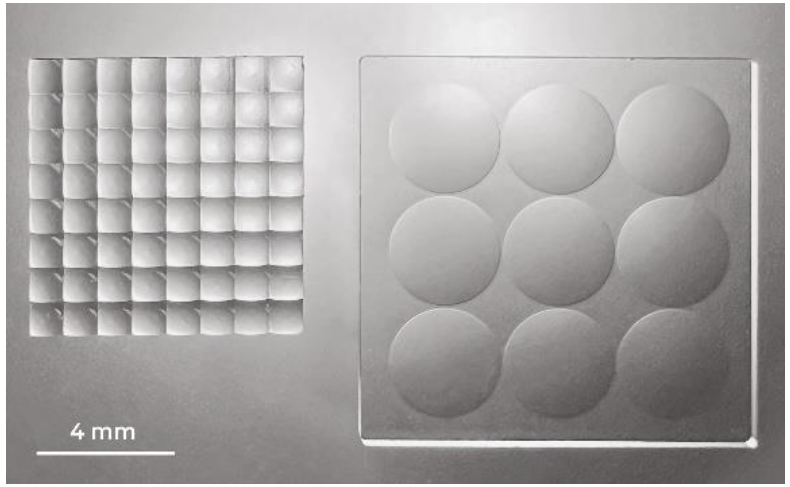
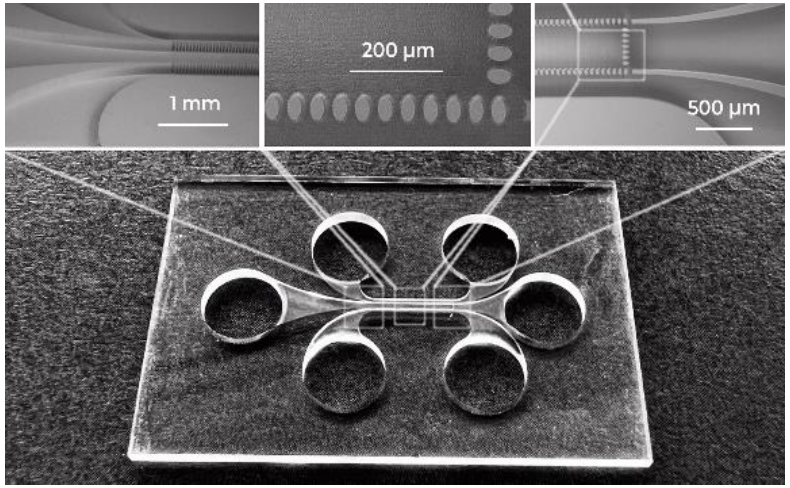
Glass microstructures

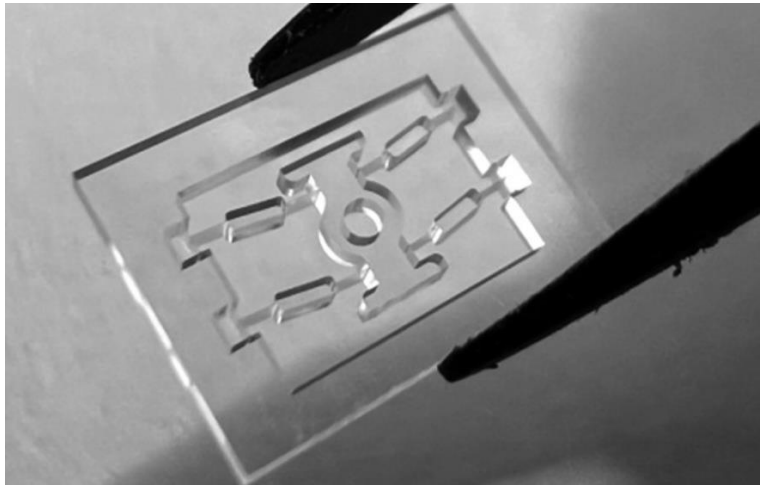
Microoptics and photonics



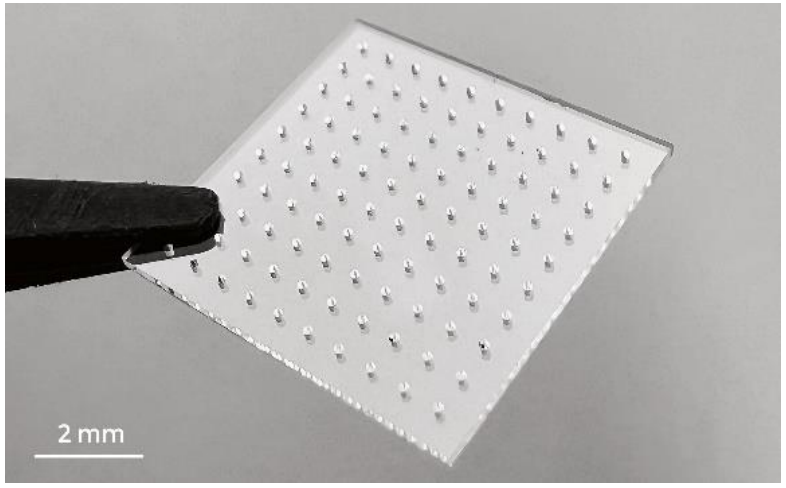
Microfluidics/ Lab-on-chip



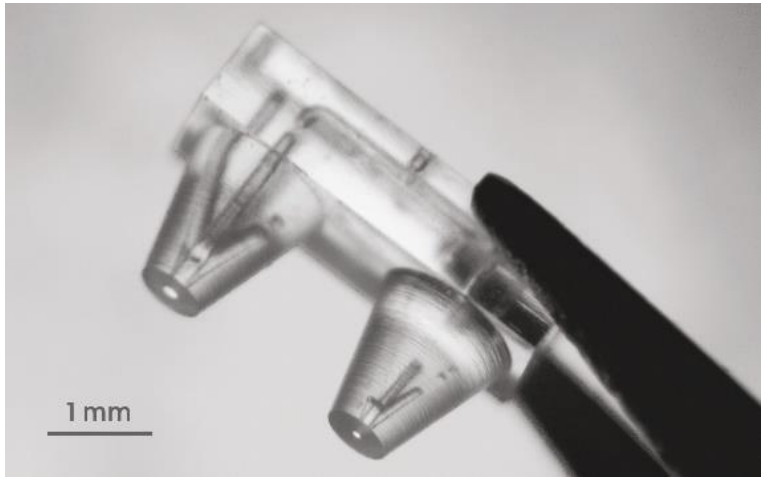
Micromechanics



Through glass vias (TGV)



Nozzles



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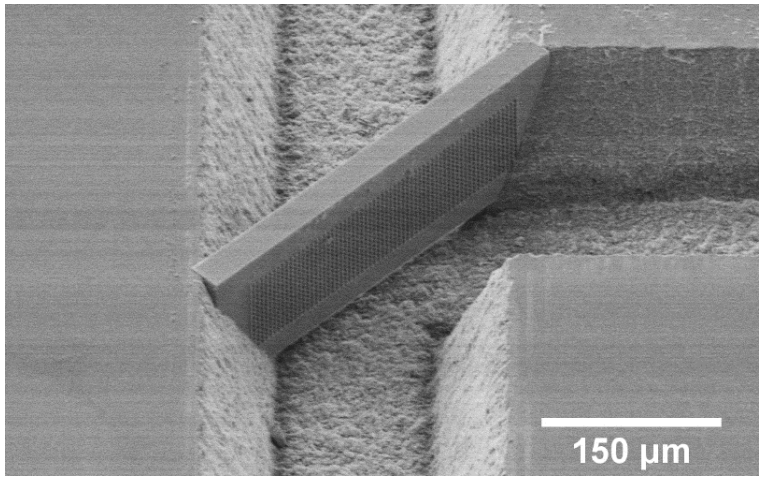
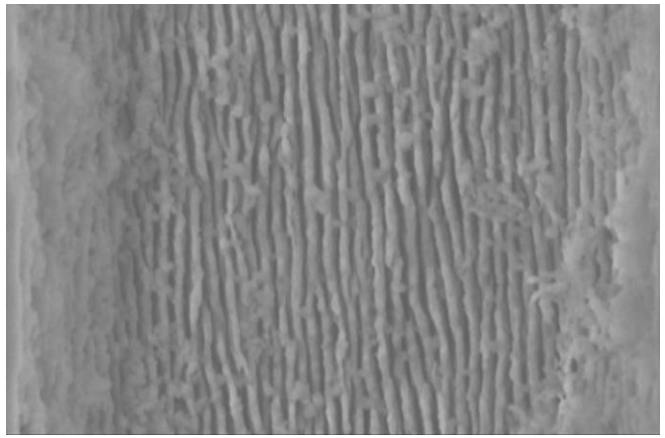
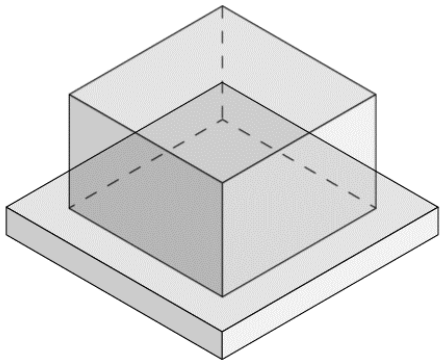


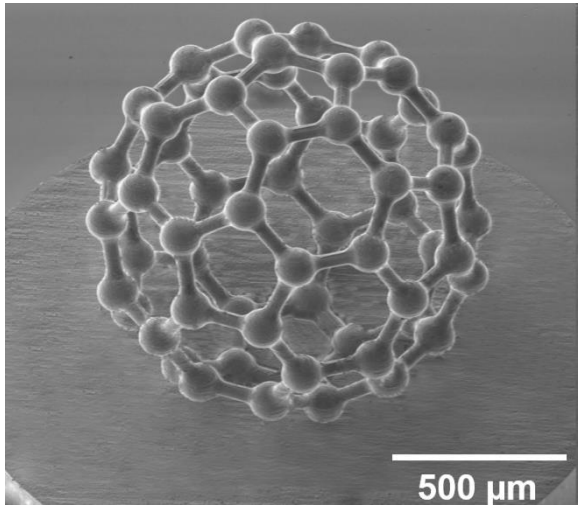
Selective Laser Etching (SLE)

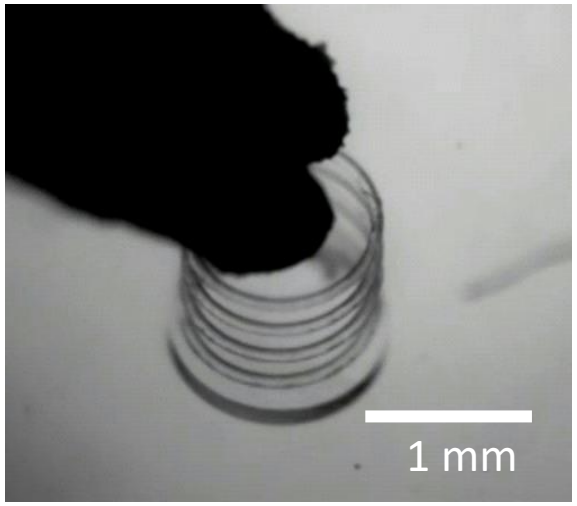
Nanogratings

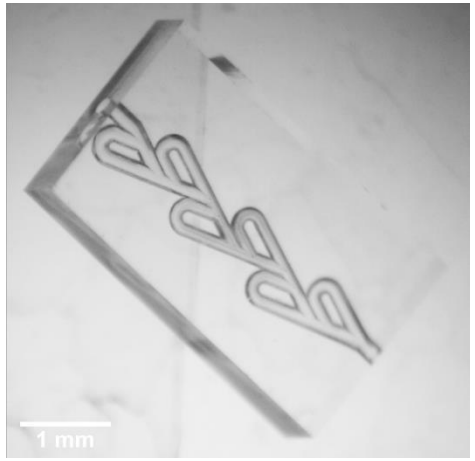


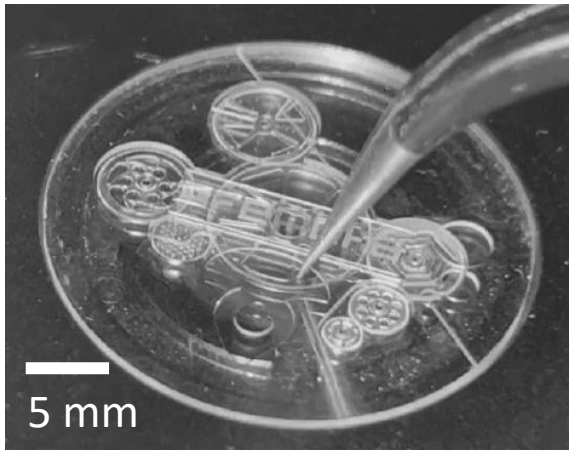


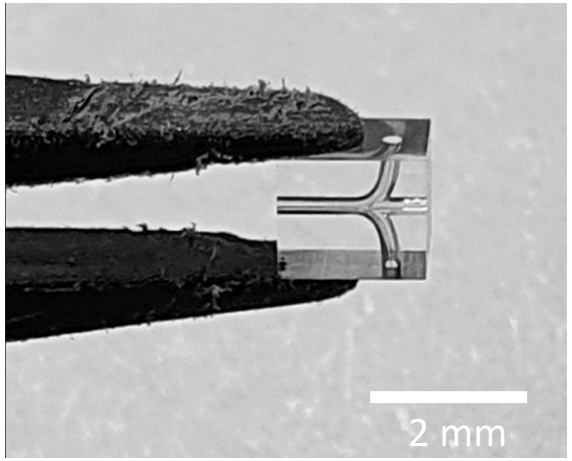
- Arbitrary 3D shapes from glass
- Surface roughness down to 200 nm
- Internal channels fabrication
- Possibilities for large structures (~cm)







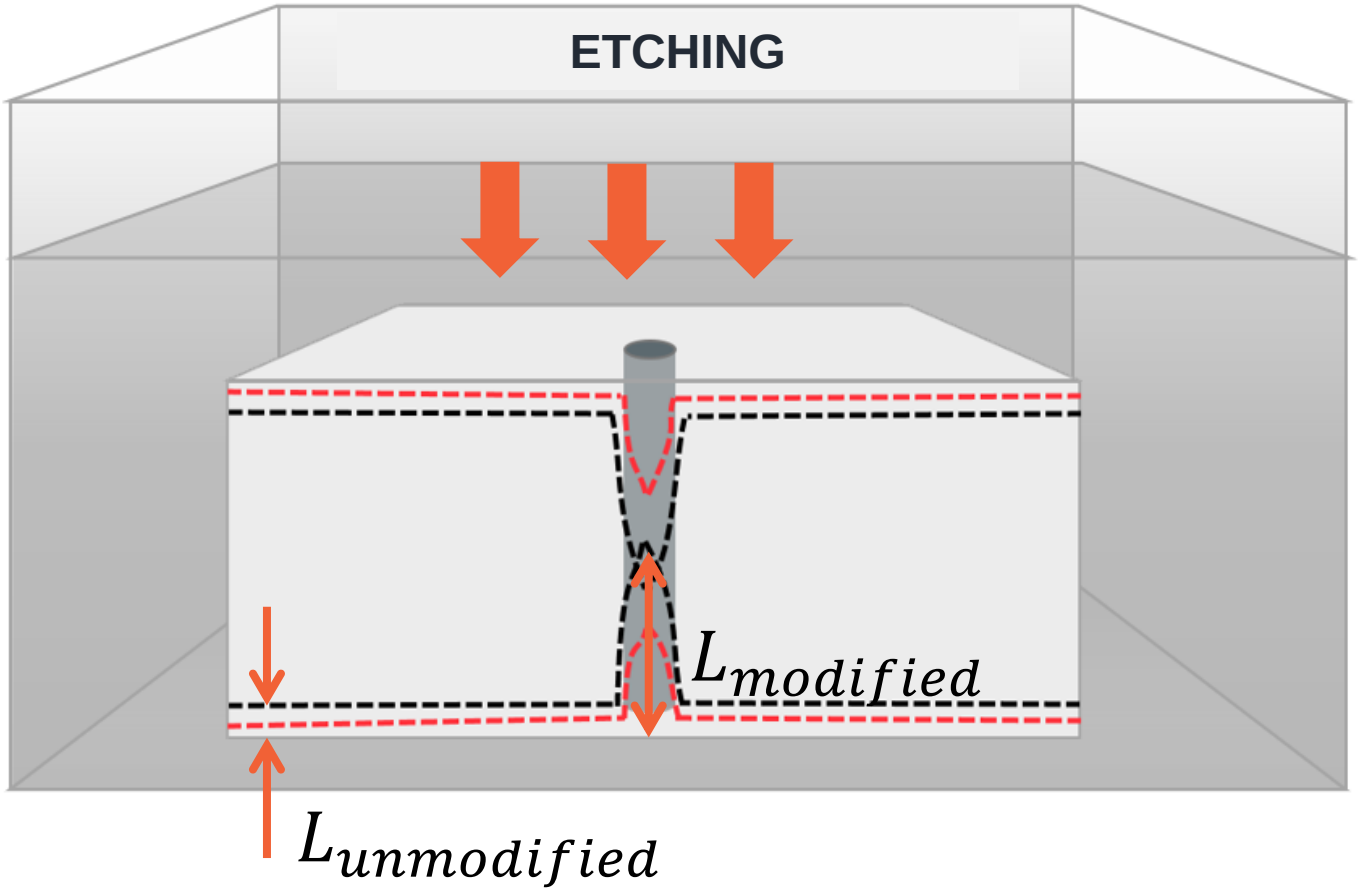




Selectivity

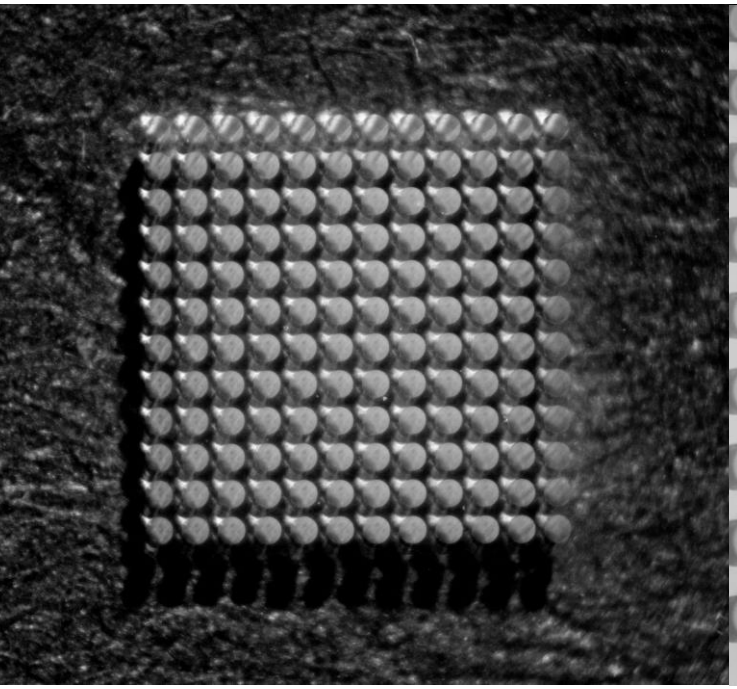
- Selectivity is the ratio between etching speed of modified and unmodified material.
- This parameter limits the highest aspect ratio of a feature that can be fabricated.

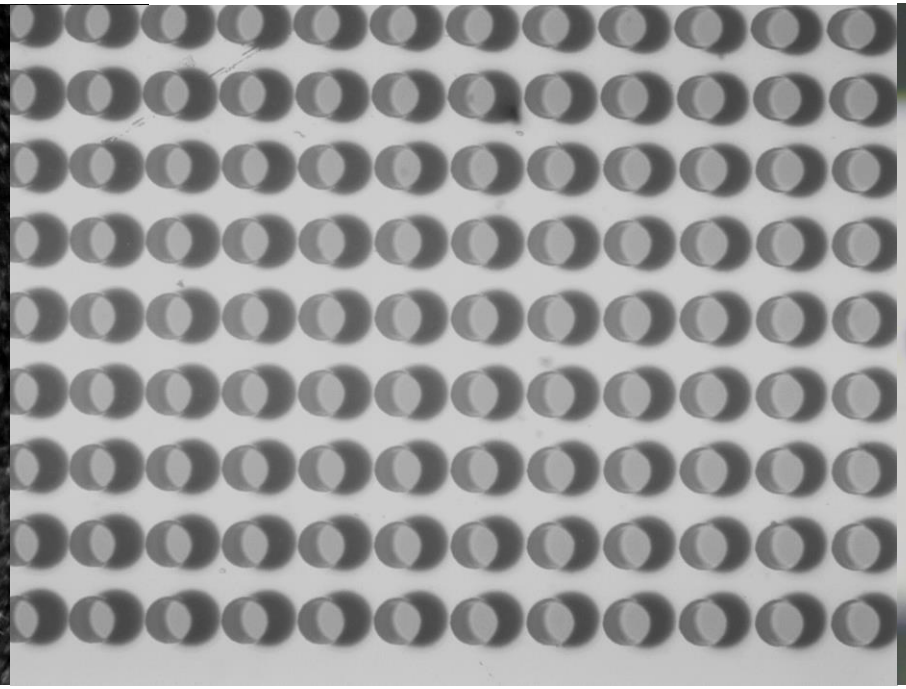
$$Selectivity = \frac{L_{modified}}{L_{unmodified}}$$

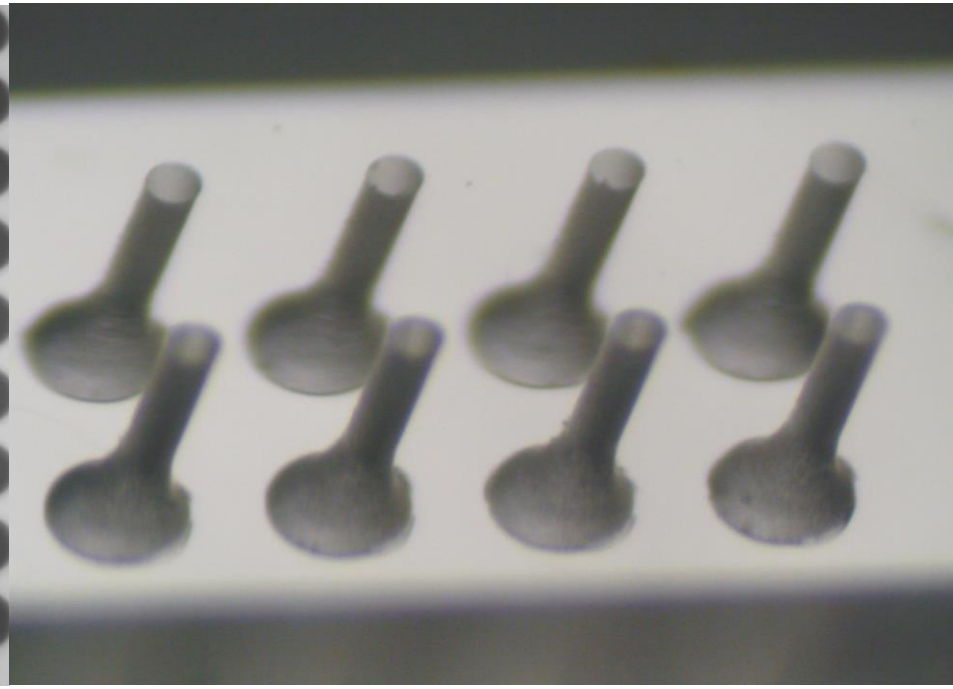


	Etching rate	Selectivity	Aspect Ratio
Fused silica glass	200 - 900 µm/h	up to 3000	up to 1000
Borosilicate glass	150 - 650 µm/h	up to 200	up to 100
Alkali-free boro-alumino-silicate glass	15 - 40 µm/h	up to 80	up to 40
Crystalline sapphire	50 – 200 µm/h	up to 70	Up to 40

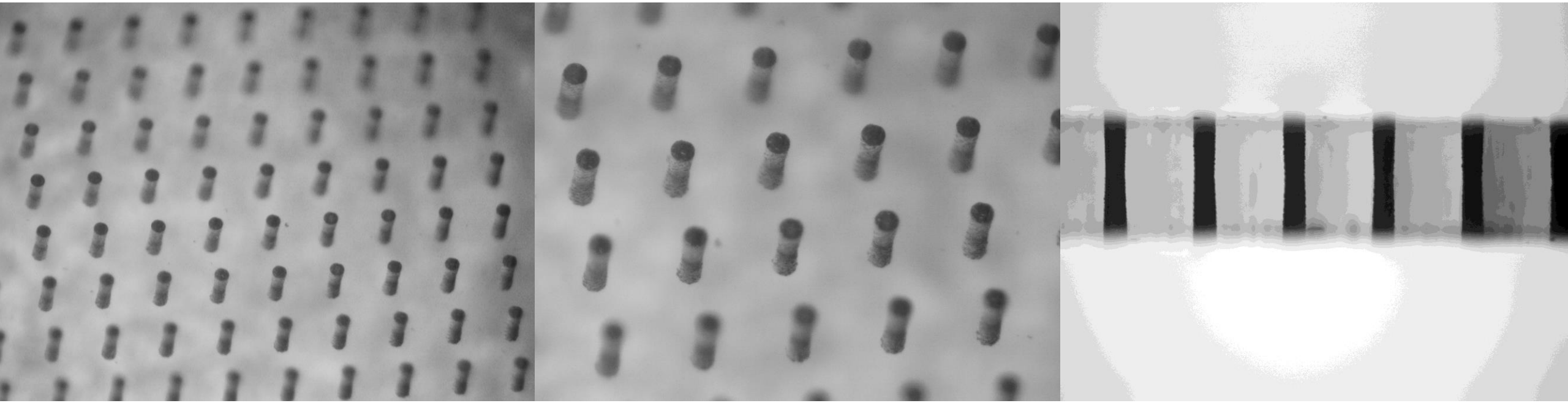
Borosilicate glass

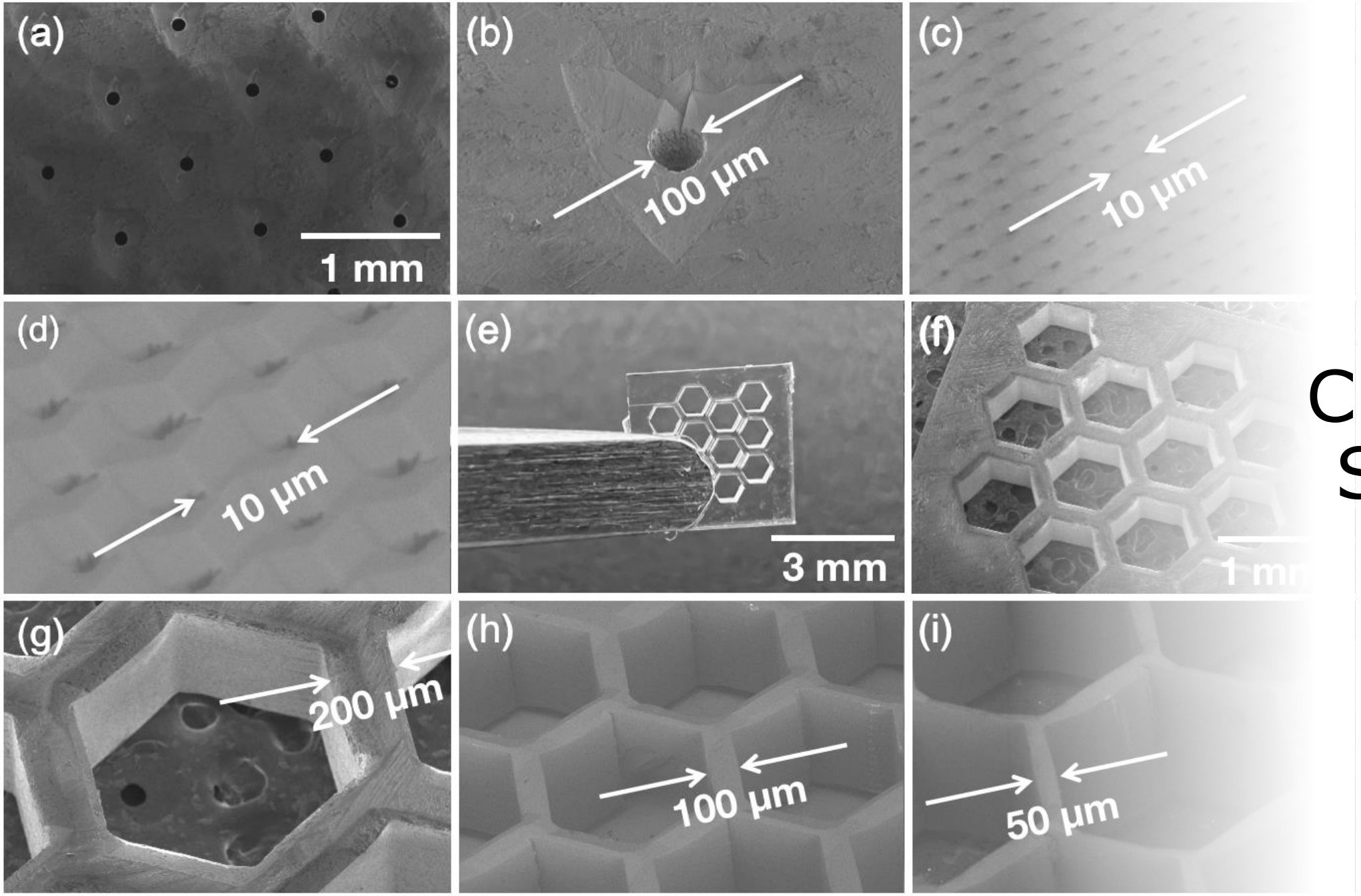






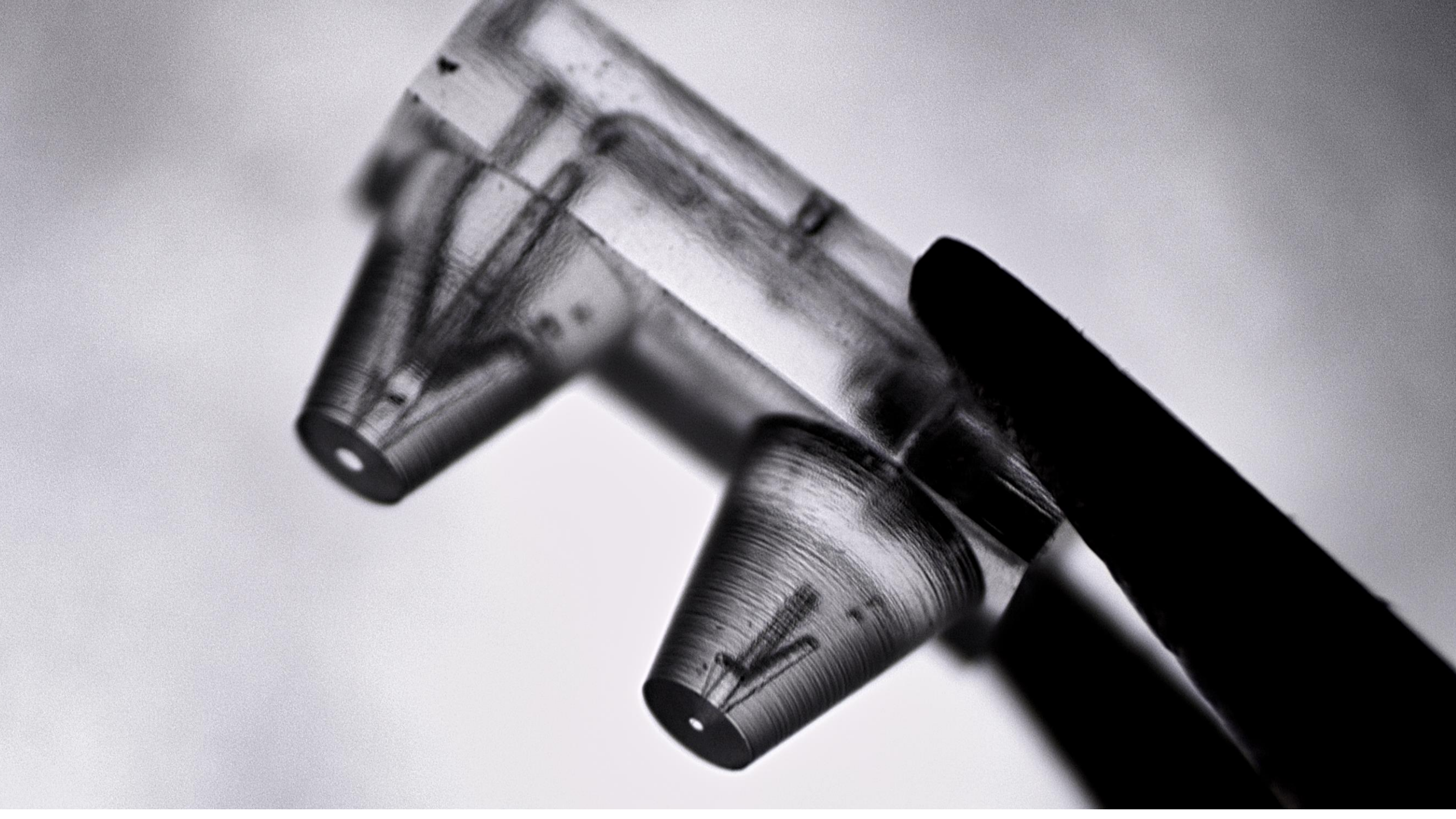
Alkali-free boro-alumino-silicate glass



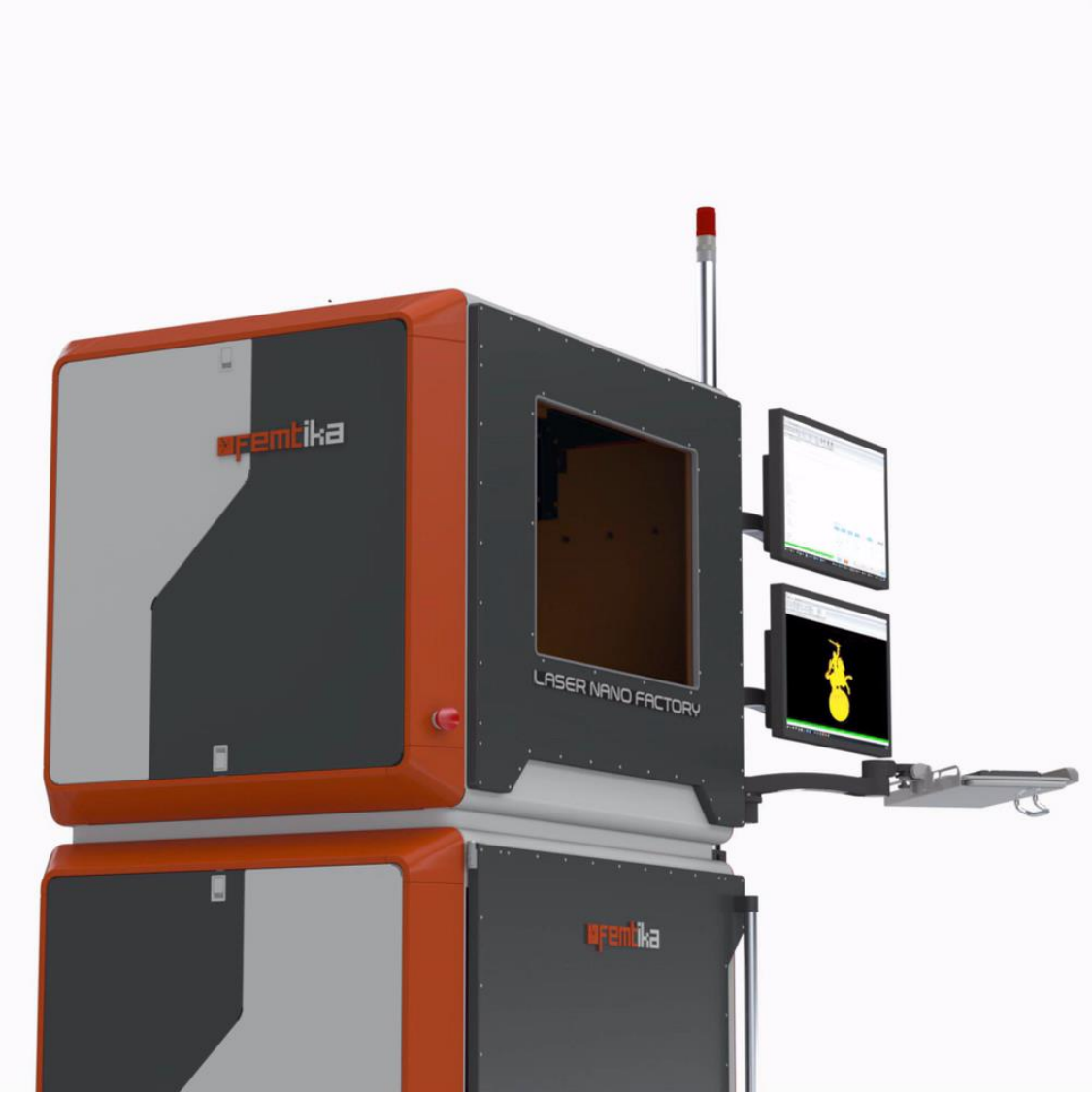


Crystalline Sapphire

Fused silica glass



Laser Nanofactory systems



- Amplified femtosecond laser allows to combine **additive** and **subtractive** manufacturing
- **Wide tunability** enables efficient fabrication of micro-nano structures using **huge range of materials** (polymers, glasses, metals, ceramics, etc.)
- Stitching-error-free manufacturing over the **entire working field**
- **Femtika's own software** for the full control of related devices (both: manual and from user defined scripts)
- **Add-ons** (for instance, optical-fiber holders) and is **customizable** (as a versatile optical characterization setup)
- System is **modular, can be adjusted** under requirements and integrated into automatic production line

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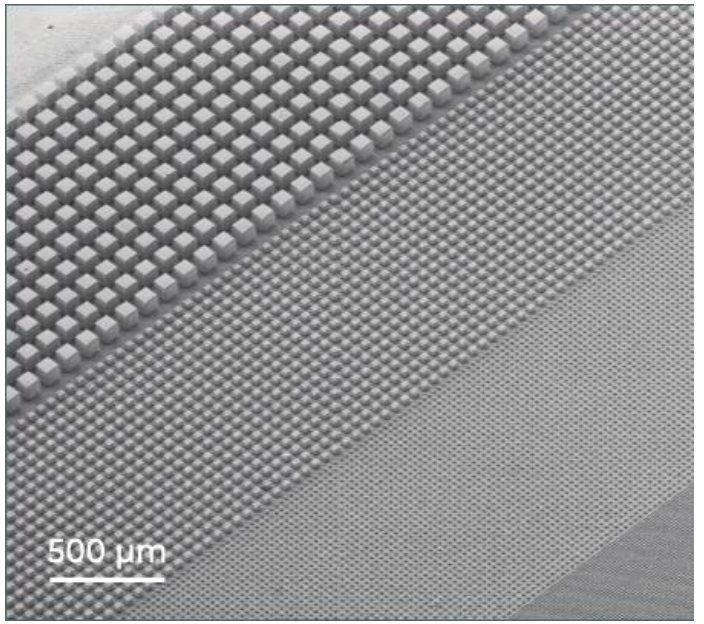

Summary

- SLE can be performed on many different glasses and crystals since nanogratings can be formed in these materials.
- In general, SLE selectivity determines possible complexity of the structures.

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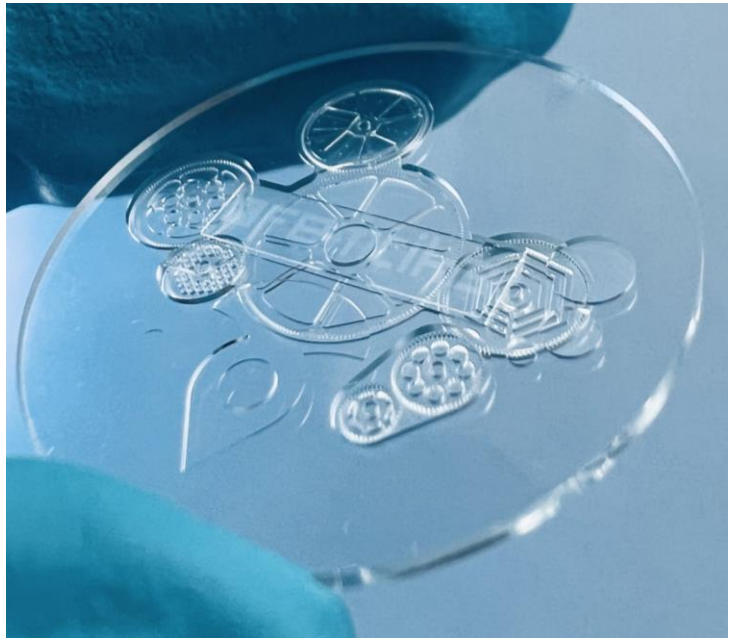
Thank you!



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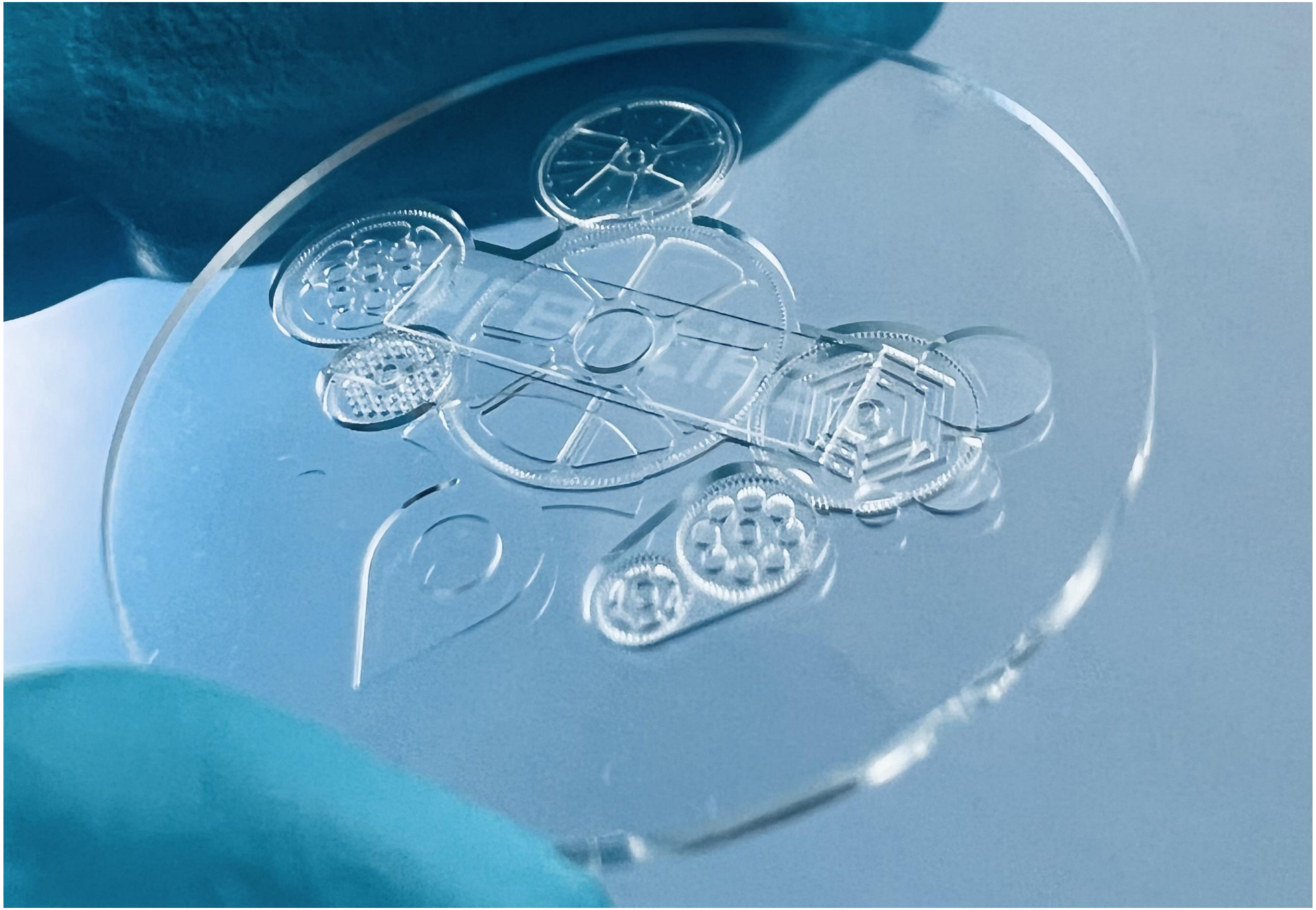
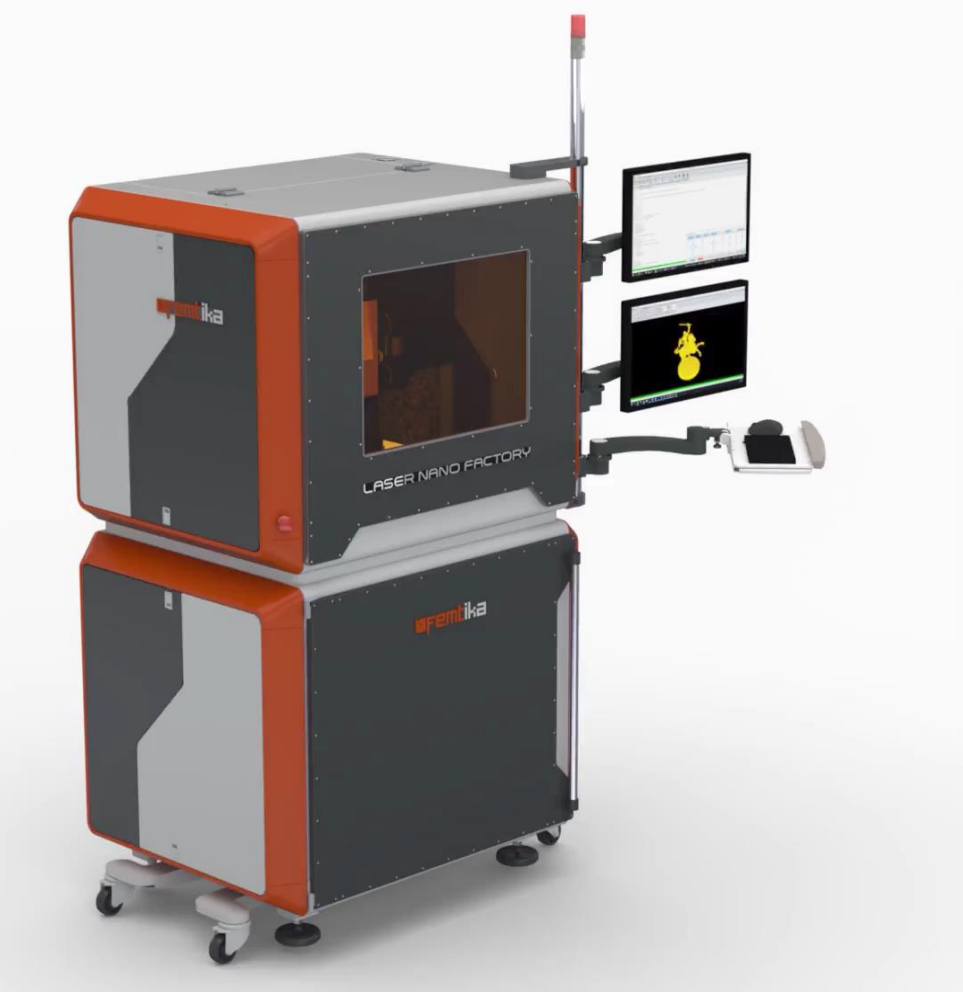


About us

- Founded in 2013
- Based in Vilnius, Lithuania
- Employees: 20 (3 PhD)
- Various R&D projects with EU partners (H2020, Eurostars)
- Member of Lithuanian Laser Association, EPIC, TOOLAS cluster

Laser Nanofactory system: main parameters



Femtosecond laser source

Wavelengths	1030 nm 515 nm
Pulse duration	<250 fs - 10 ps
Pulse energy	>200 µJ
Max average power	10 W
Repetition rate	Single-shot - 2 MHz
Burst /BiBurst	GHz, MHz

Universal vacuum sample holder

Computer-controlled illumination

Custom design to fit your samples

Capability of more than 2 kg load

Easily changeable plates for chucking the wafers

Nanopositioning

Total Travel (XY)	160 mm x 160 mm
Total Travel (Z)	60 mm
Accuracy	± 300 nm
Resolution	1 nm
Beam scanning	Galvanometer scanners

Stitching-error free fabrication

Beam power control

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

Integrated power meter enables real-time power monitoring