

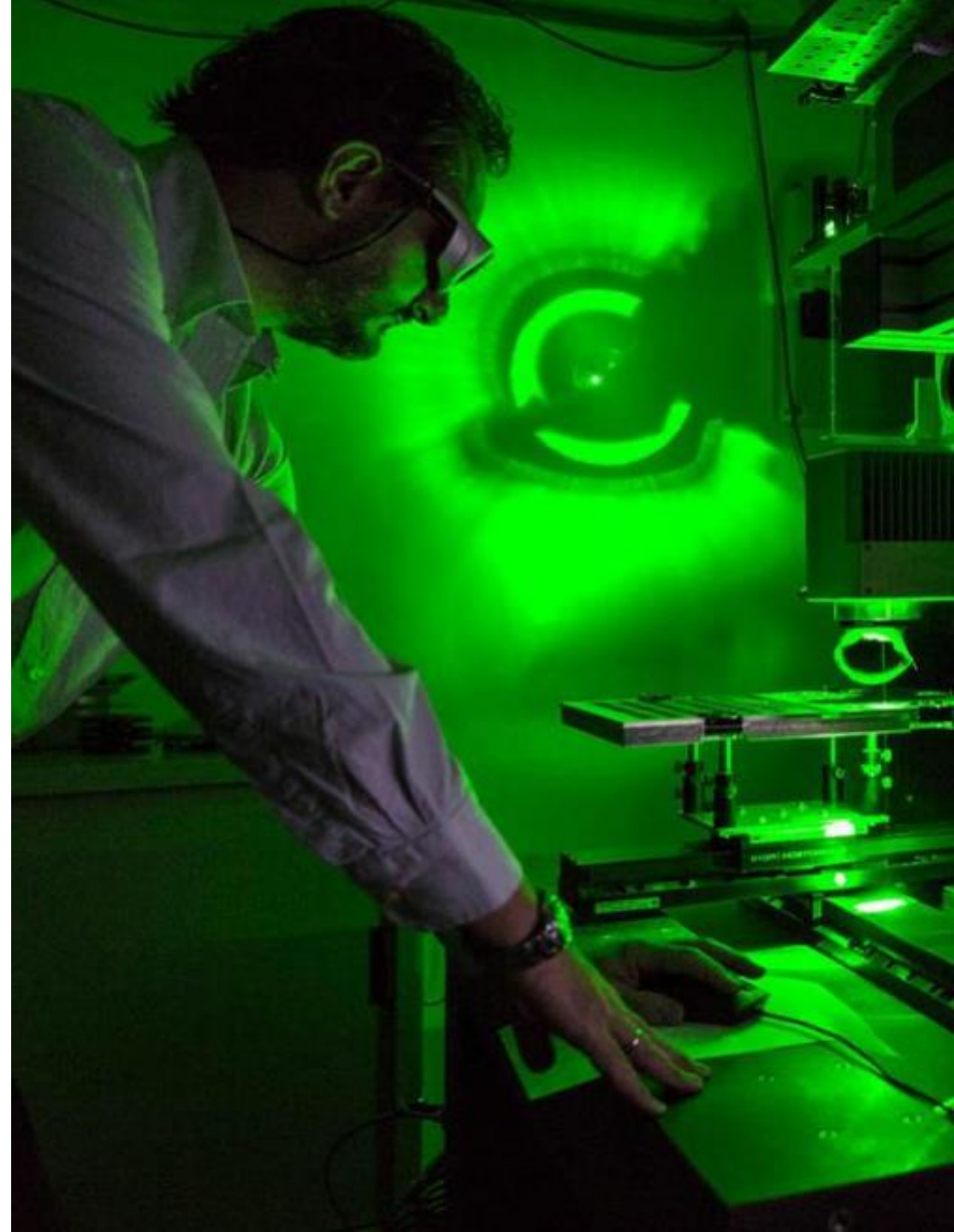
Development of femtosecond laser micromachining processes for industrial applications

Federico Bassi – R&D department – Kirana srl

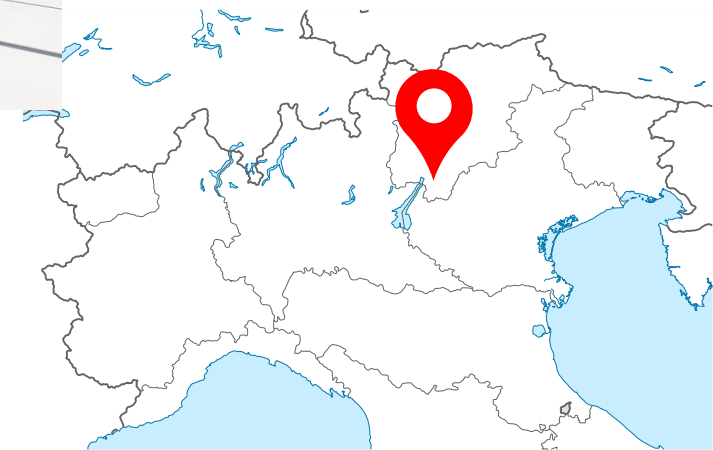
Photonic processes for multi-scale smart product functionalities
Lugano – 8/11/2024



Kirana is a company specialized in the development of laser **micromachining** processes aimed at **contract manufacturing** activities.



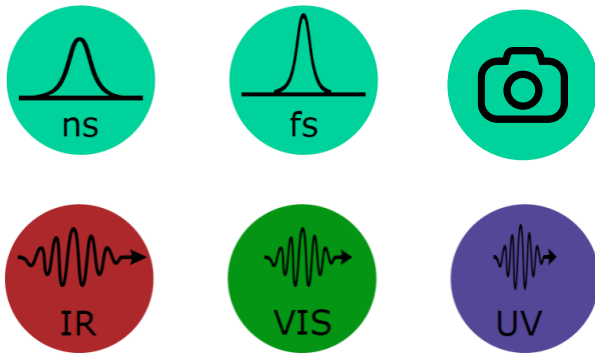
Established in **2012**, Kirana is a SME located in the technology hub of Rovereto (Italy)



Our facility: from fabrication to metrology

Micromachining Platforms

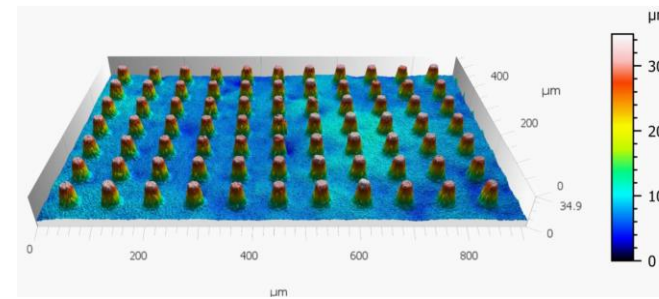
The Kirana facility is composed of several micromachining platforms in different laboratories. The Kirana technicians have full control over the platforms allowing extreme flexibility in order to meet the client's requirements. The micromachining setups are equipped with different laser sources, from nanoseconds to femtoseconds lasers at different wavelengths, as well as customizable vision system for inline inspection



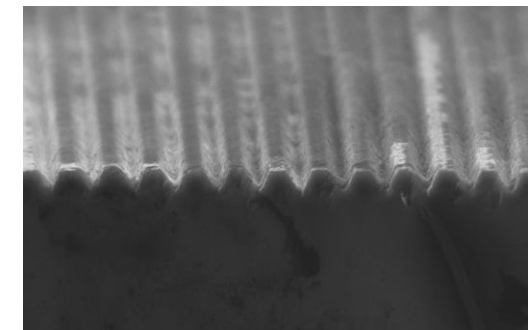
Metrology Laboratory

In the metrology laboratory, a white light interferometer is used to reconstruct the sample surfaces. A calibrated SEM equipped with a backscattered detector for topography measurement is used to characterize very small features. Together with calibrated optical microscopes, these instruments are used to optimize the micromachining processes and to provide certified measurement for clients on request.

3D White light interferometer

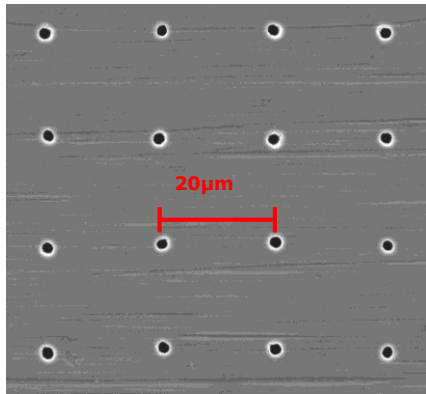


SEM



Micromachining with femtosecond lasers

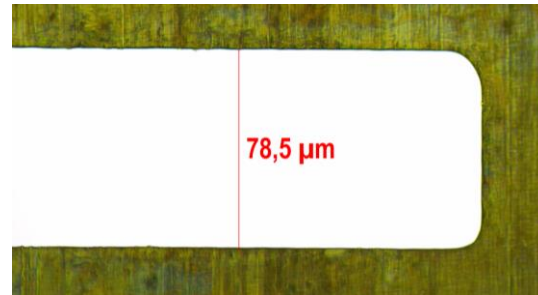
Micro drilling



2 μm holes on 50 μm thick stainless steel.



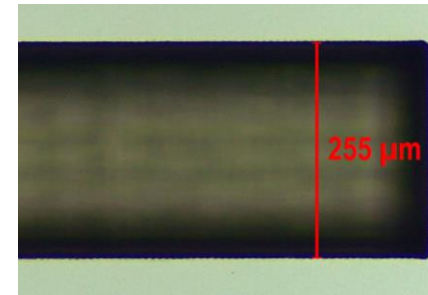
Micro cutting



*80 μm window
100 μm brass*



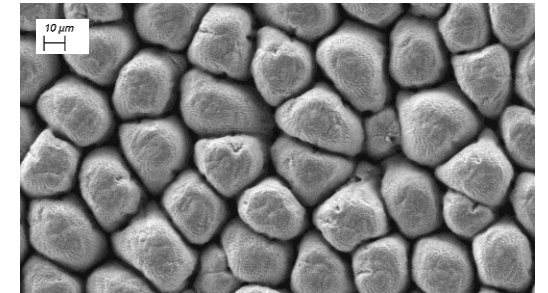
Micro milling



255 μm wide channel on glass



Micro-Nano texturing

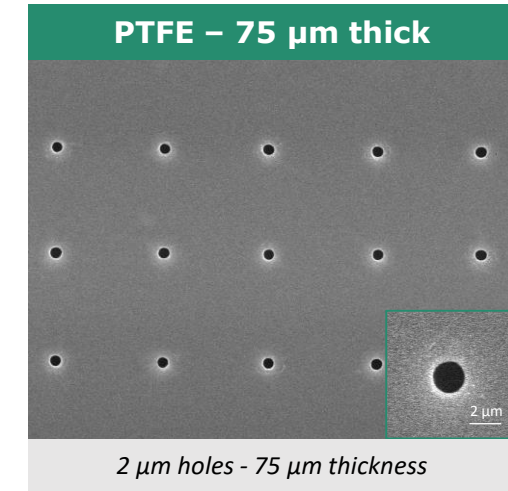
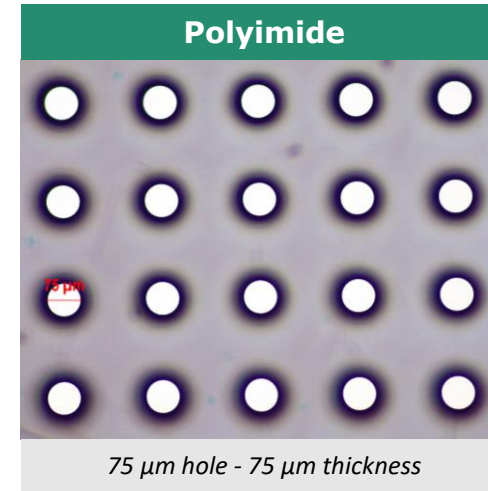
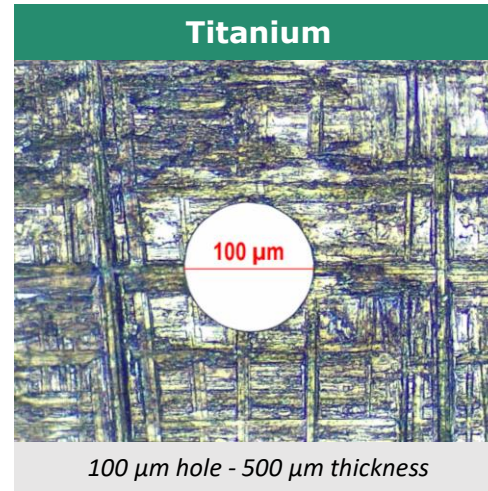
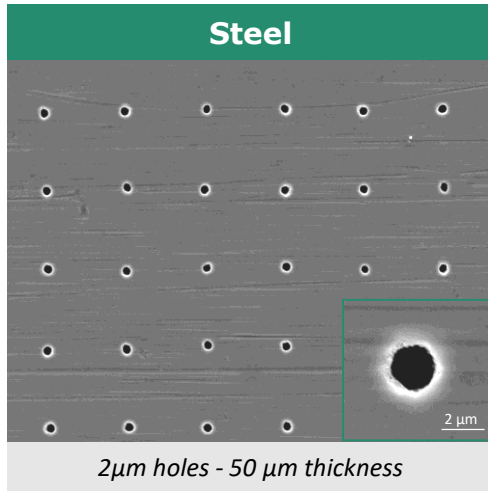


*Laser Induced Periodic
Surface Structure
on steel*



Micro drilling

Micro-holes on various materials.



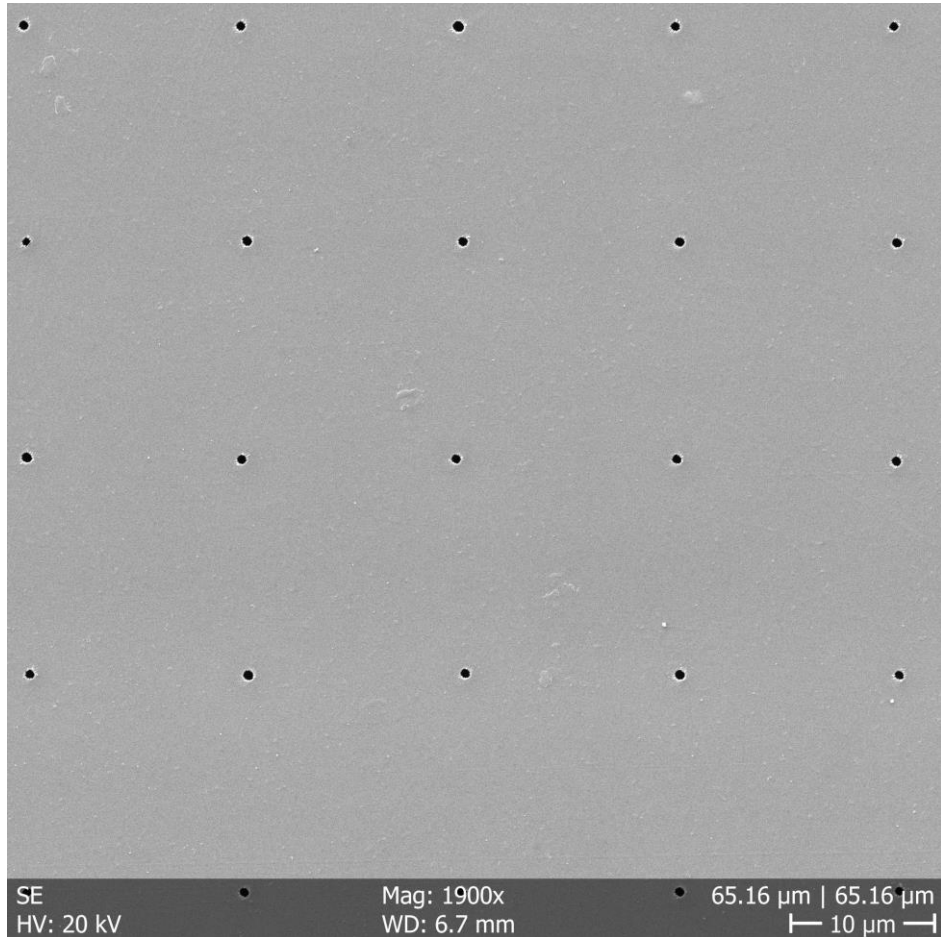
Typical Specifications:

- Hole size: down to 0.5 μm
- Accuracy and repeatability: down to 0.5 μm
- Aspect-ratio (thickness/lateral dimension): up to 50:1
- Thickness: up to 1 mm

Applications:

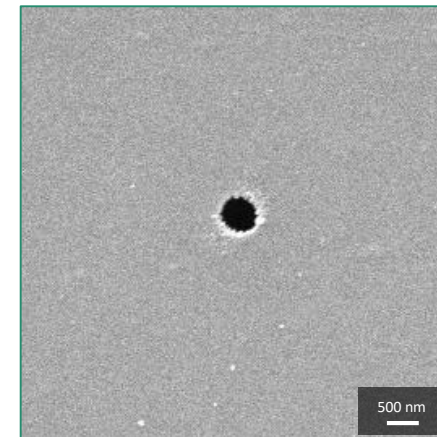
- Leak test in pharmaceutical/food industry
- Gas flow meters
- Microfluidics (automotive/biotech)
- Optical masks
- MEMS

Micro drilling: toward nanoscale



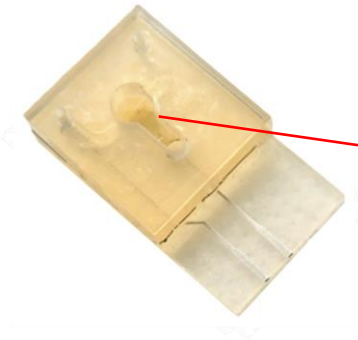
Grid of 500 nm holes (outlet side) in a polyimide tape with 12,5 μm thickness

Repeatability ± 80 nm

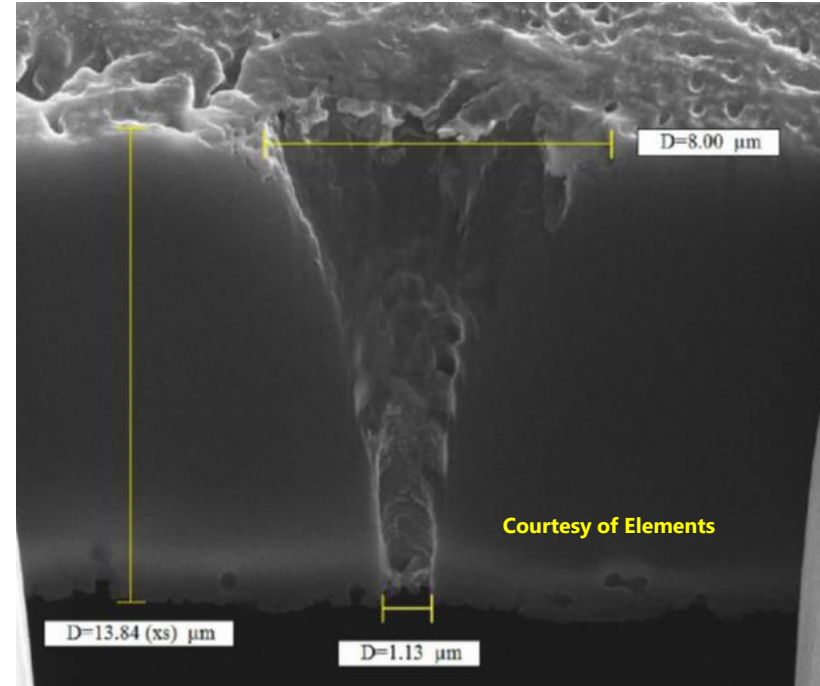


Micro drilling: case study

Target application:
«flow cells» for nanoparticle detection



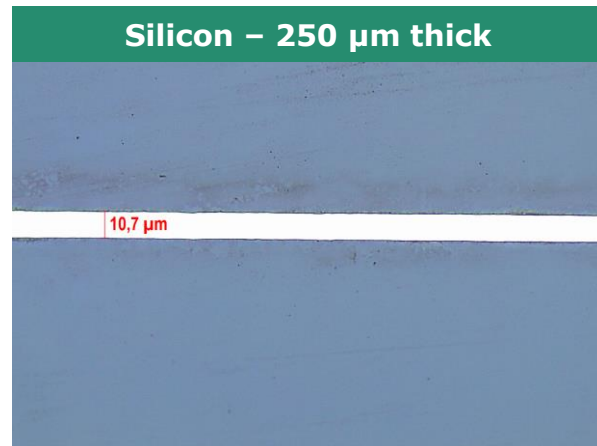
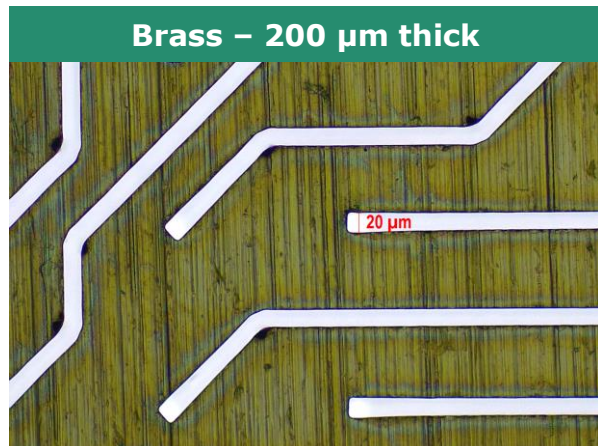
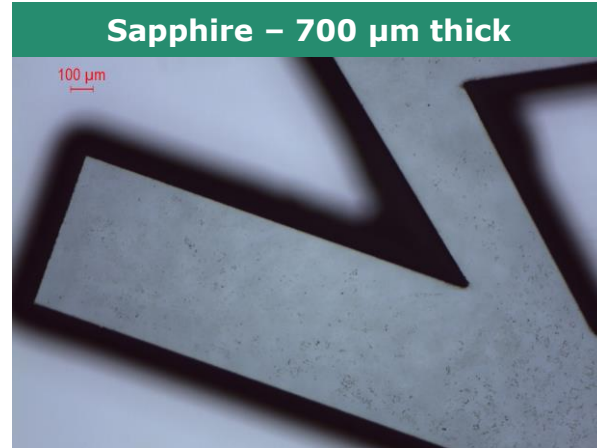
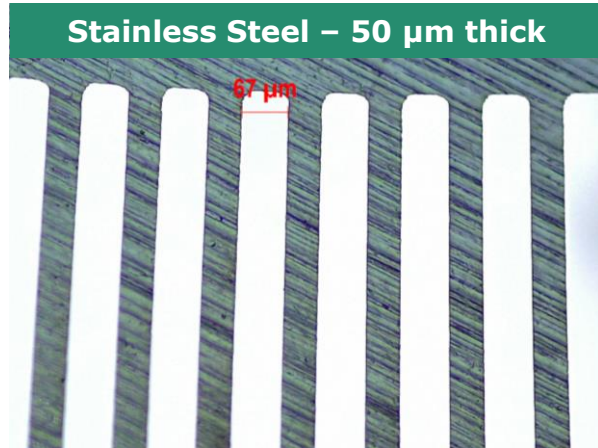
These devices incorporate thin polymeric membranes with nano-holes, designed to match the size of the nanoparticles to be detected



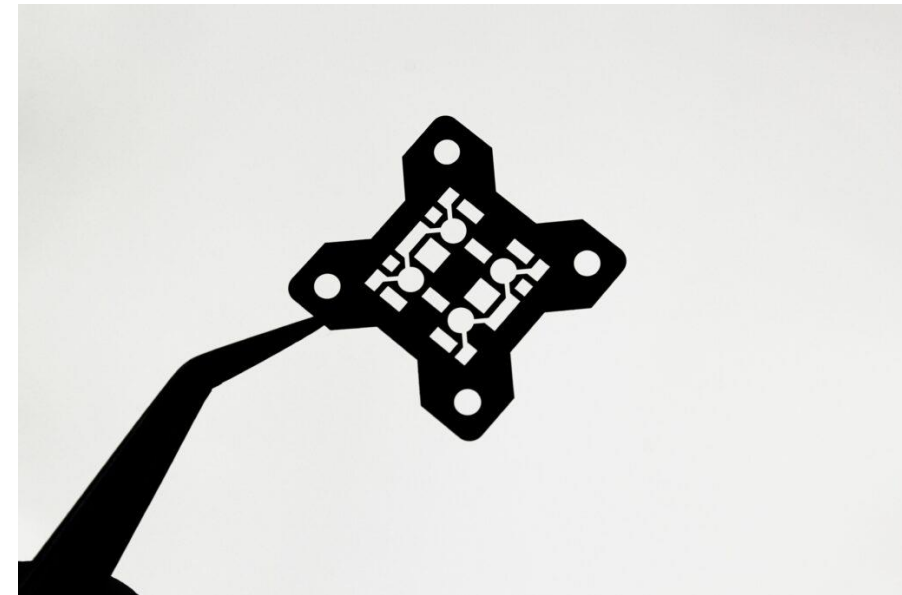
Project funded under grant agreement No [951998]. PULSATE is supported by the Photonics Public Private Partnership

Micro cutting

Precision cuts with outstanding kerf quality and minimized heat affected zone

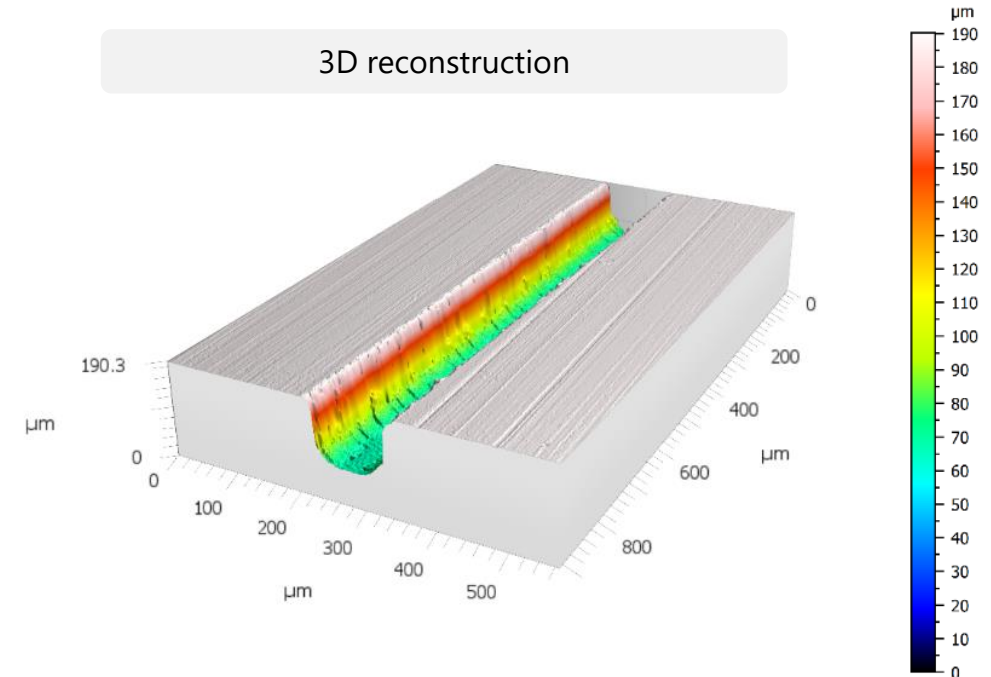
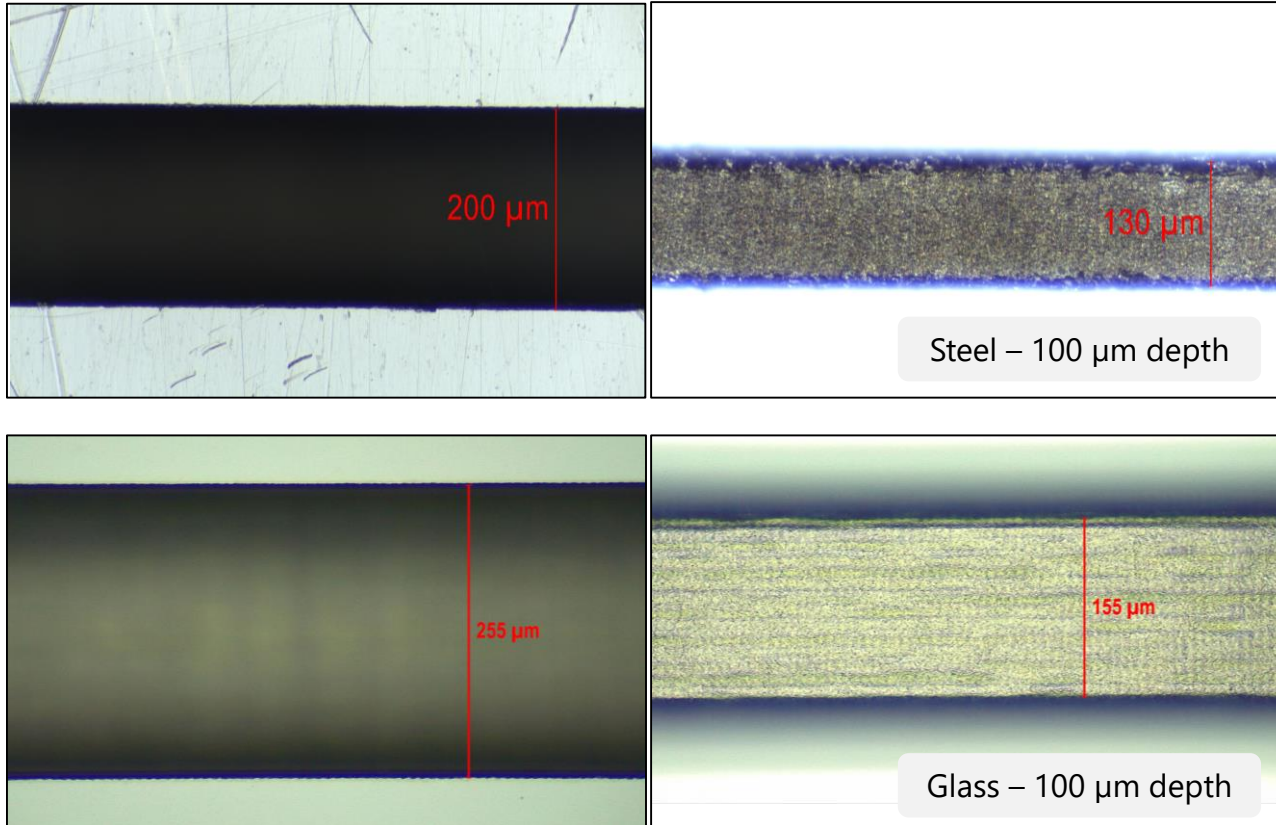


Example application:
Shadow masks / deposition masks



Micro milling

Creation of micro channels on metals and transparent materials.



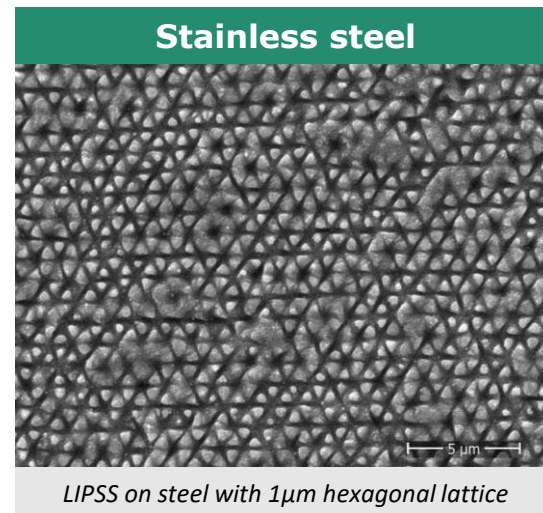
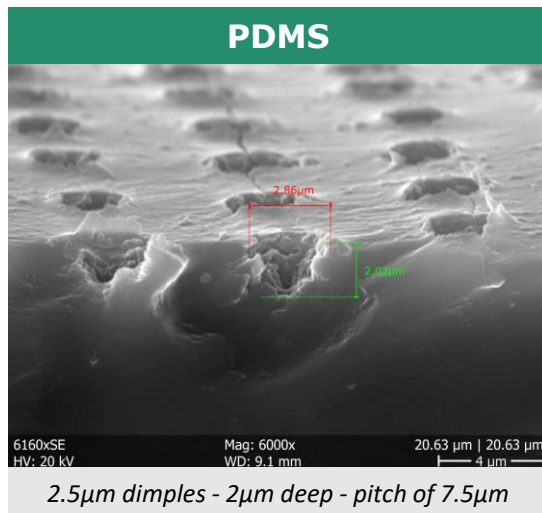
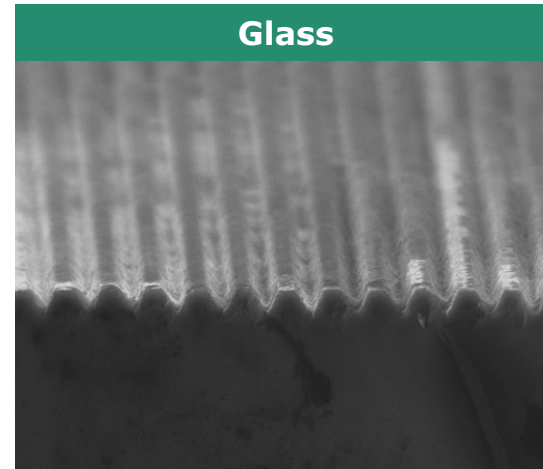
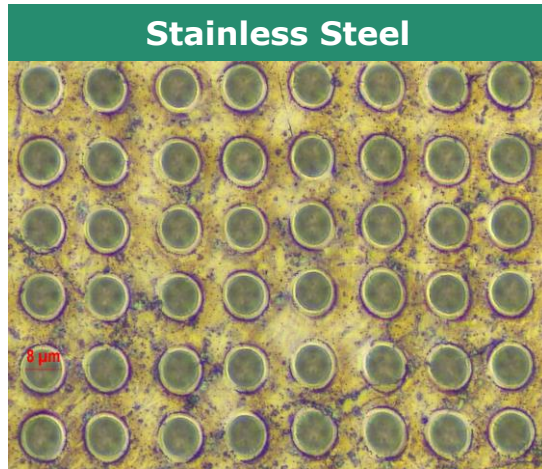
Typical applications

- Micro fluidics
- Components for optical, microelectronic and micromechanical instruments

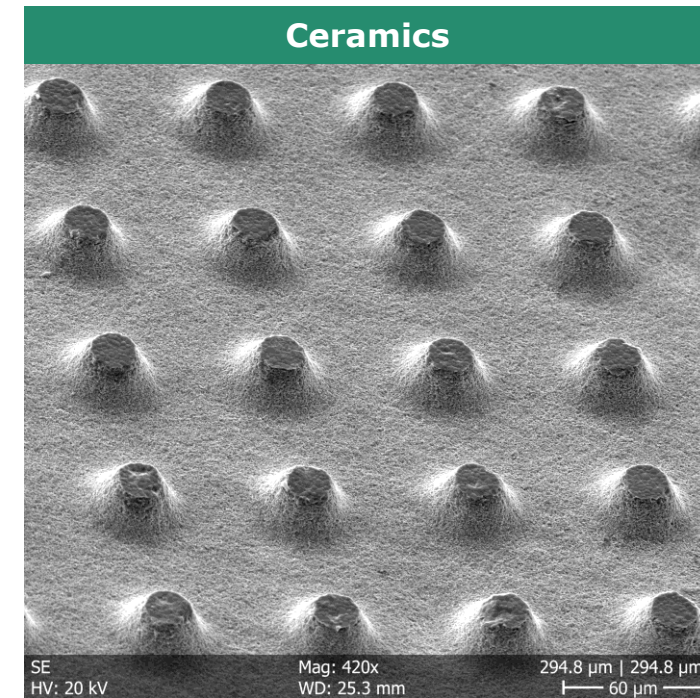
Micro texturing

Examples of structuring on materials of different nature for different applications.

-> Target: enable new surface functionalities



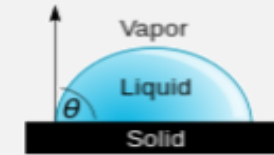
Example Application:
Solid oxide fuel cell patterning



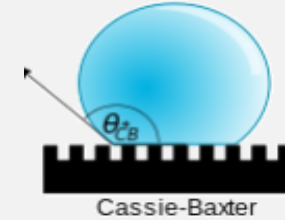
Basbus et al., *Applied Surface Science*, Vol. 652, p.159372 (2024)
DOI 10.1016/j.apsusc.2024.159372

Micro texturing: tribological applications

With femtosecond lasers, by tailoring the process parameters, it is possible to control the wettability of the substrate from super-hydrophilicity to super-hydrophobicity.

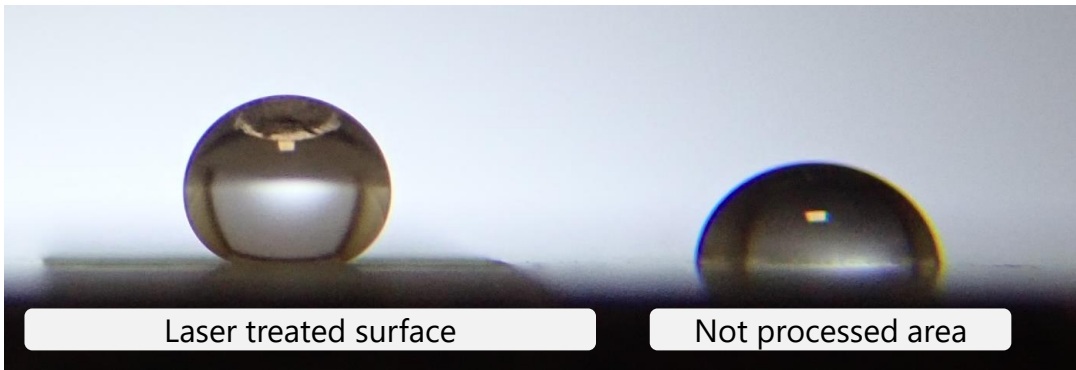


Hydrophilic behaviour



Hydrophobic behaviour

Image source: https://en.wikipedia.org/wiki/Cassie%27s_law



8 μ L of distilled water on PFA (E79A Zocca Rivestimenti) after femtosecond laser radiation exposure

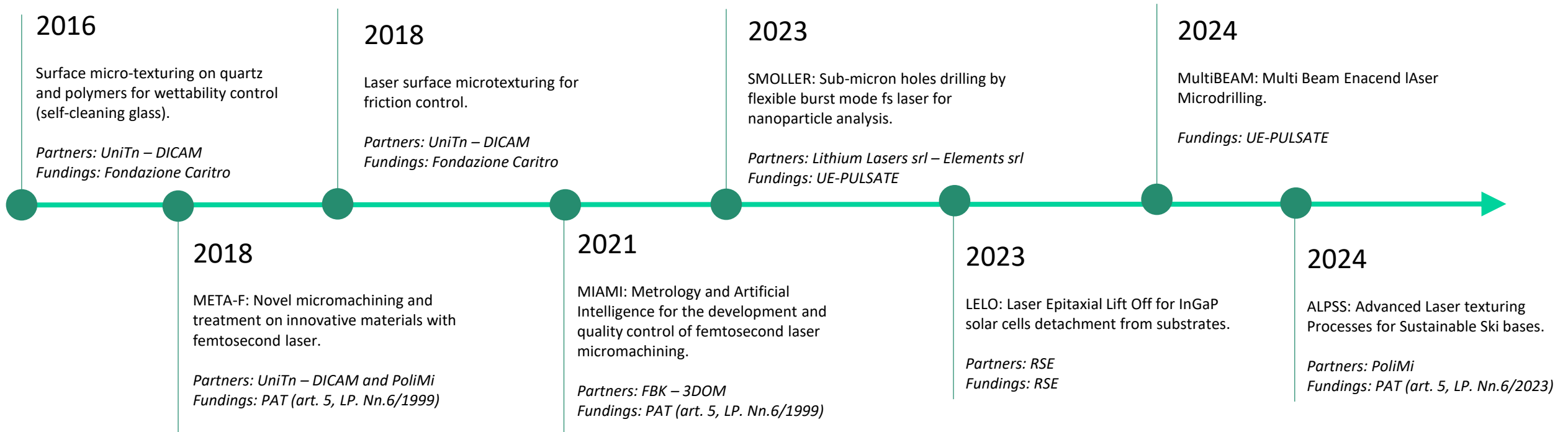


8 μ L of distilled water on steel after femtosecond laser radiation exposure

Research and Development



The R&D team is constantly engaged with universities and research centers of excellence in research projects aimed to seek and develop new laser micromachining processes for novel application. These collaborations ensure a continuous increase of Kirana’s know how. This translates in a state of the art service for our customers.



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