

Applications of ps-laser machining

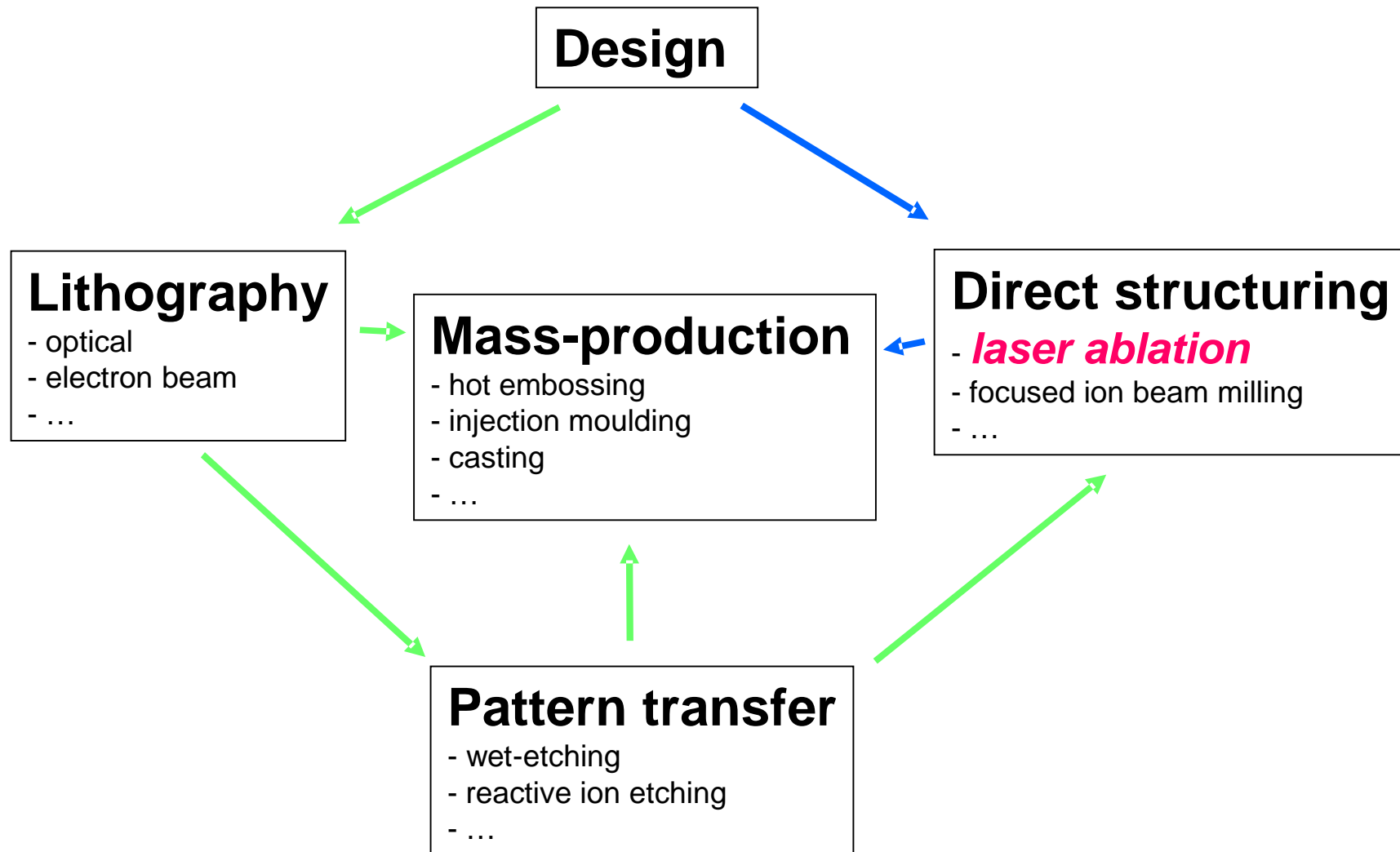
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Outline

- n place of micromachining in microtechnology
- n microstructuring using short-pulse lasers
- n ps-laser ablation system at EMPA
- n examples of applications

Microstructuring methods



Advantages and drawbacks of ps-laser micromachining



- one step process
- no chemicals
- any type of material

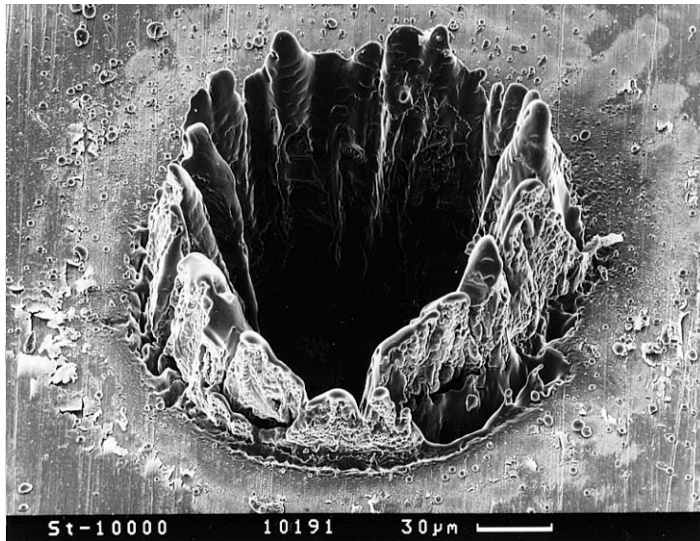


- debris
- roughness
- sidewall angle
- resolution is limited to a wavelength
- new technique (technical problems to solve)
- exposure to nanoparticles (risks are unknown)

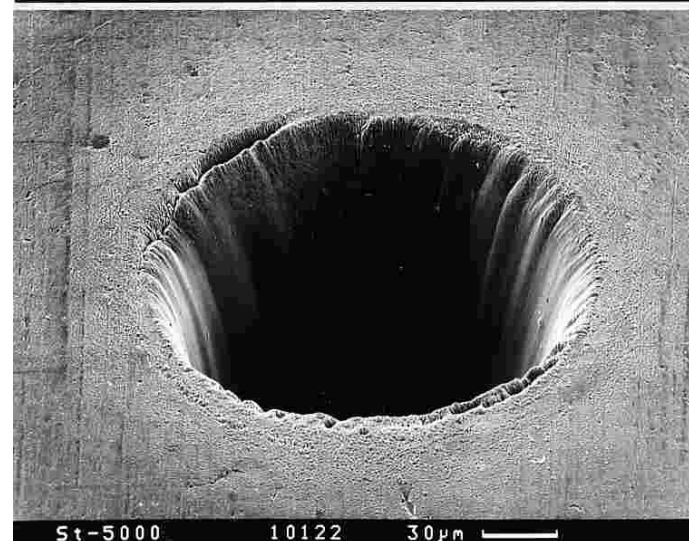


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Laser processing with ns- and fs- pulses



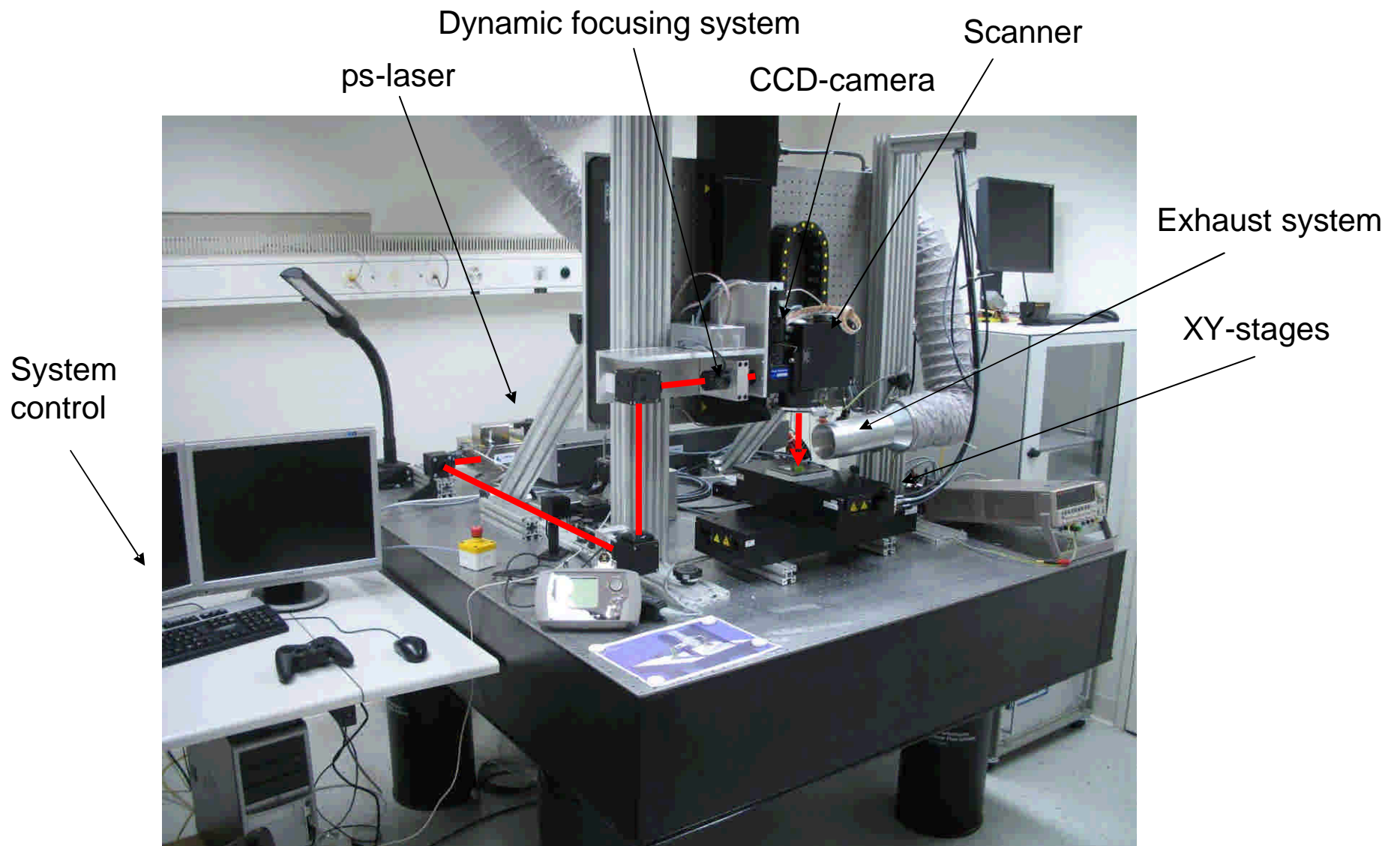
ns



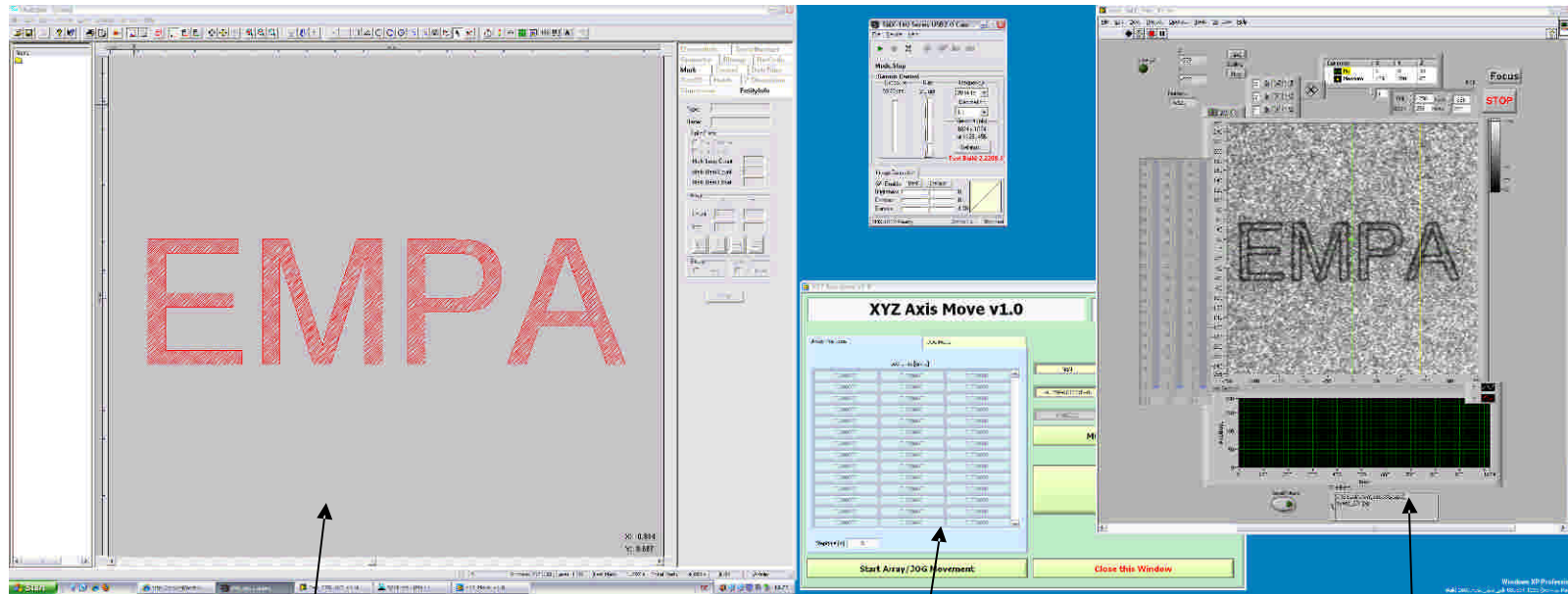
fs

B.N. Chichkov et al., Appl. Phys. A 63, 109-115 (1996)

Overview of the system



Screenshot from the control PC



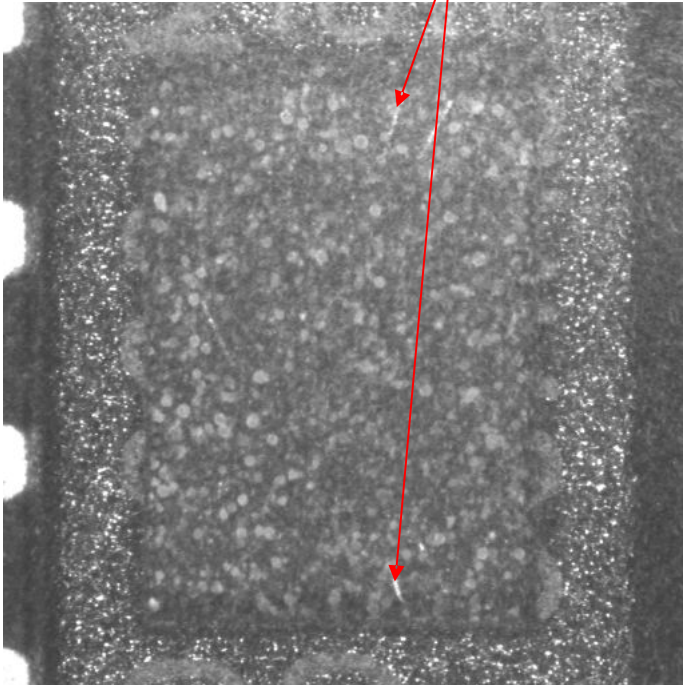
Scanner control interface

Stages control

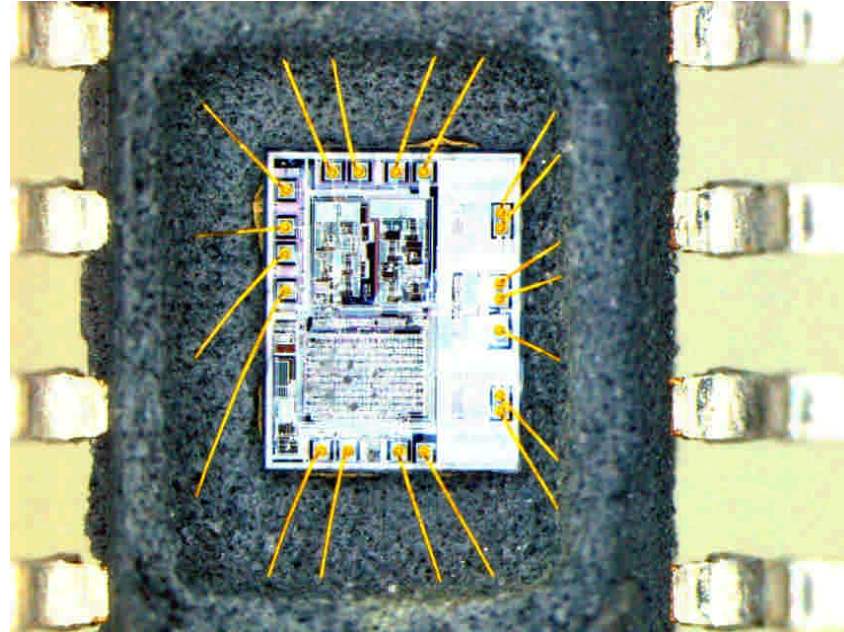
CCD camera

Chip opening

Bondwires

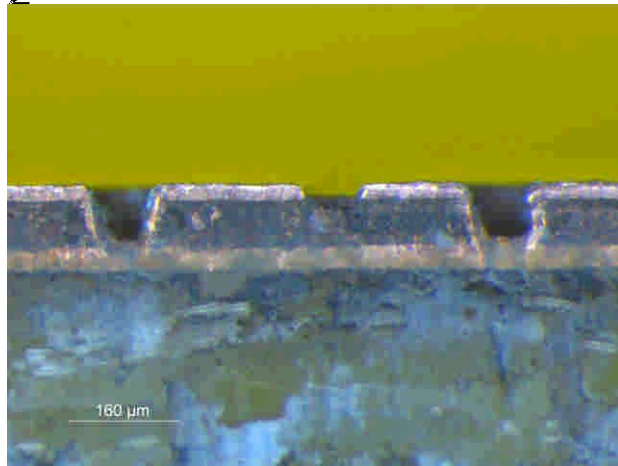
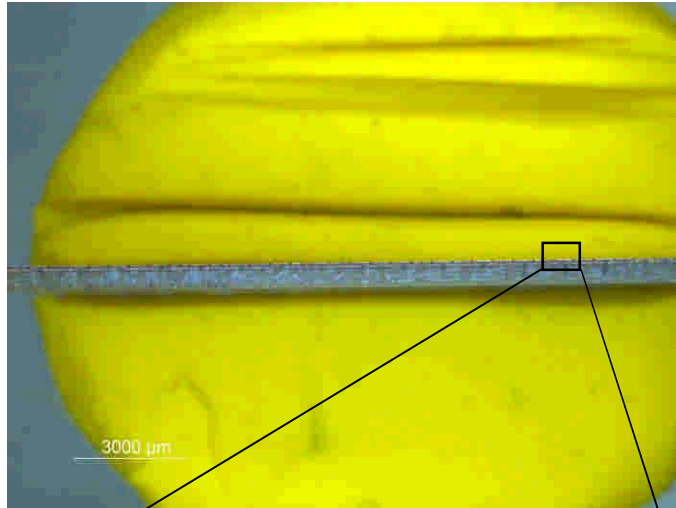


After removal of encapsulation material by the laser

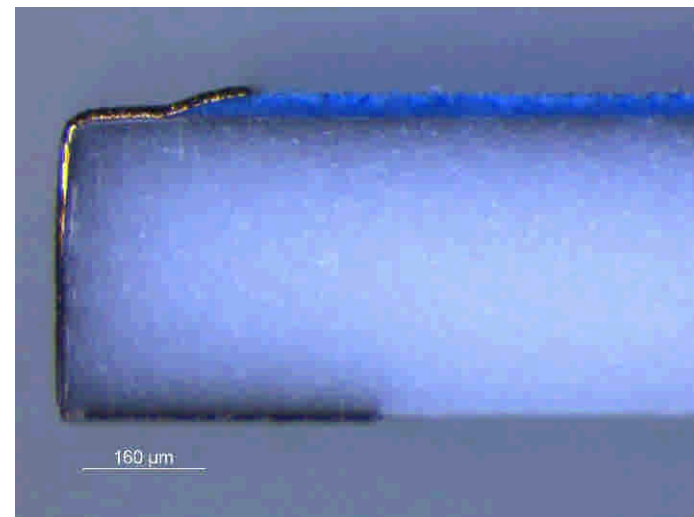
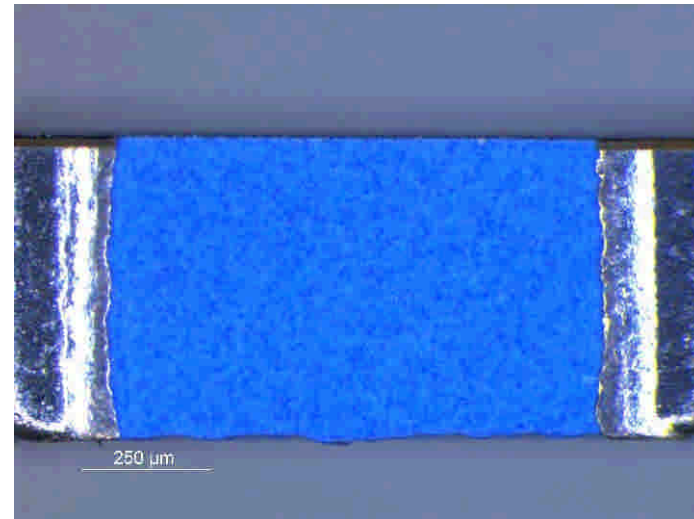


After removal of residual layer by Nitric acid

Laser cutting



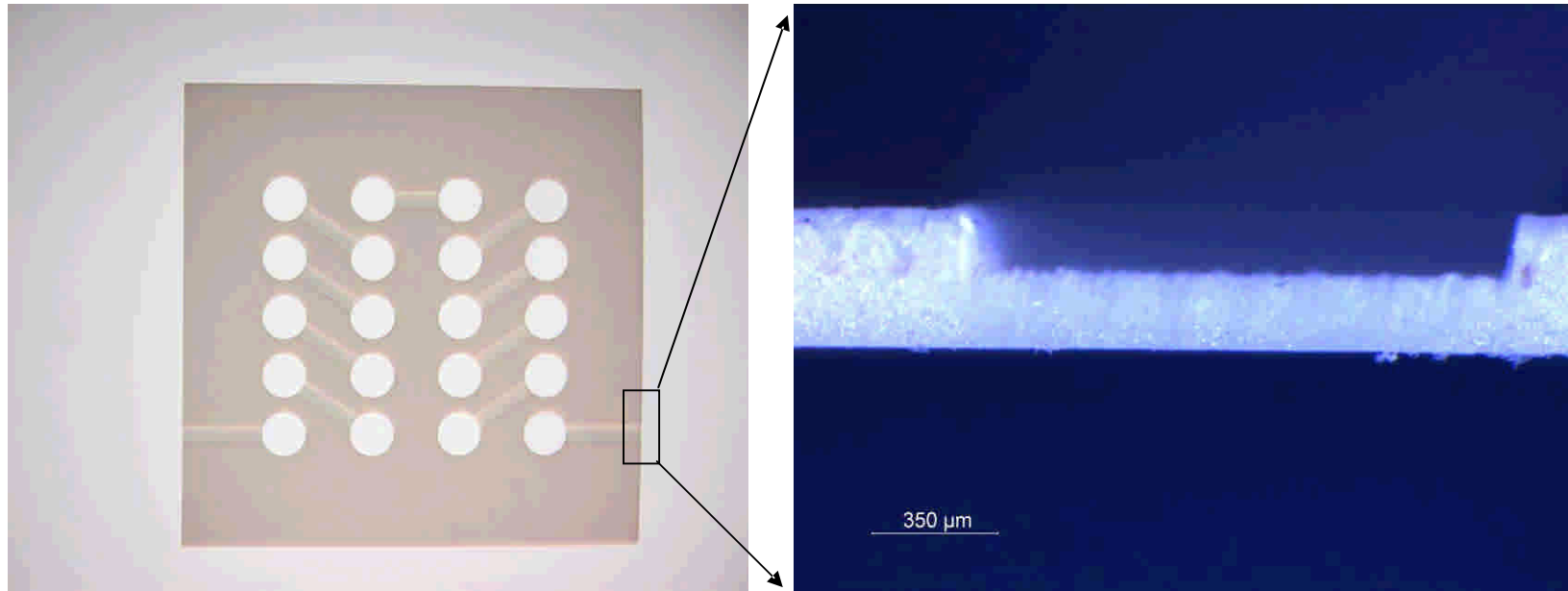
Cross-section through a microvias structure



Cross-section through a resistor

Laser cutting

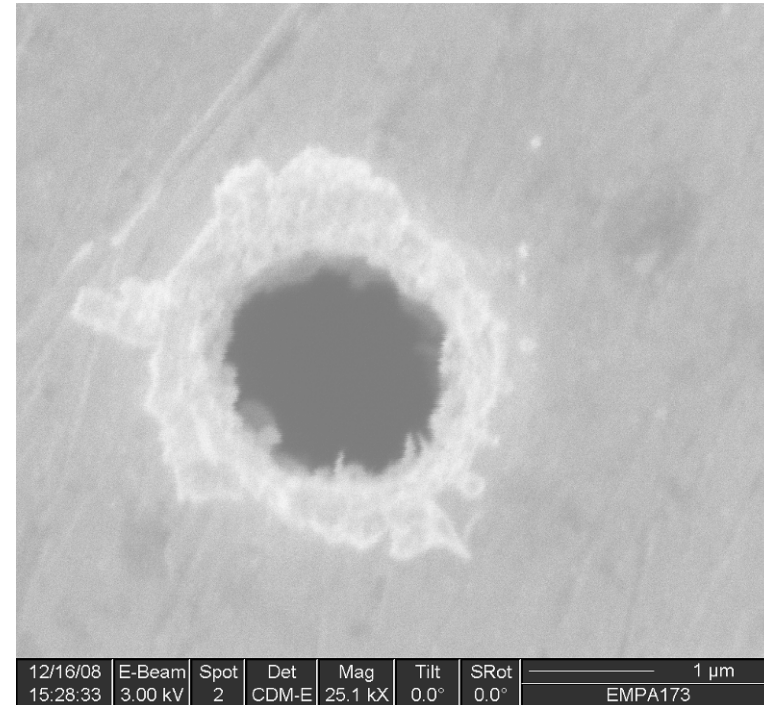
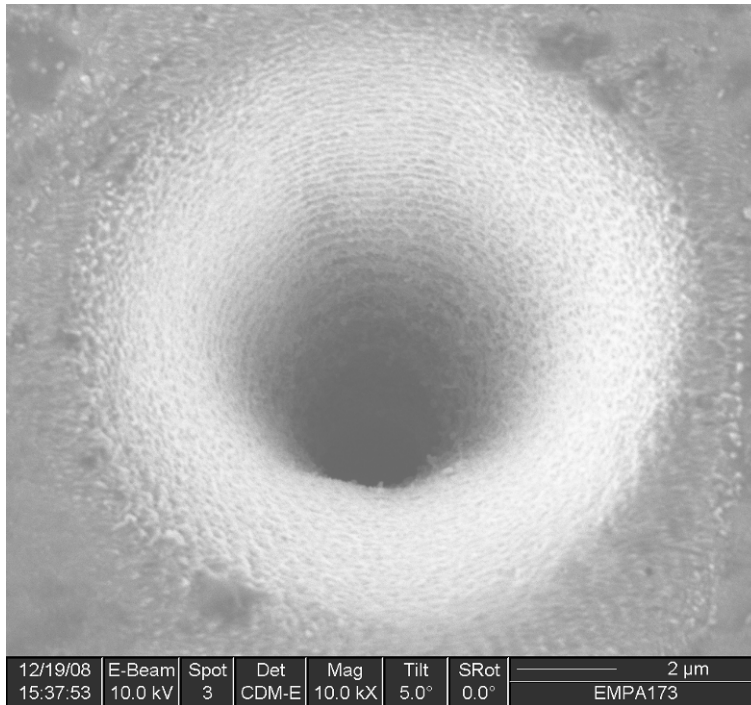
ceramics



Ceramic plate for thermoelectric applications

Laser drilling

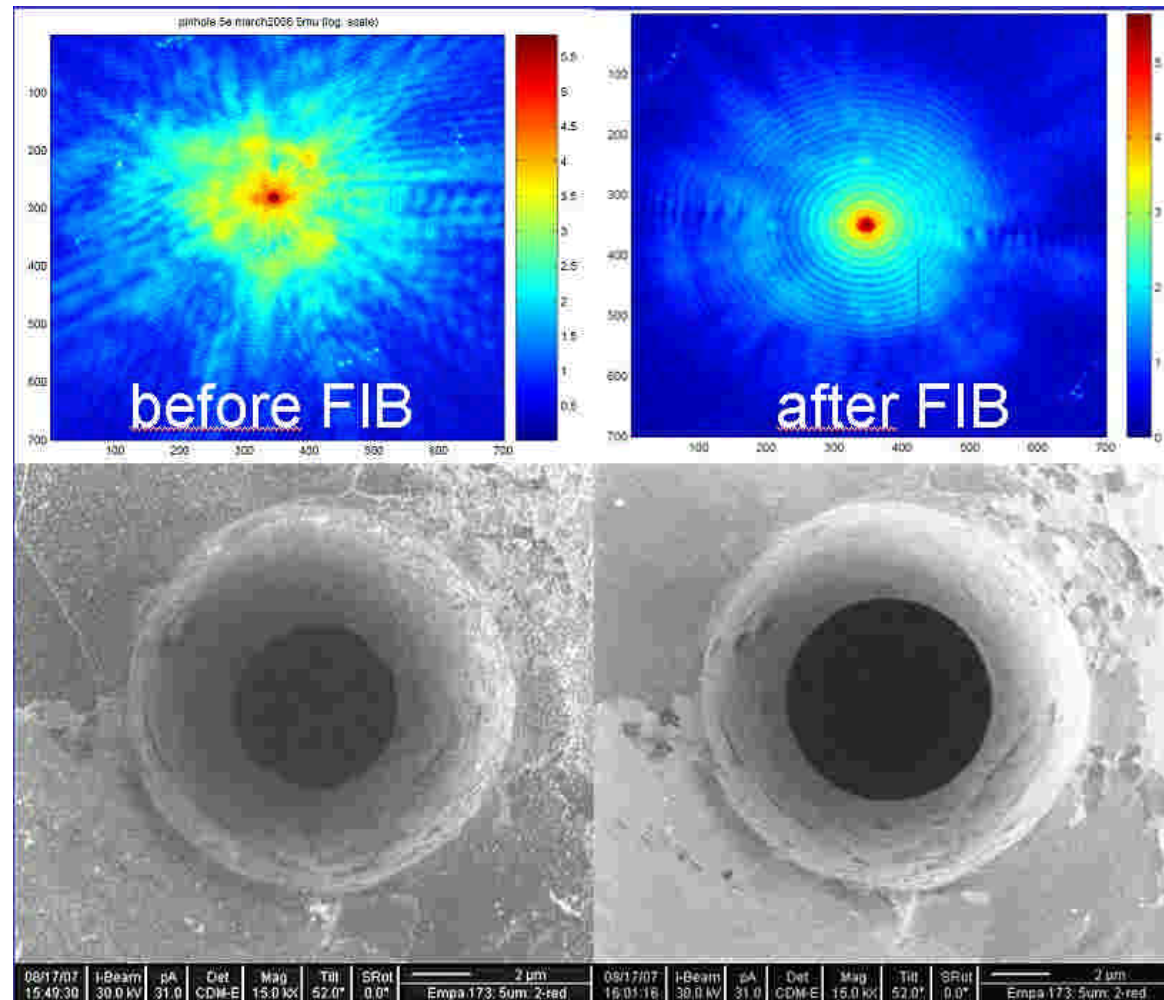
Pt/Ir foil



Ablation side (left) and backside (right) of a pinhole in Pt/Ir foil.
Foil thickness - 50 μm, apex diameter of the pinhole - 1.8 μm

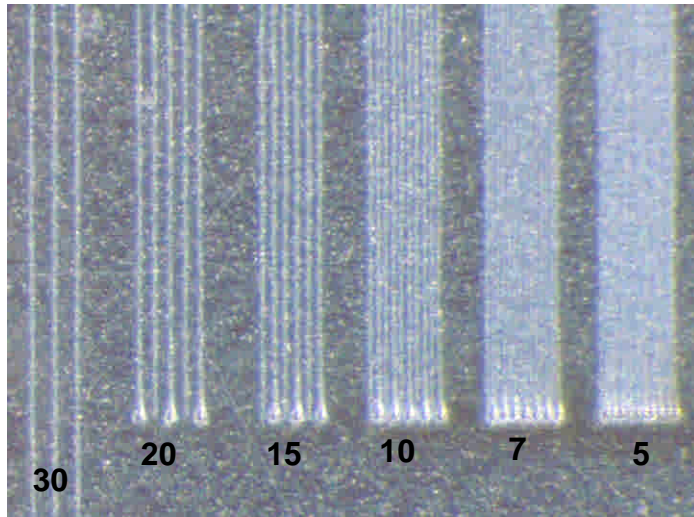
Laser drilling

X-ray diffraction from the microaperture

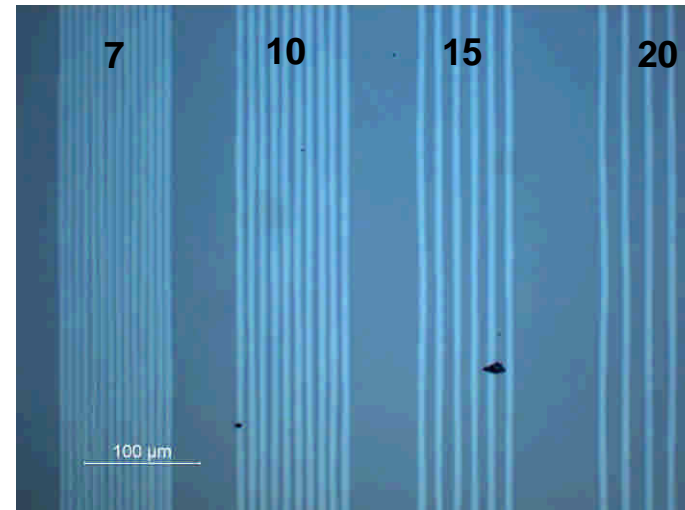


Microgratings

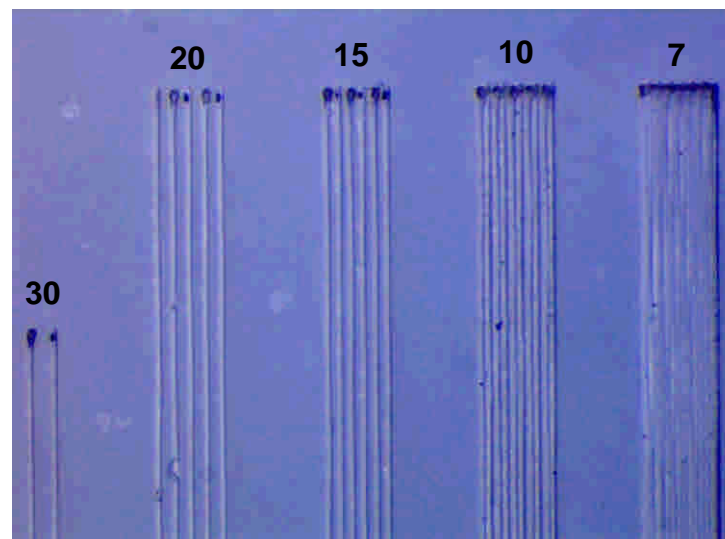
Steel



Silicon



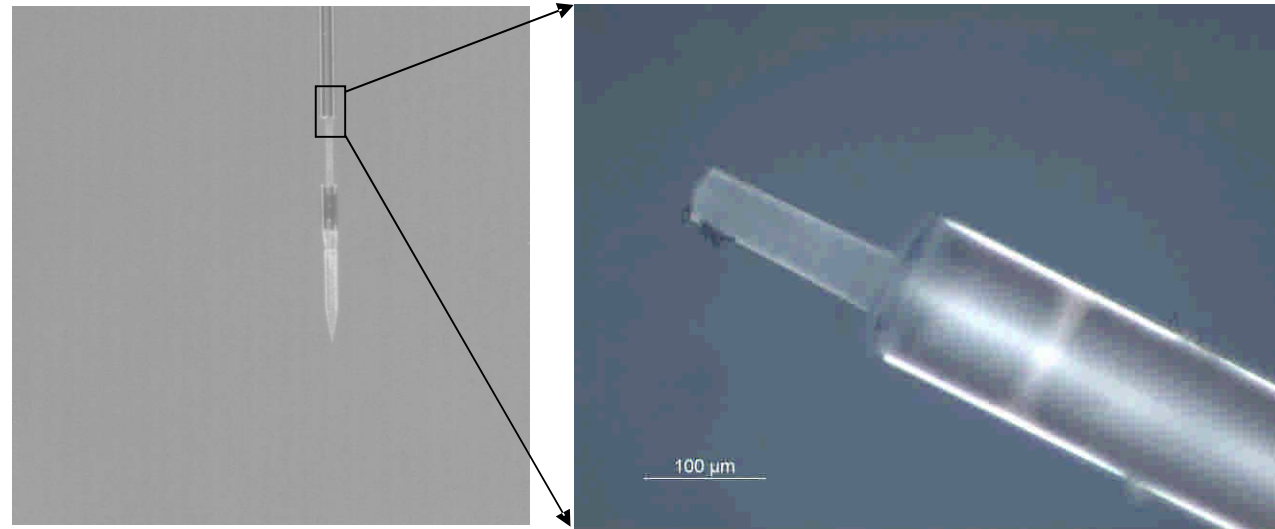
BK7 glass



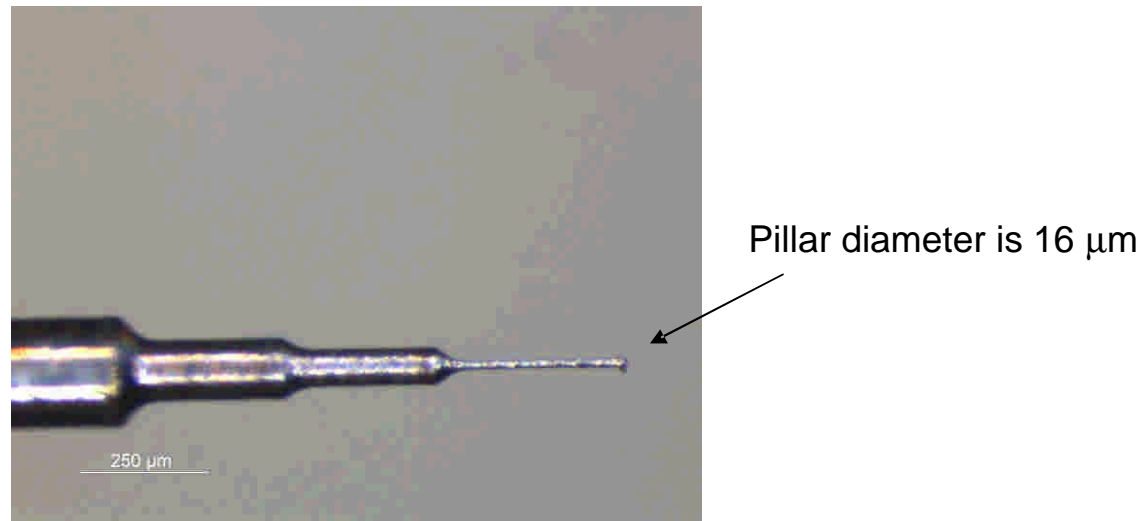
Numbers in the images are grating periods in μm

Micropillars

**Fused silica
(SiO₂)**

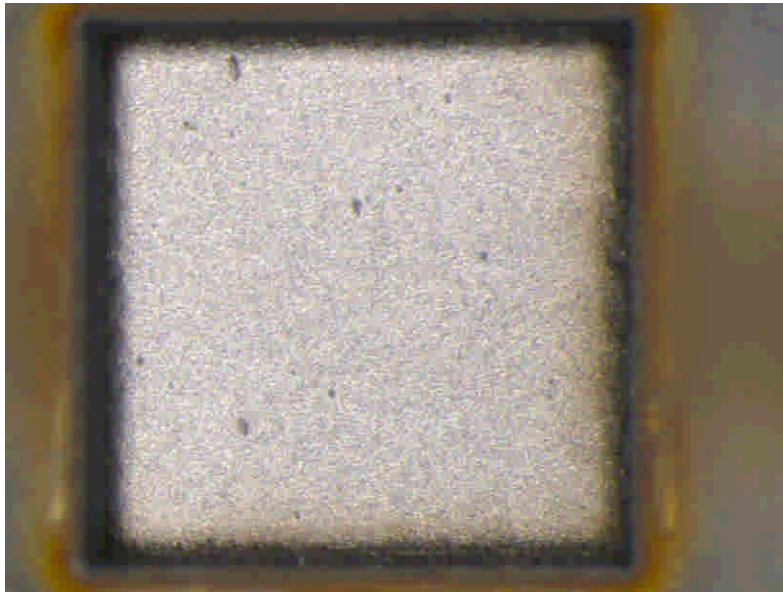


Steel



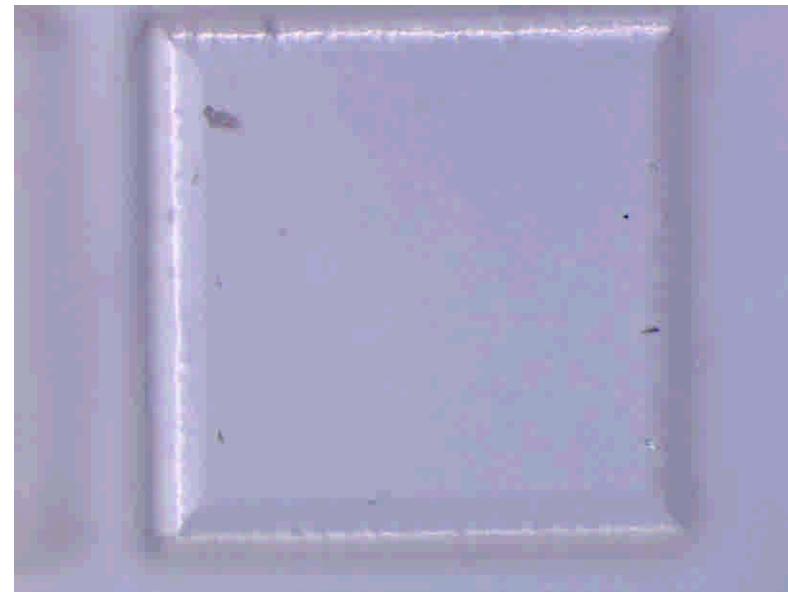
Low roughness machining

Steel



Depth = 100 μm , Ra = 0.3 μm

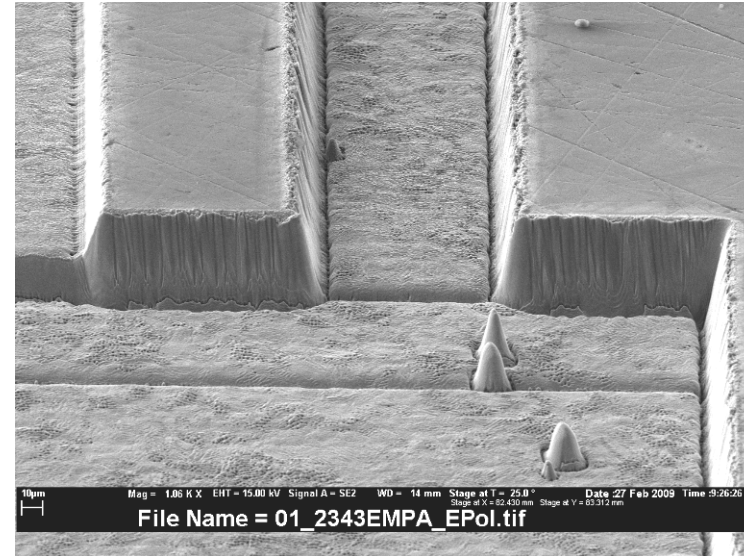
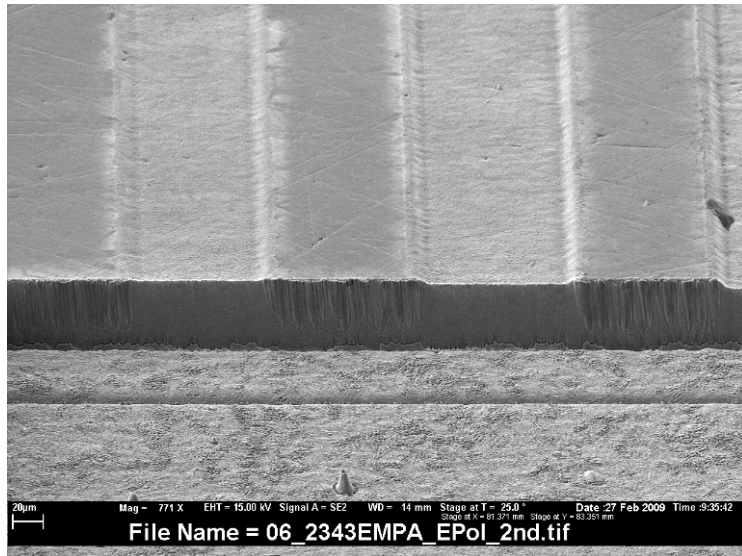
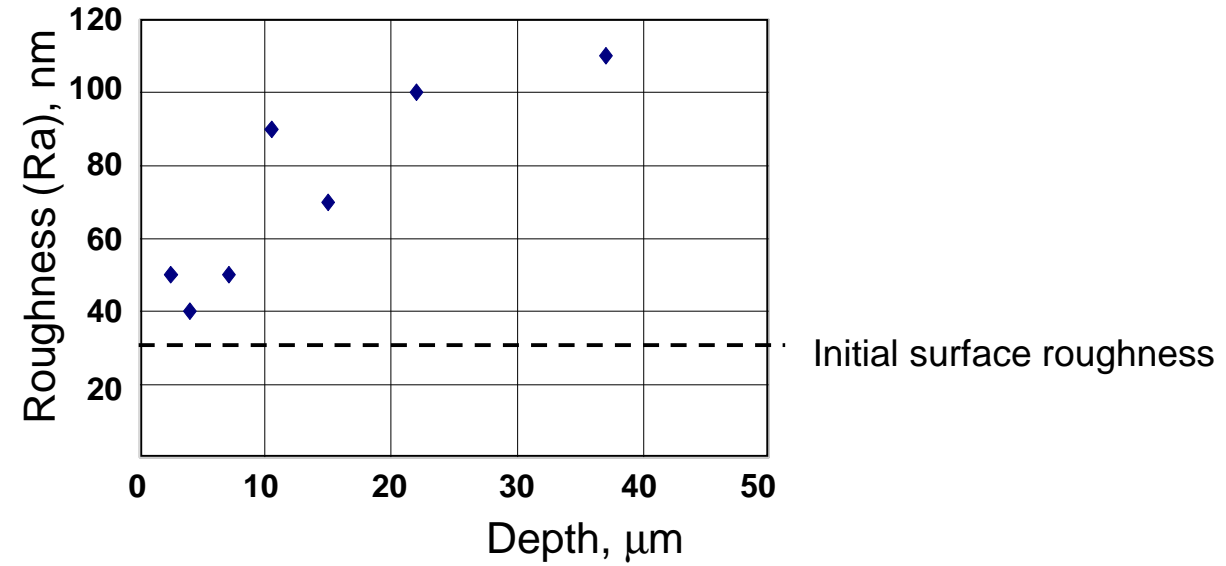
BK7 glass



Depth = 320 μm , Ra = 0.2 μm

Low roughness machining

steel



Summary

A ps-laser machining is emerging technique for industrial applications:

- n It provides cost effective alternative to advanced lithographic methods
- n It allows processing of “non-machinable” materials
- n It allows fabrication of 3D-structures hardly realizable by other methods