Latest Advances in High Precision Laser Micromachining of Transparent Materials

Oxford Lasers Ltd

www.oxfordlasers.com

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1 Introduction of Oxford Lasers Ltd

- **Founded in 1977, spin-off from Oxford University. 39 years in the laser industry.**

- **Started laser micro-machining business in 1993.**

- **Two divisions:**

  Laser micro machining (subcontract services and laser systems)

  High speed imaging

- **Markets: R&D Centres, Microelectronics, solar, Medical, Automotive, Telecoms, Pharmaceutical**

Our 23 years of expertise in Laser Micro Machining

1 Micro

Processing spot size typically 5 - 50 µm

Material removal typically 10 - 1000 μm^3 per pulse

0.1 - 1 mm^3 per minute

2 Short pulse

"Nanosecond" lasers approx 10^{-8} secs

"Picosecond" lasers approx 10^{-11} secs

"Femtosecond" lasers approx 10^{-13} secs

3 Genuinely "micro" 2.5um corner radius

<1um surface roughness

4 Small Heat Affected Zone 10nm - 2.5 µm

Customers Applications

Micro-machining System

Design and Supply

Applications Labs & Subcontract

1000s of different jobs

Software Team

Incorporate layout and features based on experience of using and supplying systems

R & D Projects

EU & UK funded collaborative projects on advanced next generation laser applications

Digi PRINT

LaserMicroFAb

smartonics

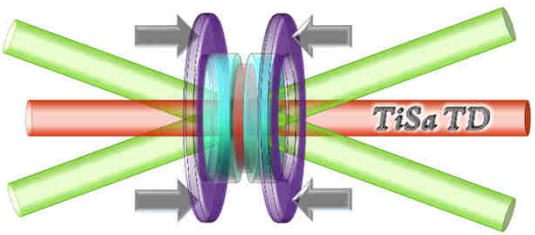
Oxford Lasers Process Knowledge

Our Capabilities/Capacities

- **Equipment**
  - **In house flexible configuration**
- **Materials**
  - **Metals, ceramics, polymers, glasses**
- **Wavelengths**
  - **Near IR, visible, UV, deep UV**
- **Pulse Lengths**
  - **Nanosecond, picosecond, femtosecond**
- **Volumes**
  - **Single samples to 500,000 parts/year**

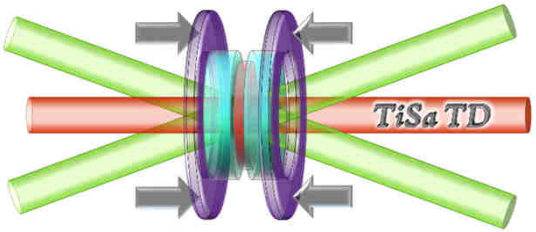
Subcontract Services, Proof of Concept Services, R&D

High Precision Laser System Built



2. European TiSa TD Project

Dr. Dimitris Karnakis
Dr. Nicola Bellini

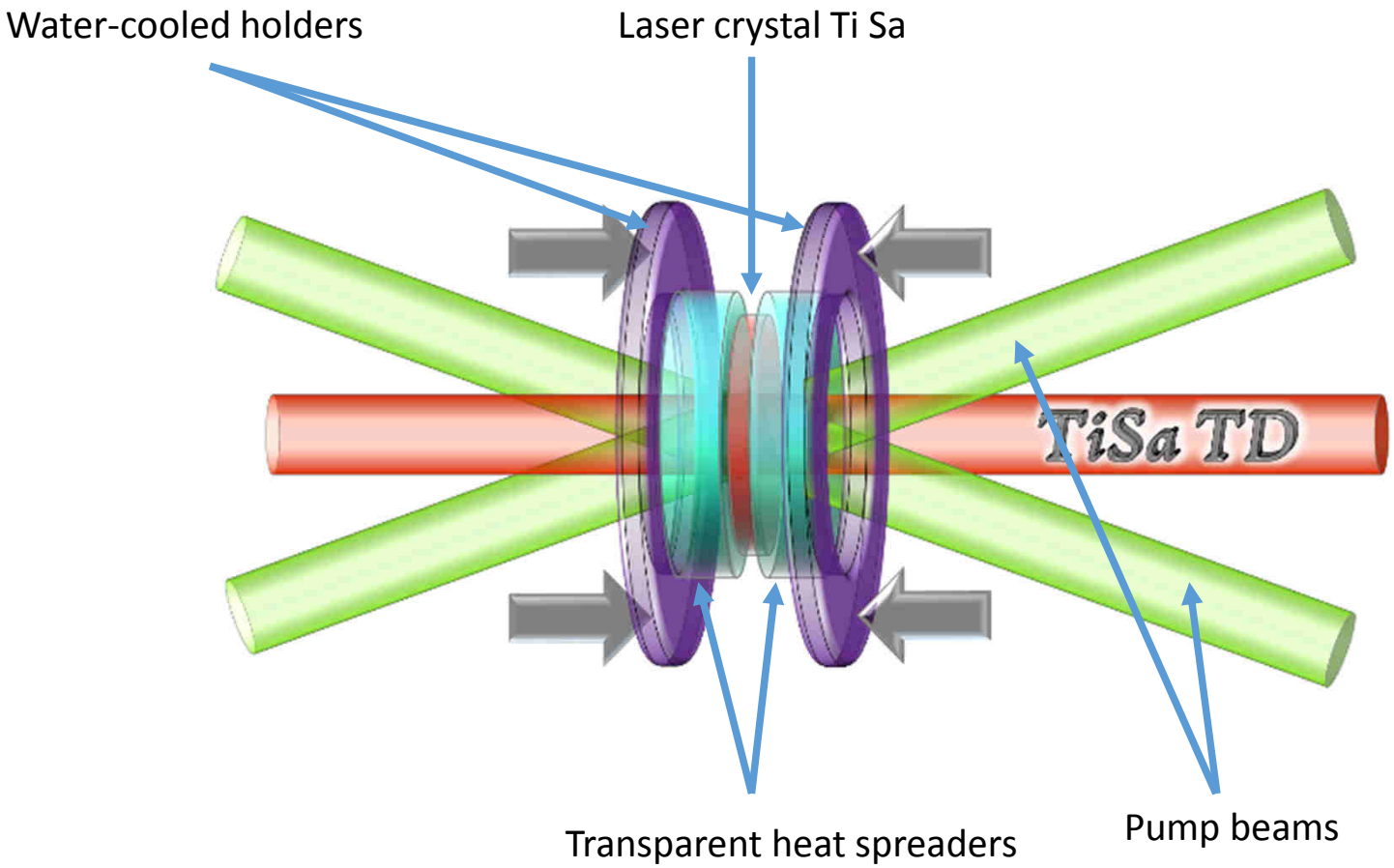


- Femtosecond laser Processing of Transparent Materials (glass, synthetic diamond, sapphire)
- Start date: Dec 2013 (duration 36M + 9Mextension due to delays)
- Demonstrate the feasibility of industrial high-average power (>100W),10MHz rep rate ultrafast Ti:sapphire (Ti:Sa) lasers.
- Demonstrate their applications
- <u>Other Partners :</u>

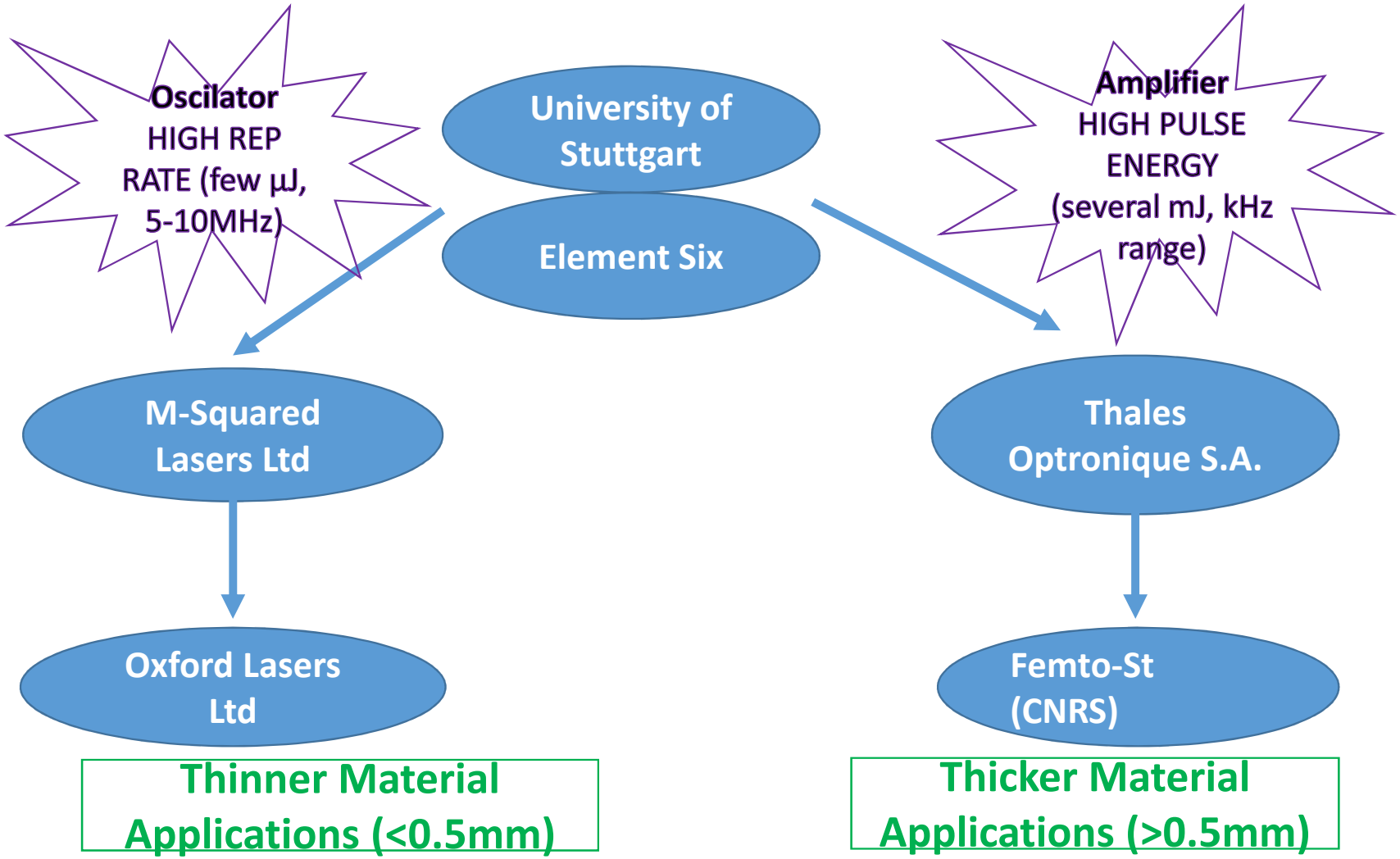
- University of Stuttgart
- Thales Optronique S.A.
- M-Squared Lasers Ltd.
- Element Six Ltd
- Femto-ST (CNRS)
- Kite Innovation (Europe)

The TiSa TD project has received funding from the European Community's Seventh Framework Programme under Grant Agreement No. 619177

The heart of the laser



Partners' role and Organisation



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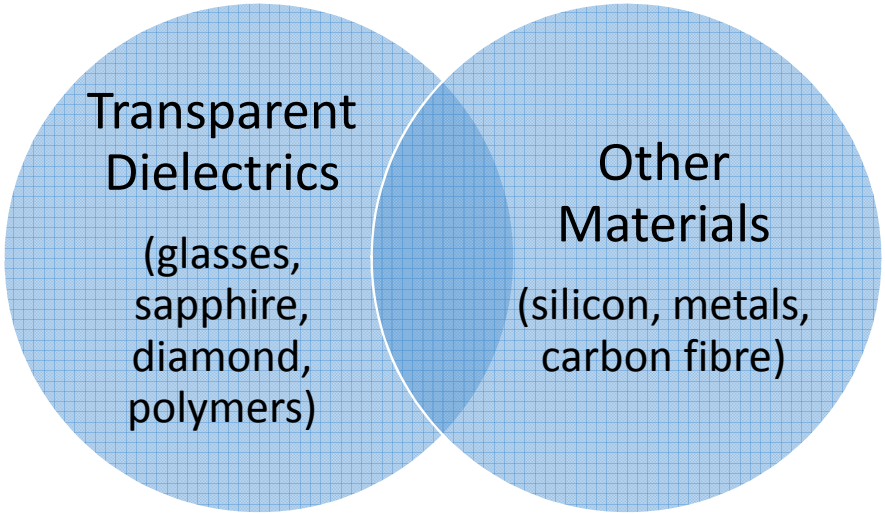
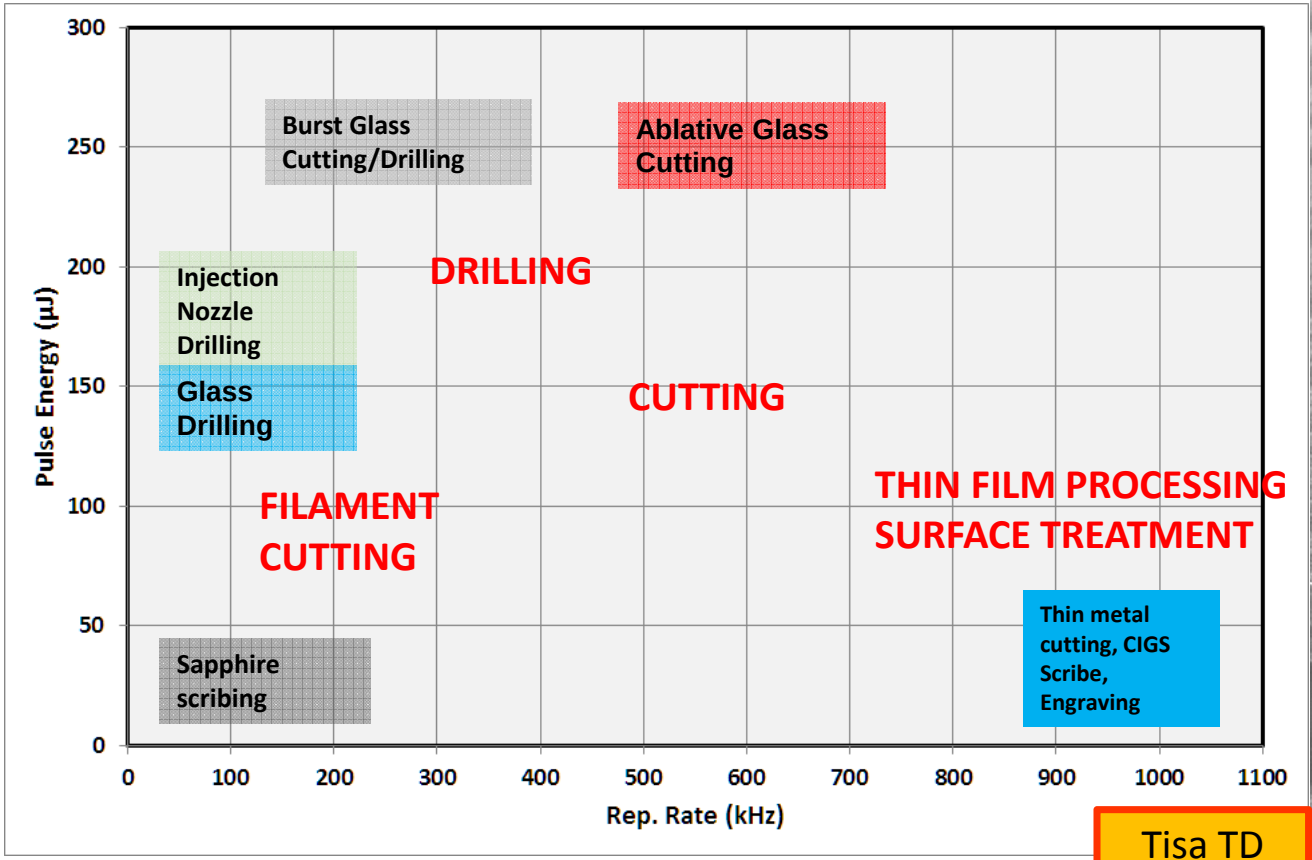
Industrial Materials

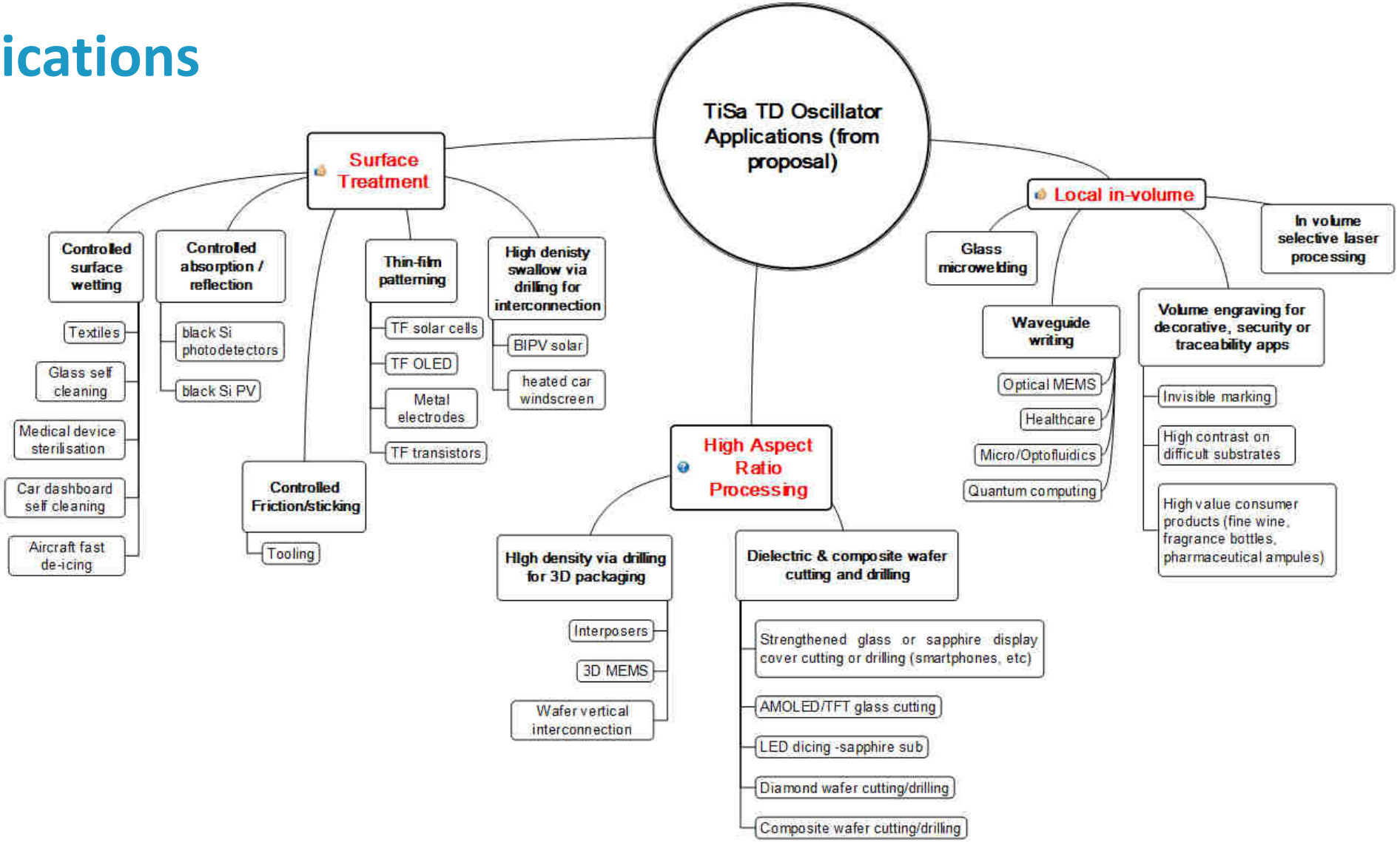


Laser pulse energy vs. PRF

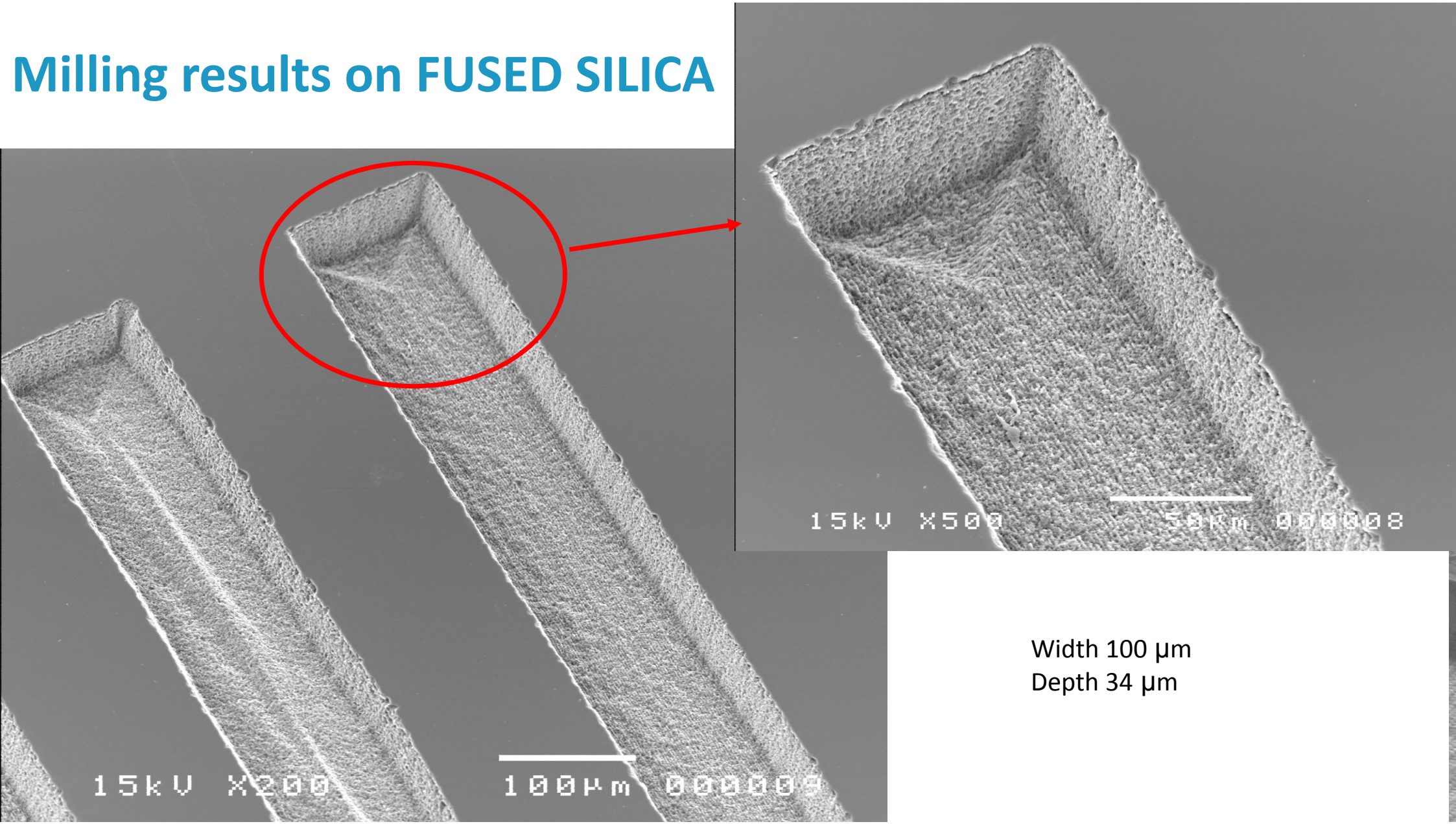


Tisa TD
oscillator
2-5µJ
10MHz

Applications

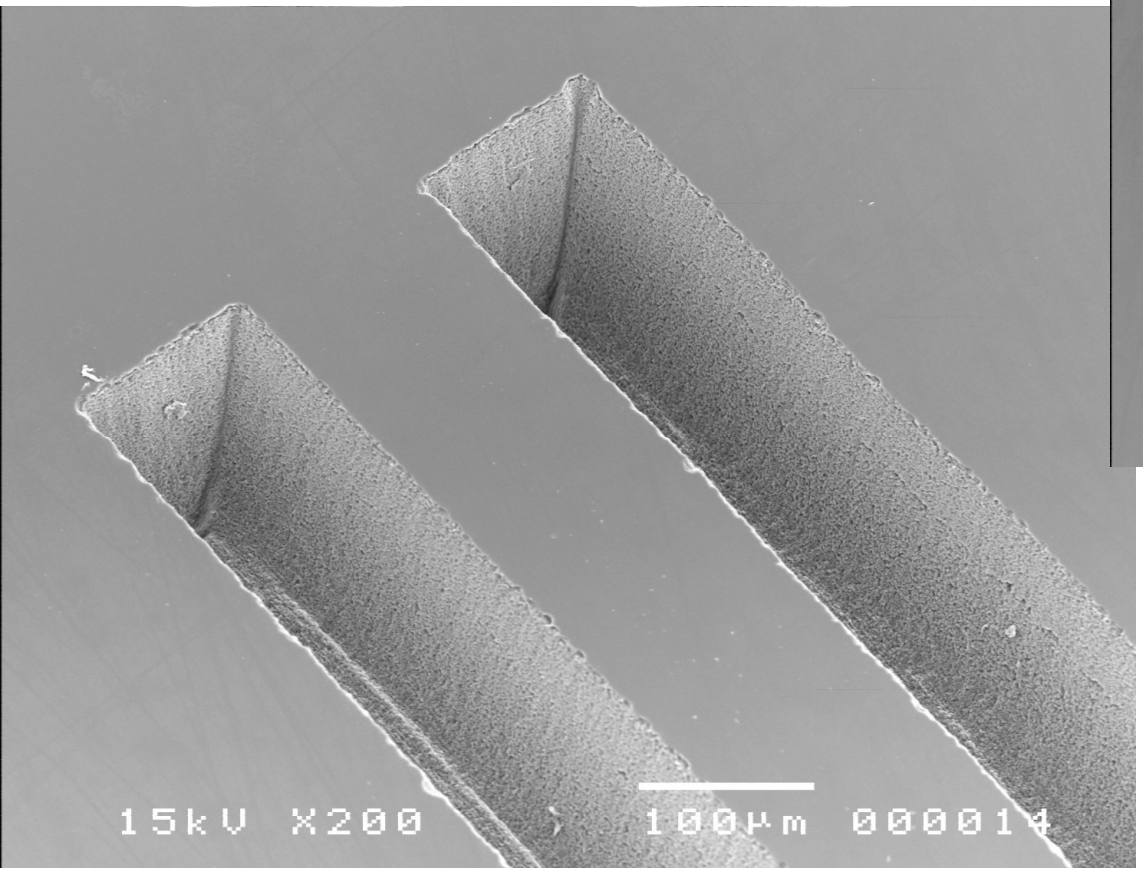


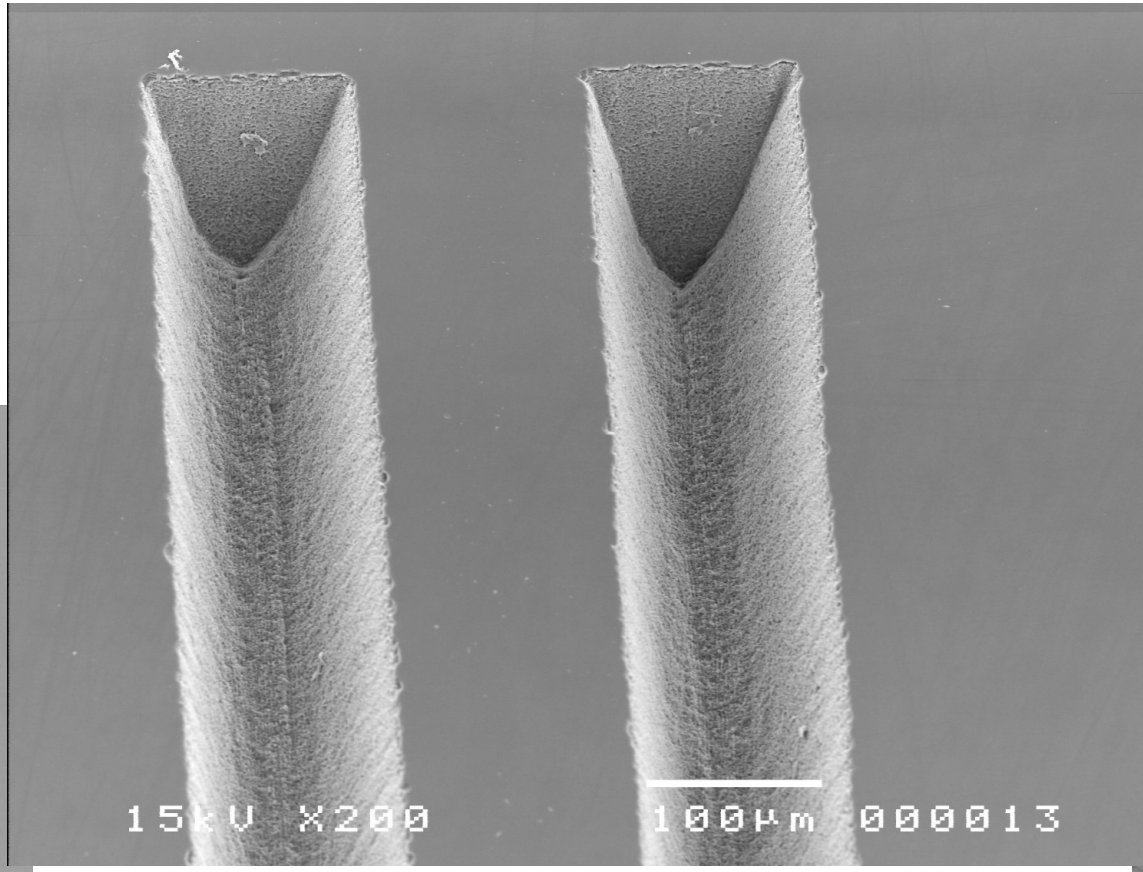
Milling results on FUSED SILICA



Width 100 µm
Depth 34 µm

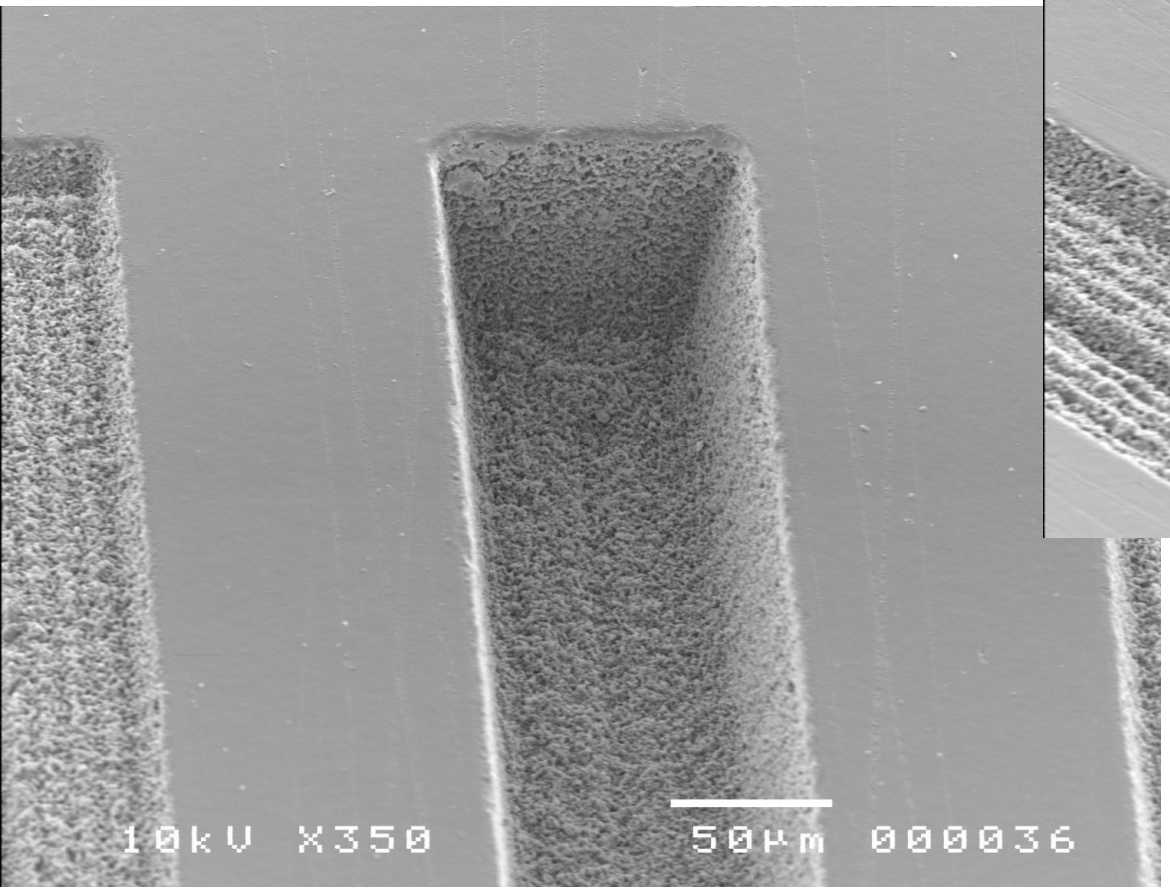
Milling results on FUSED SILICA

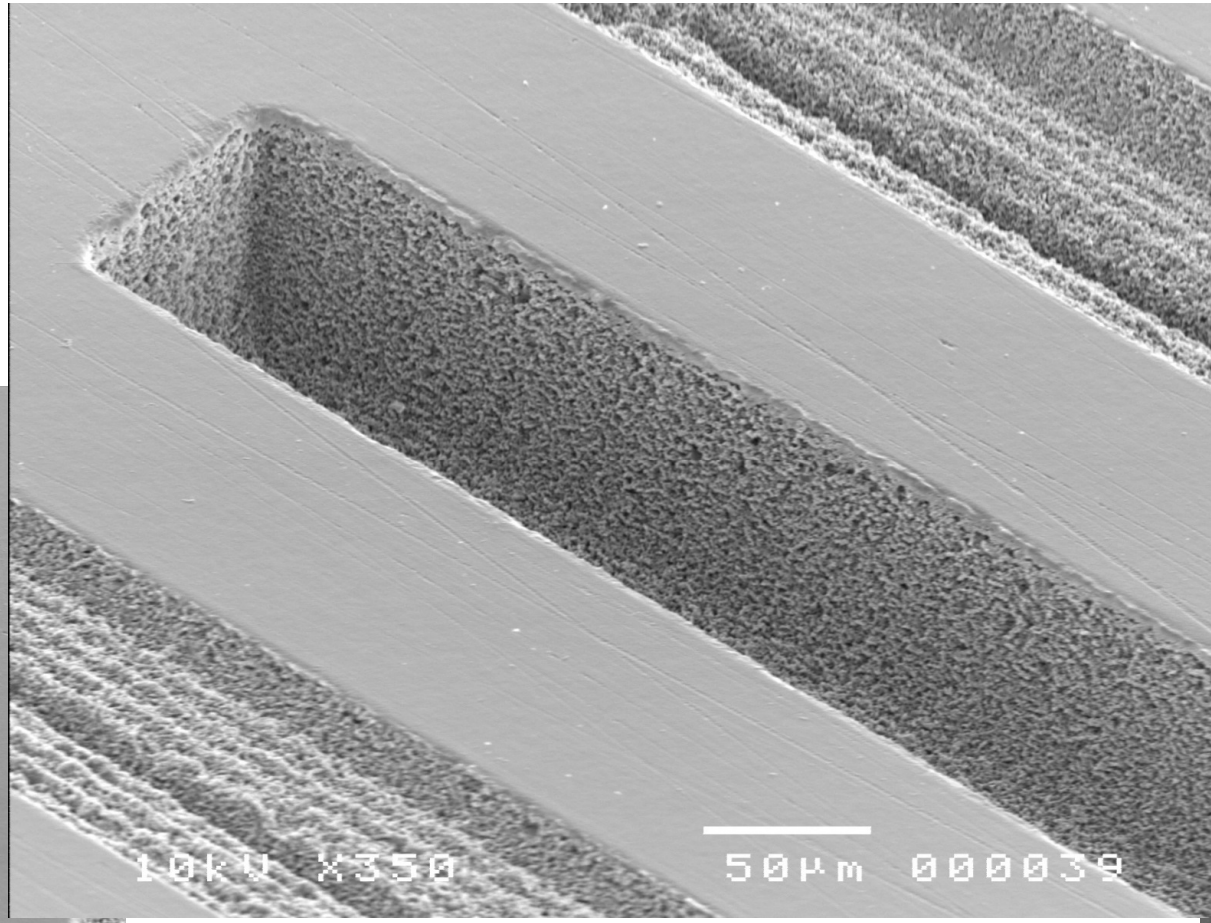




Width 100 µm
Depth 120 µm

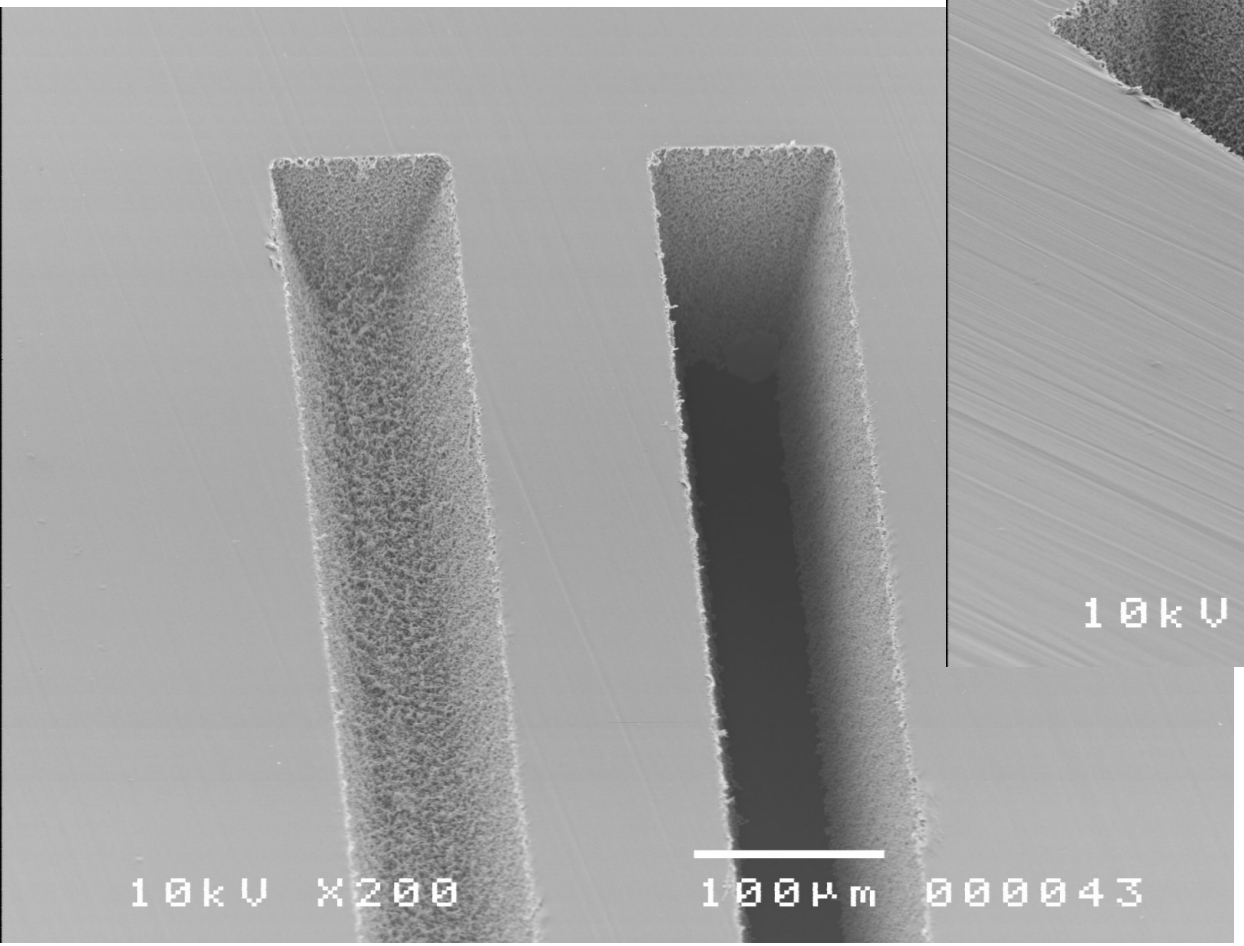
Milling results on PMMA

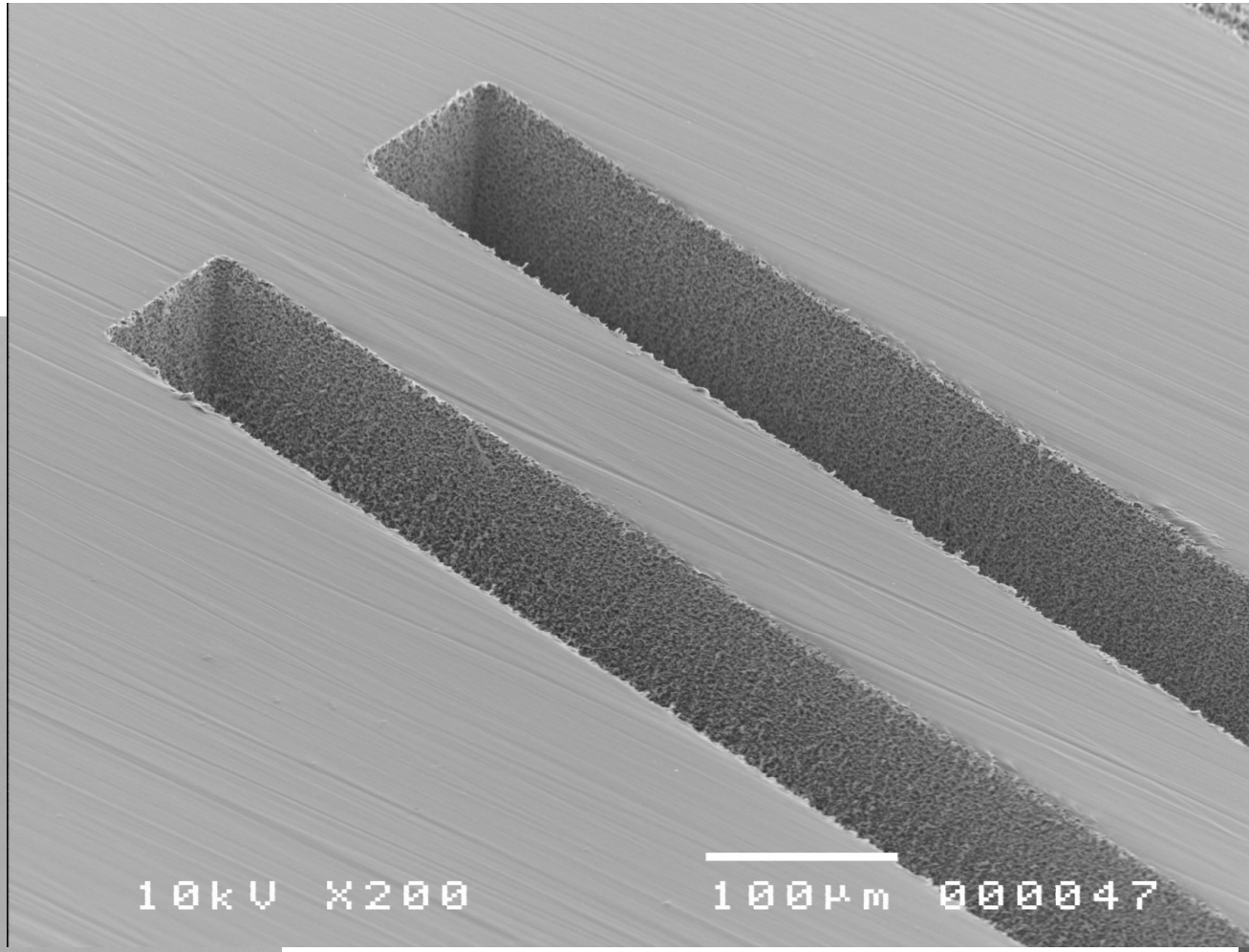




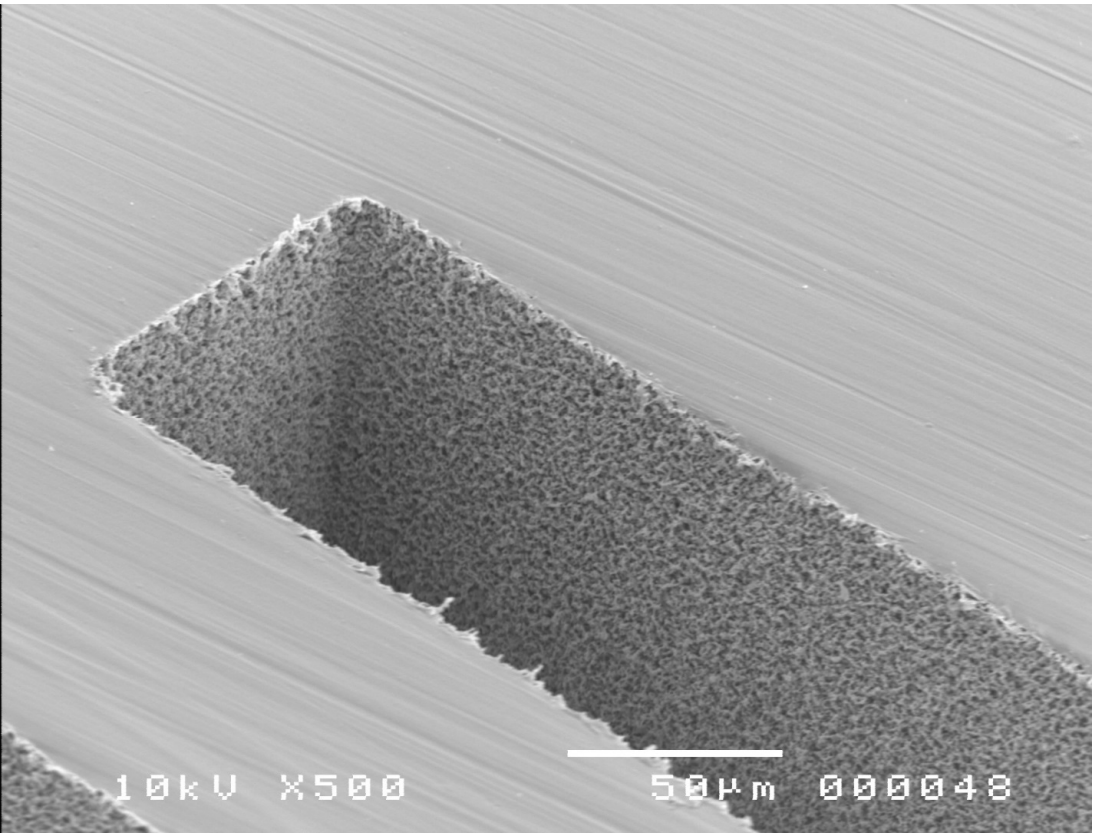
Width 100 µm
Depth 70 µm

Milling results on FEP

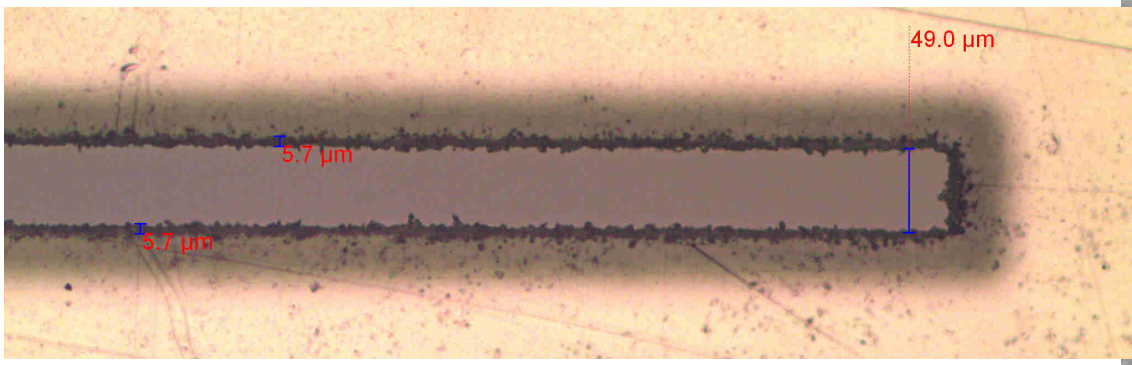




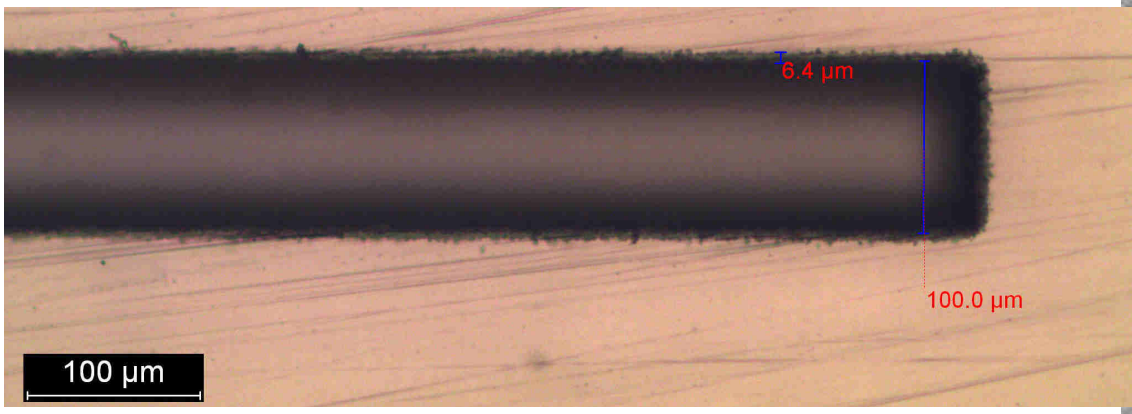
Milling results on FEP



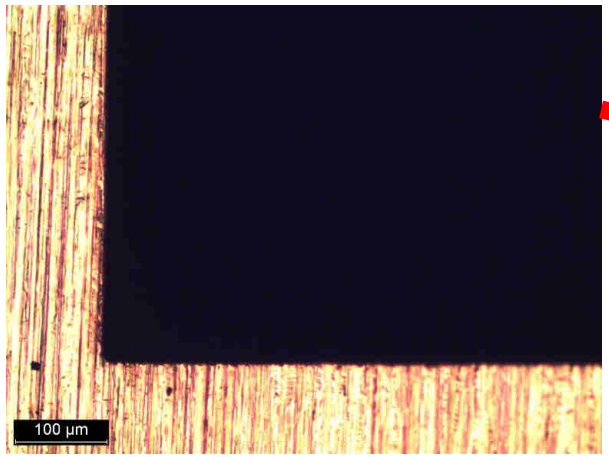
Exit side

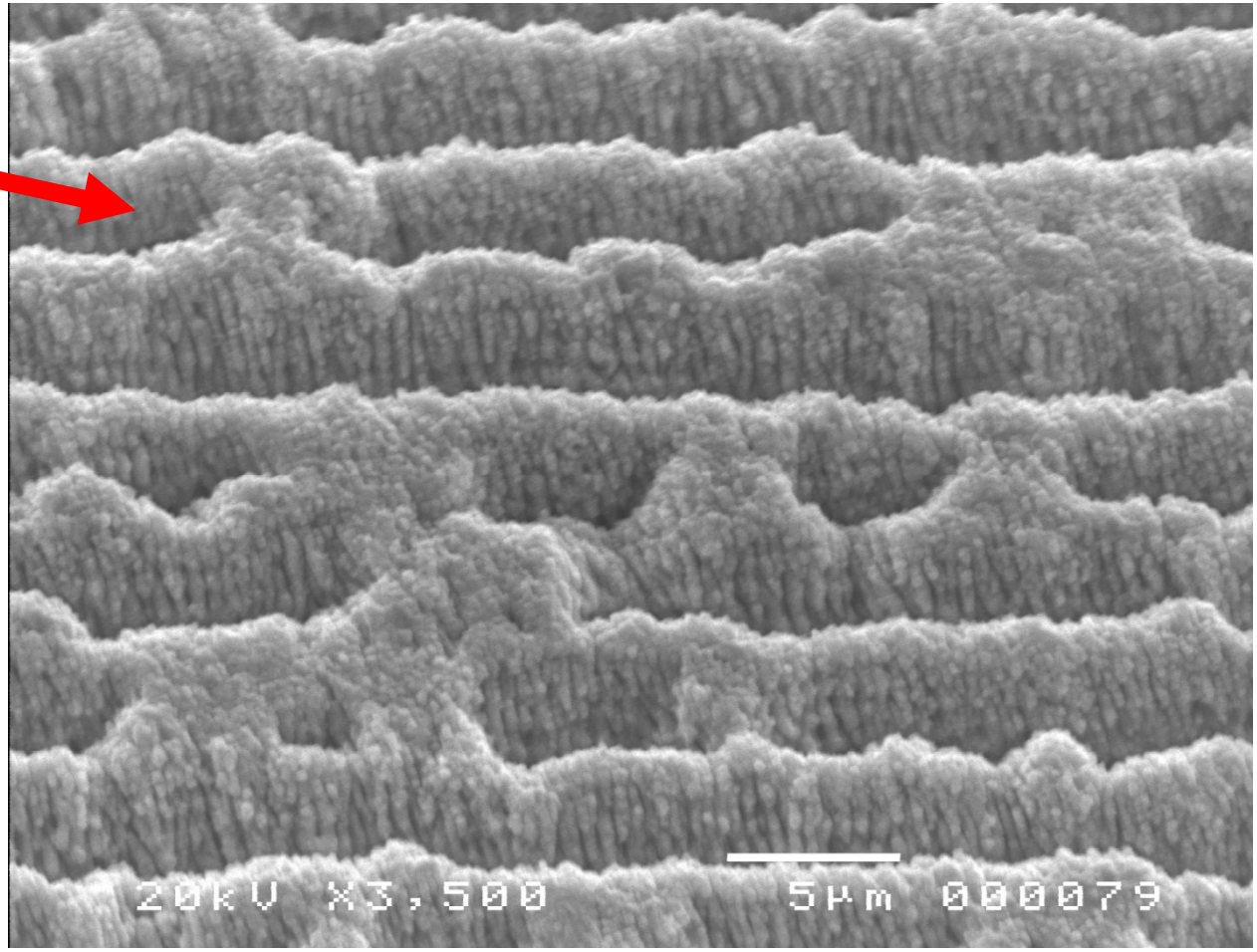


Entry side
125 µm thick



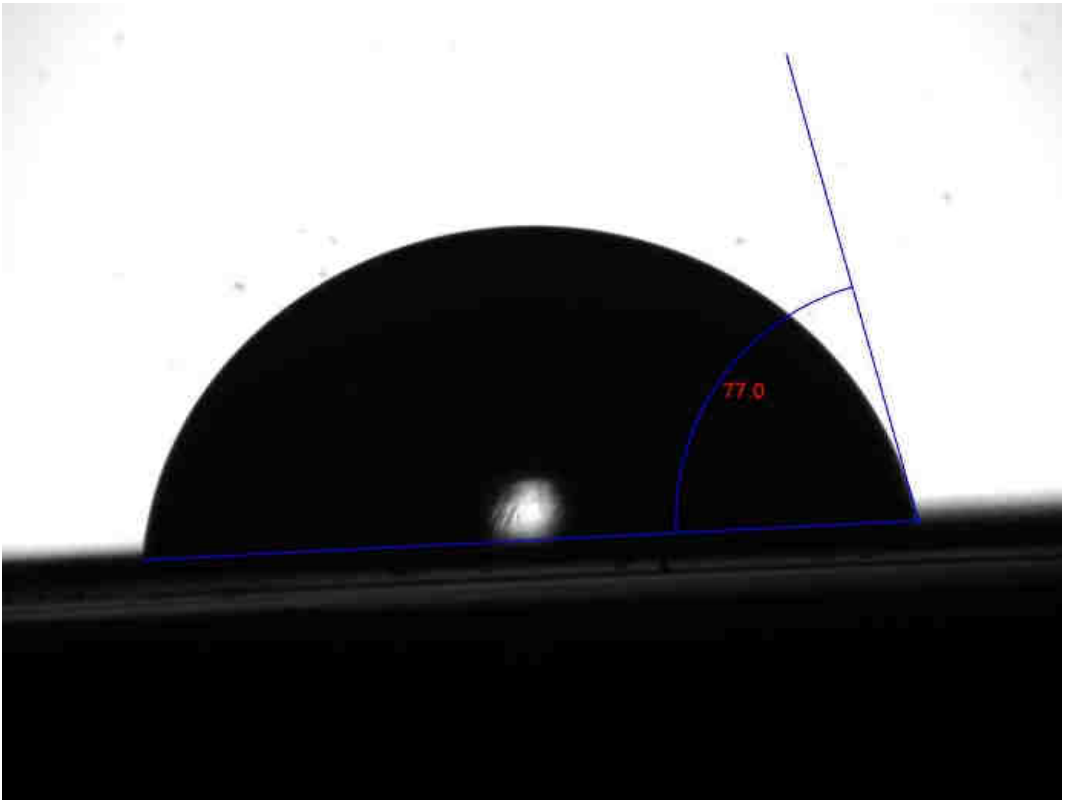
Fs laser SURFACE Modification on STAINLESS STEEL



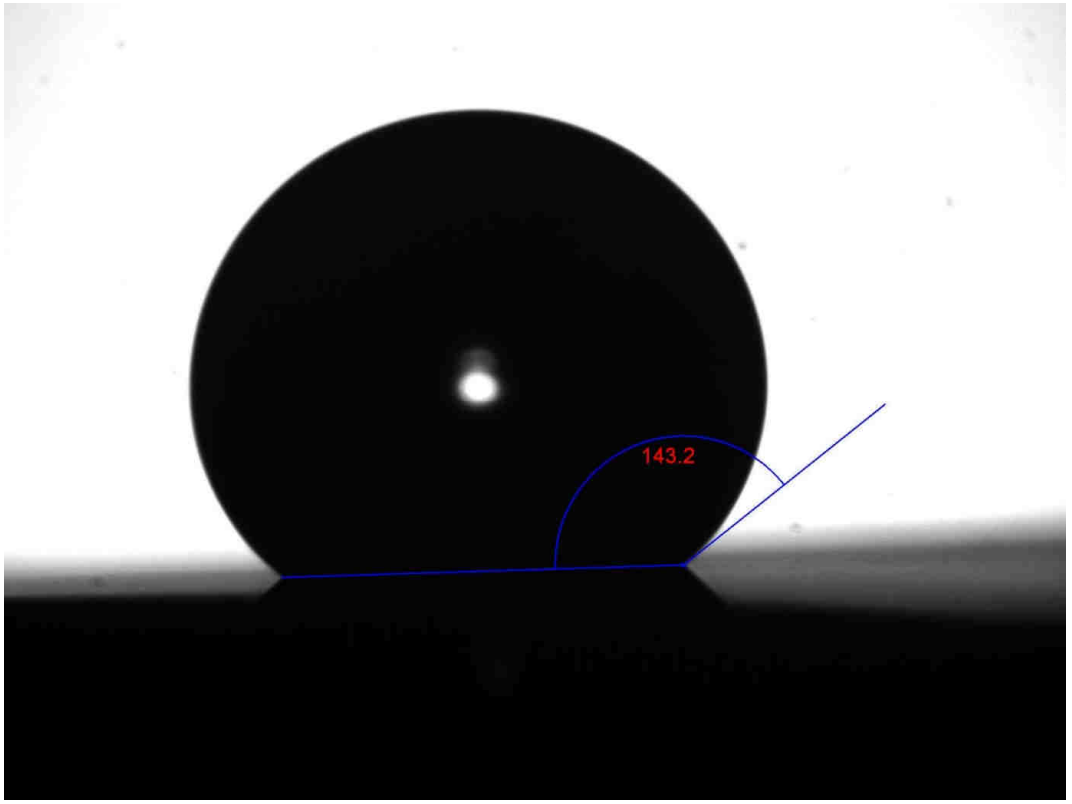


Light trapping

Fs Laser surface wettability control

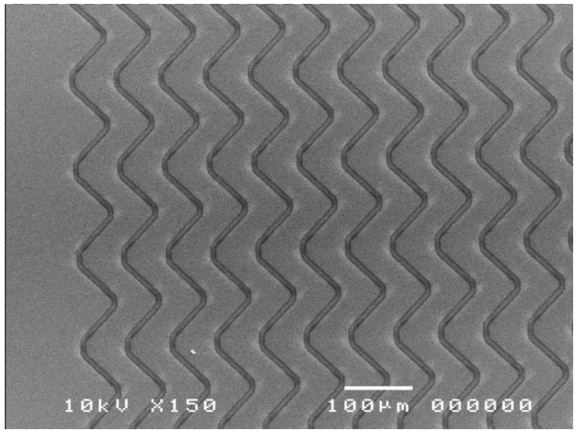


Before laser texturing
(hydrophilic surface)

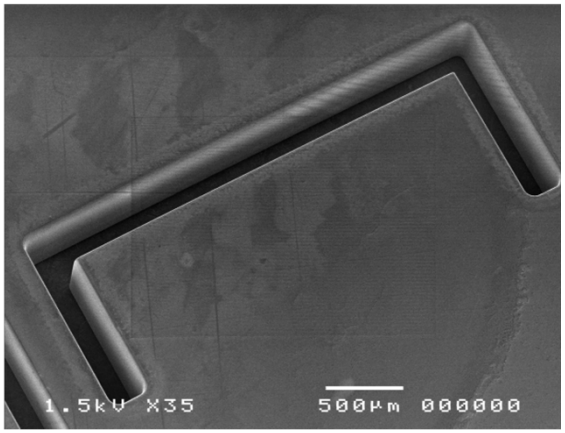


After laser texturing
(hydrophobic surface)

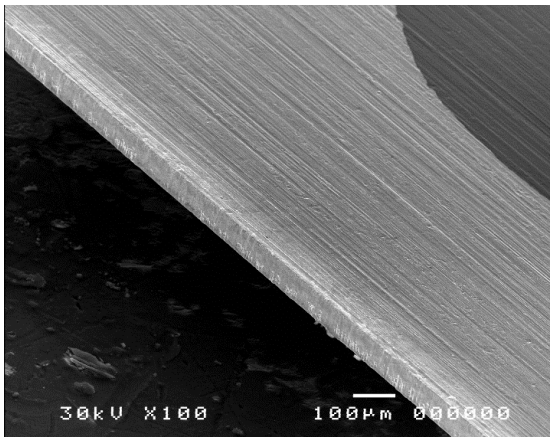
Other material machining



Patterning - ITO on glass

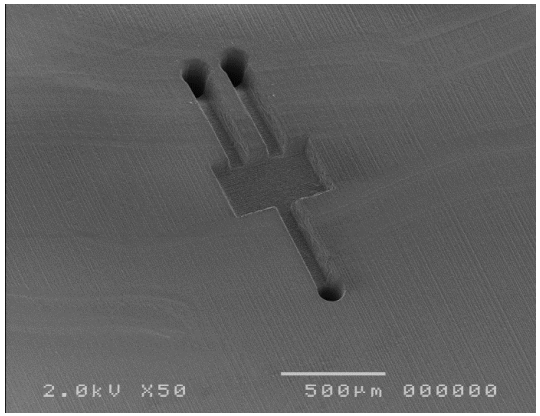


Sapphire

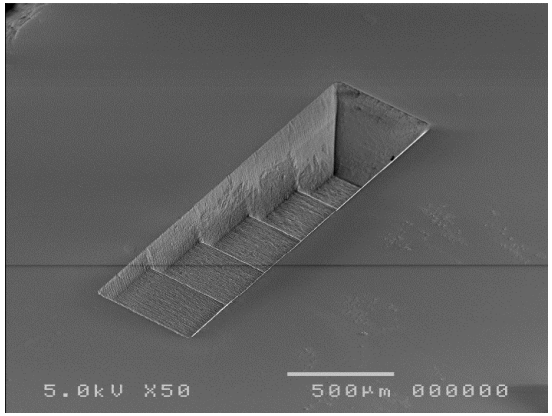


Nickel

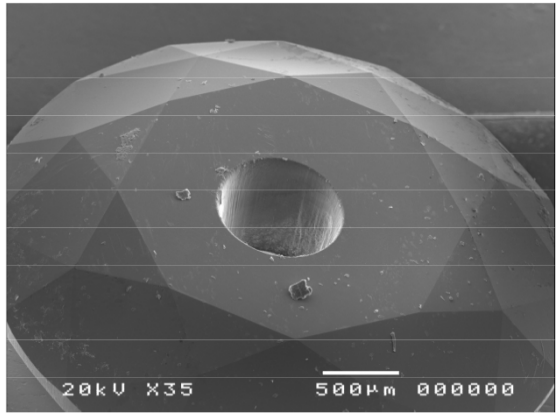
PTFE



Glass



Diamond



Thank you!

Any questions are welcome