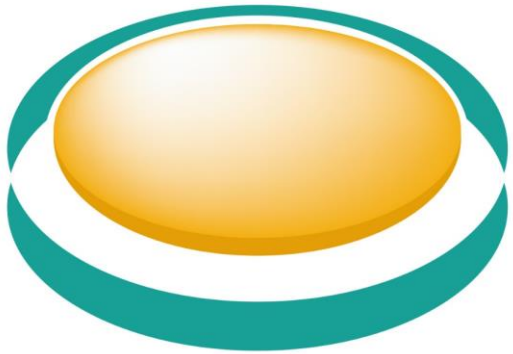


FLOIM

Flexible Optical Injection Moulding of optoelectronic devices

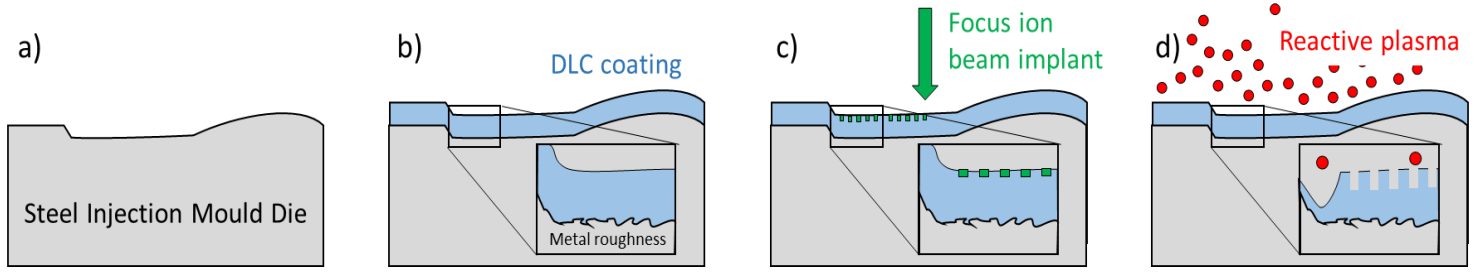
High-performance DLC-based mould patterning technology with high control over micro and nano features

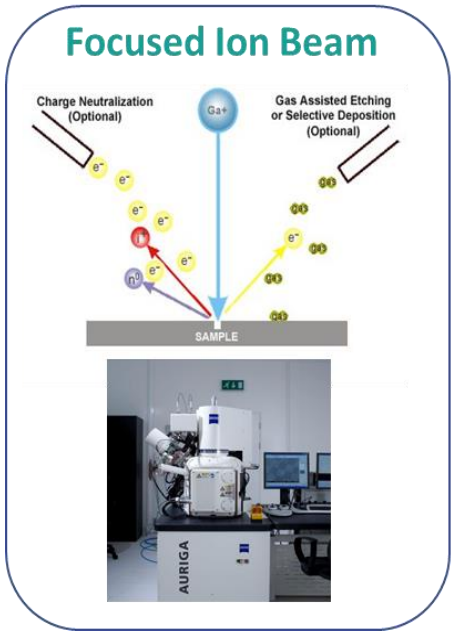
FLOIM Meeting, 28th April 2022 World of Photonics, Munich

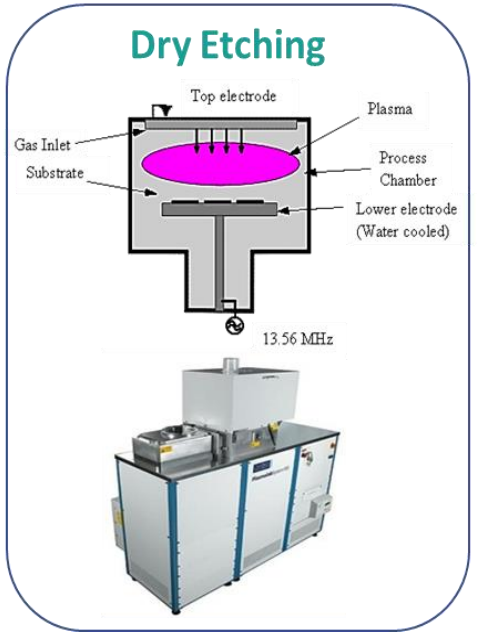
Dr. Zahra Gholamvand, ADAMA Innovations

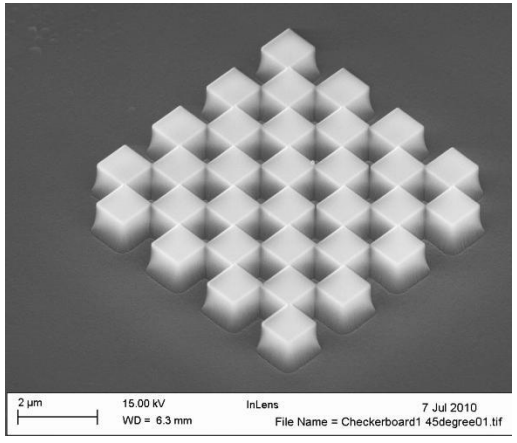
ADAMA's Core Technology

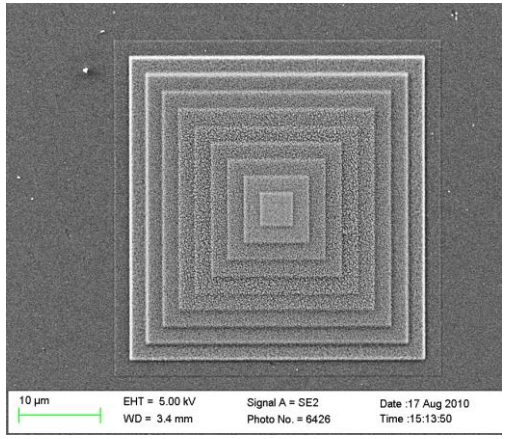
- Direct write, high performance *resistless masking* for **diamond** and **diamond like carbon (DLC)**
- Two step process: Implantation & Dry etch
- Mask-free, on curved and irregular surfaces
- Multi-scale, from 5-nm resolution to 200 microns features over cm scale areas
- Wafer-scale batch throughput

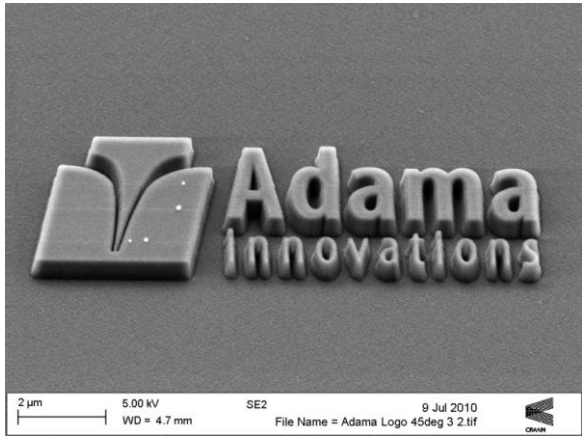


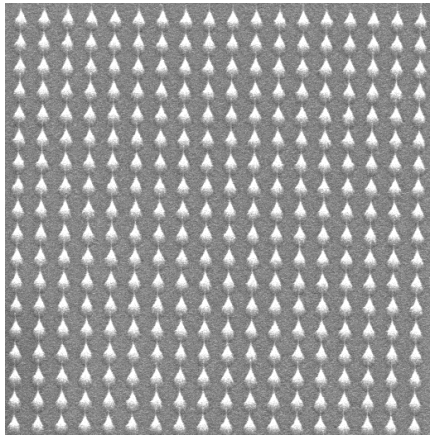


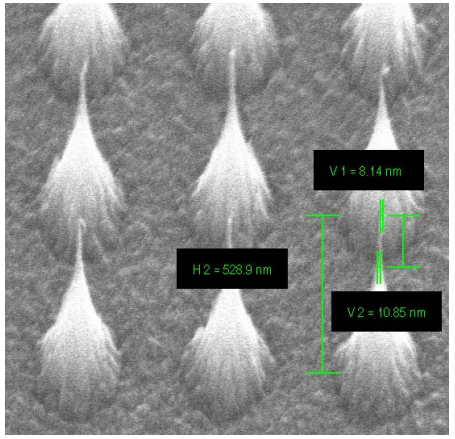












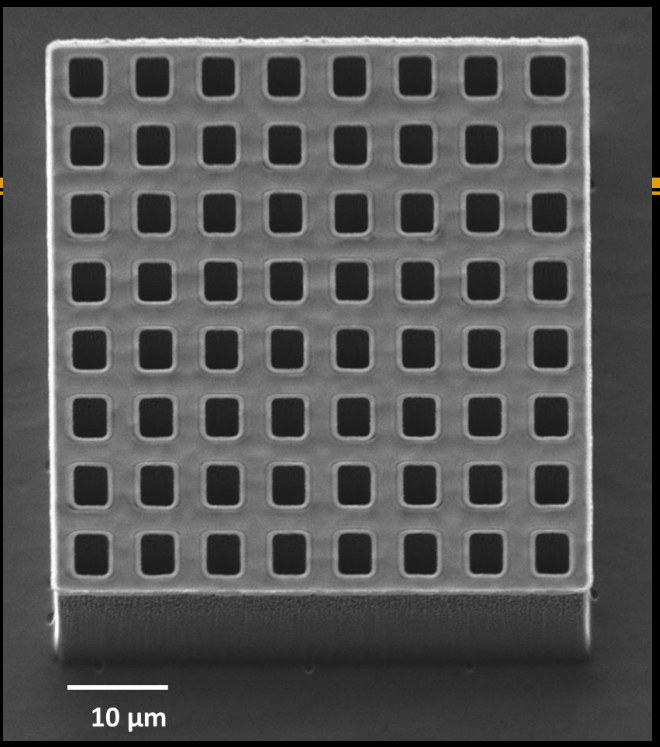
DLC Direct Write Patterning Technology

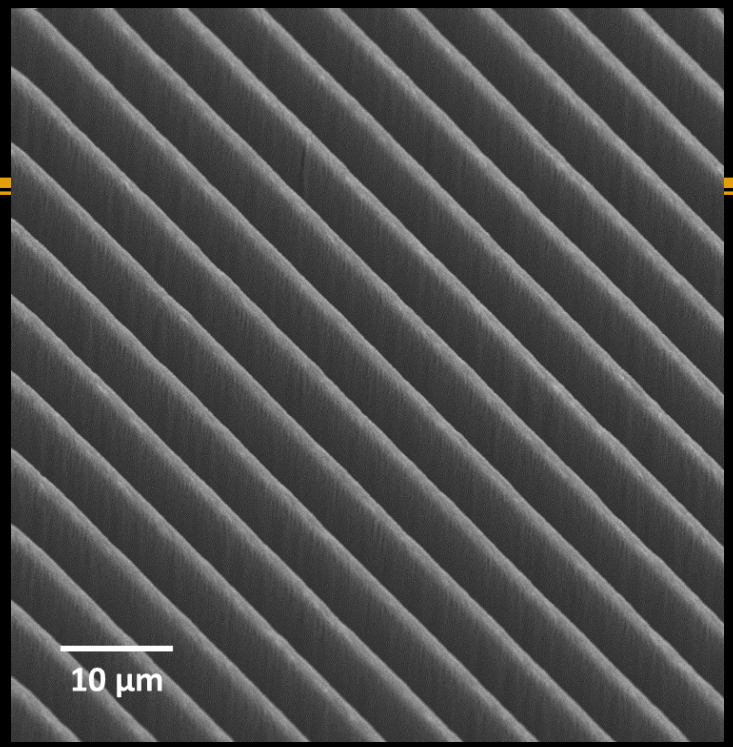
The benefit of using DLC coating for moulding:

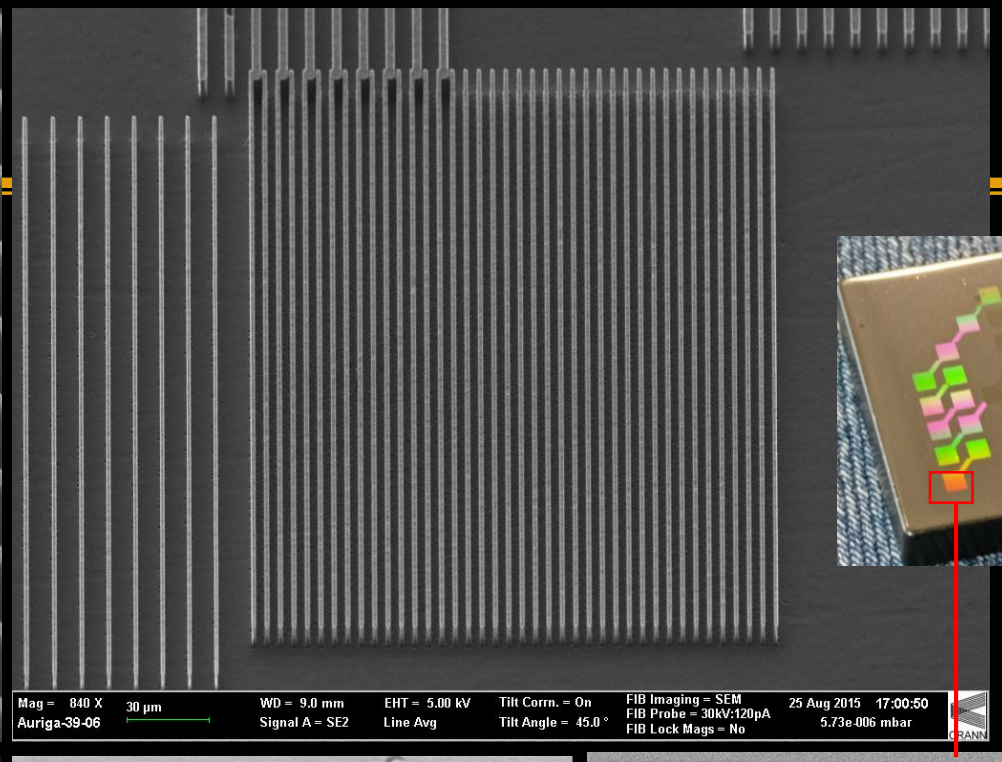
- Smooth conformal coatings from nm to tens of µm thickness
- Strong adhesion to tooling steel
- Low adhesion and friction to polymers and easy de-moulding
- Improved feature quality and integrity
- Low thermal expansion and high elastic modulus
- Low thermal conductivity protects melt temp during filling
- Enhanced die lifetime and reusability

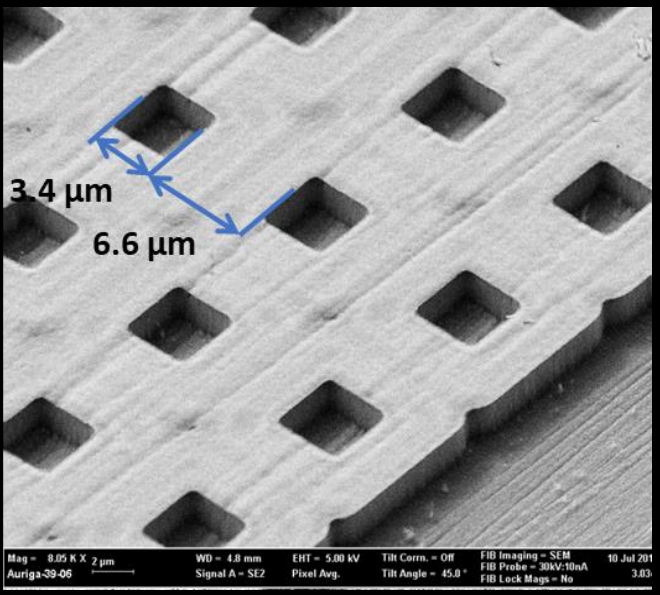
benefits of Direct Write Patterning with FIB:

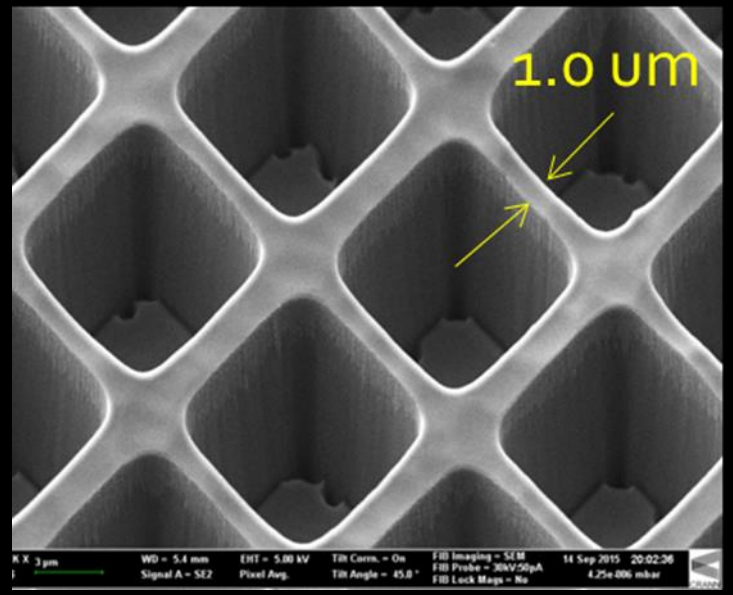
- Scalability: nm to 100 µm features over cm^2 range areas
- Resistless masking
- Compatibility to directly write patterns on non-planar surfaces
- High relief/aspect ratio small/large features can be produced
- Grey-scaling: Placing patterns of different height on the same mould
- Combining with conventional machining techniques such as mechanical milling and laser machining to create multi-scale features

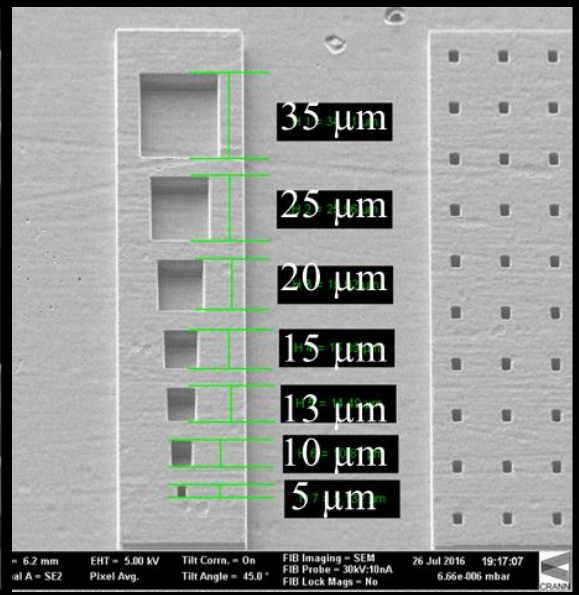

10 µm

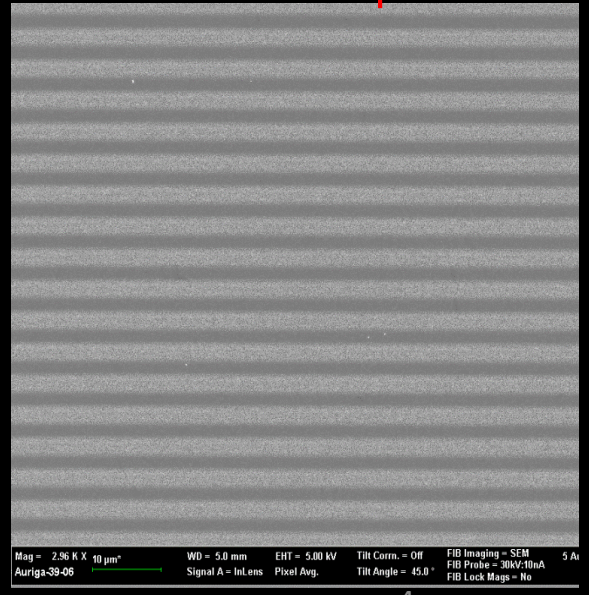

10 µm


Mag = 840 X
Auriga-39-06
30 µm
WD = 9.0 mm
Signal A = SE2
EHT = 5.00 kV
Line Avg
Tilt Corrn. = On
Tilt Angle = 45.0 °
FIB Imaging = SEM
FIB Probe = 30kV:120pA
FIB Lock Mags = No
25 Aug 2015 17:00:50
5.73e-006 mbar

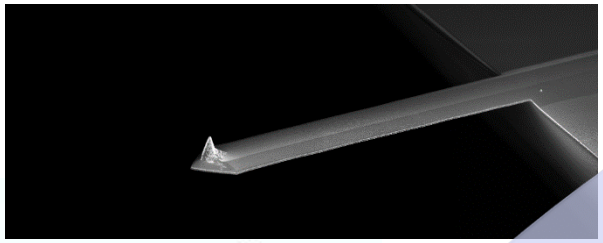

3.4 µm
6.6 µm

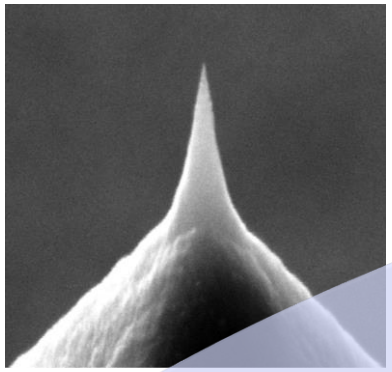

1.0 um

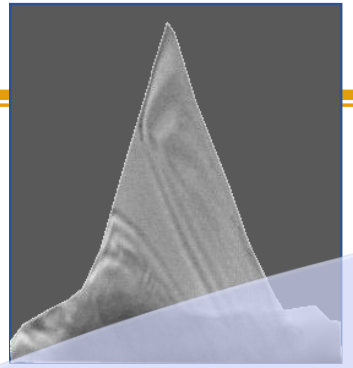

35 µm
25 µm
20 µm
15 µm
13 µm
10 µm
5 µm

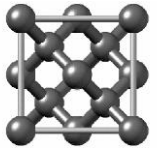


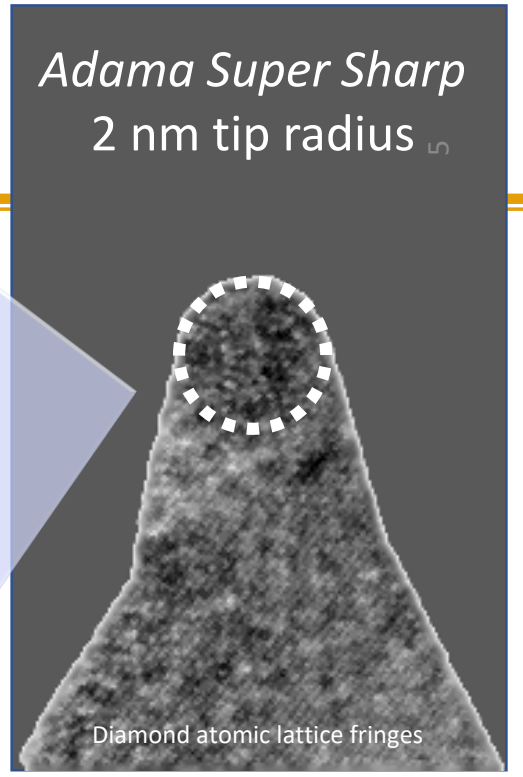
Diamond Probes

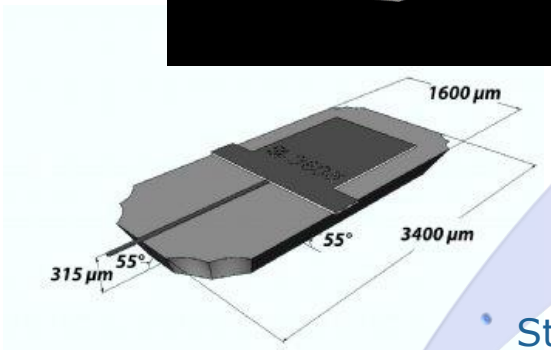












Standard Si chip

Diamond coated Si cantilever

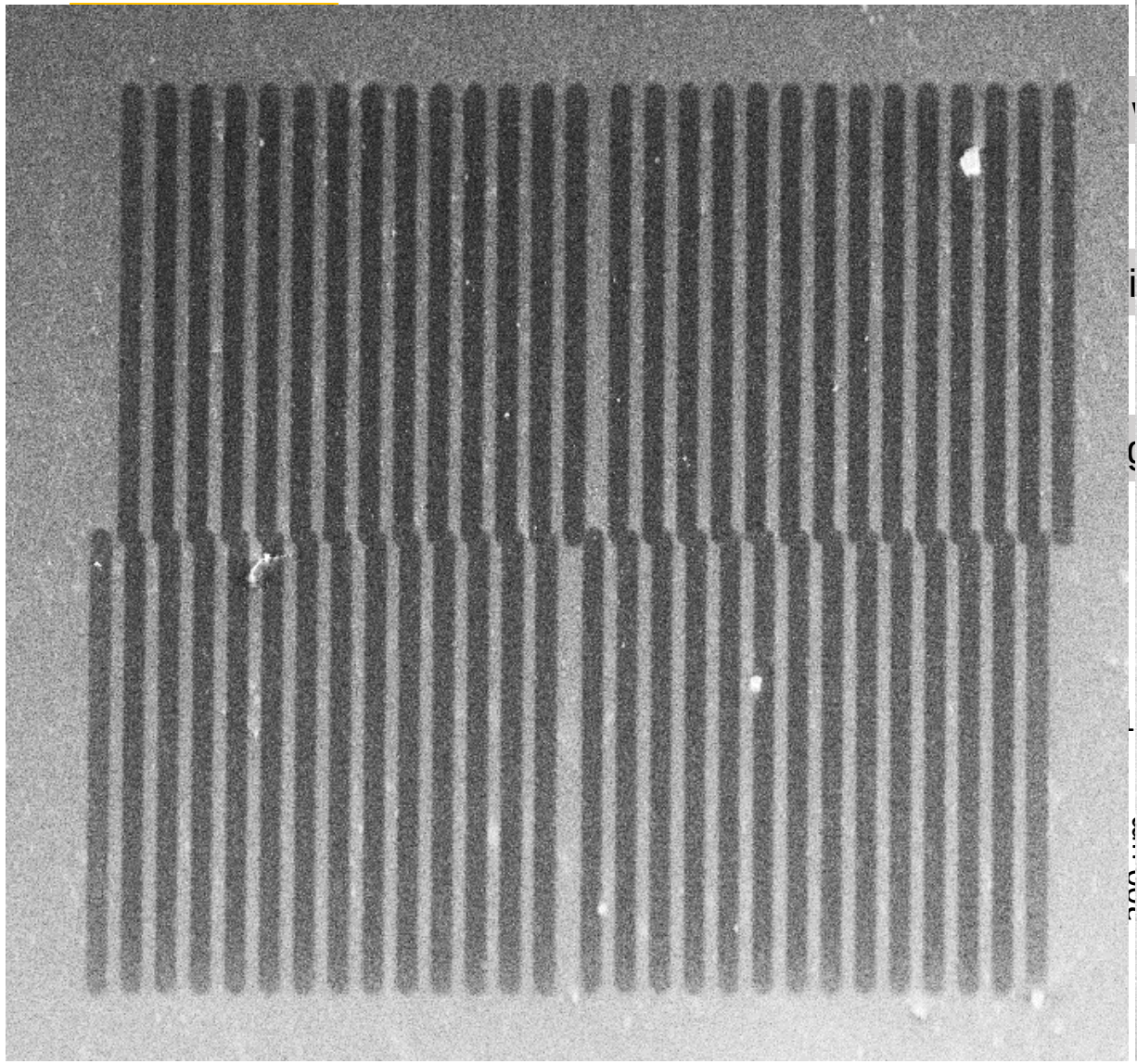
Diamond coated tip

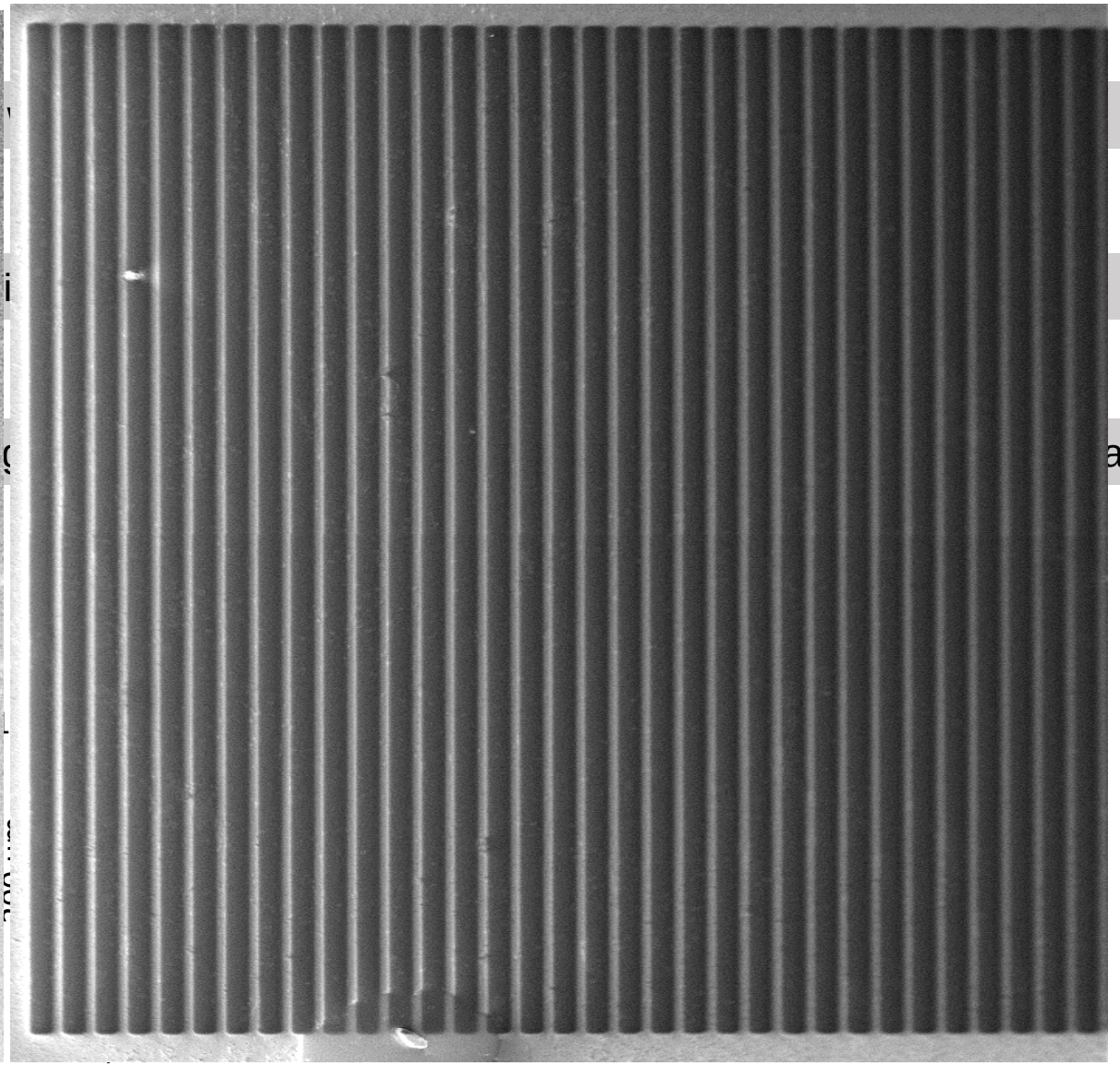
Single crystal apex

Super sharp diamond

Wafer scale diamond probe production

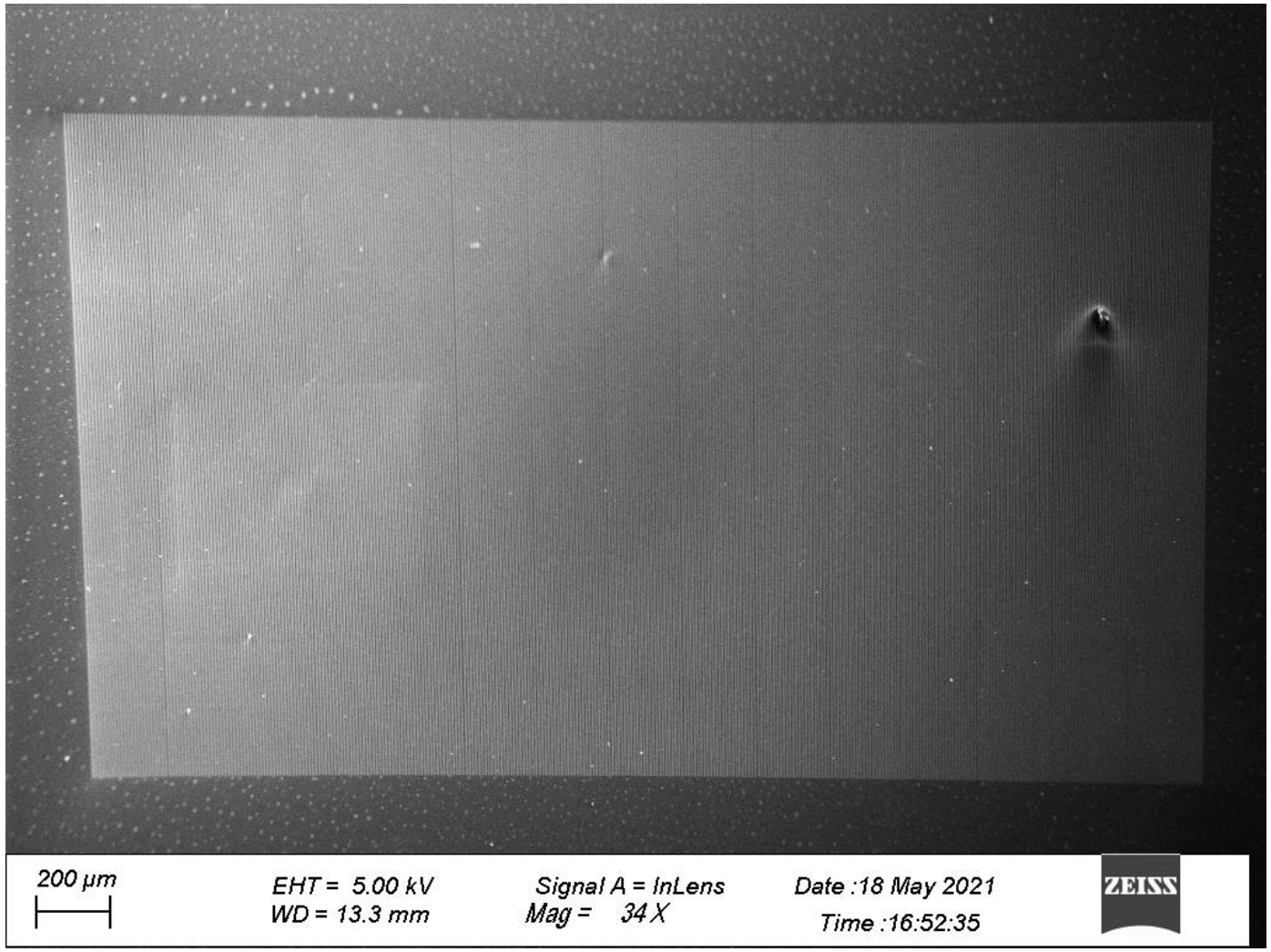
WP2-Task 2.1 - Tooling technologies

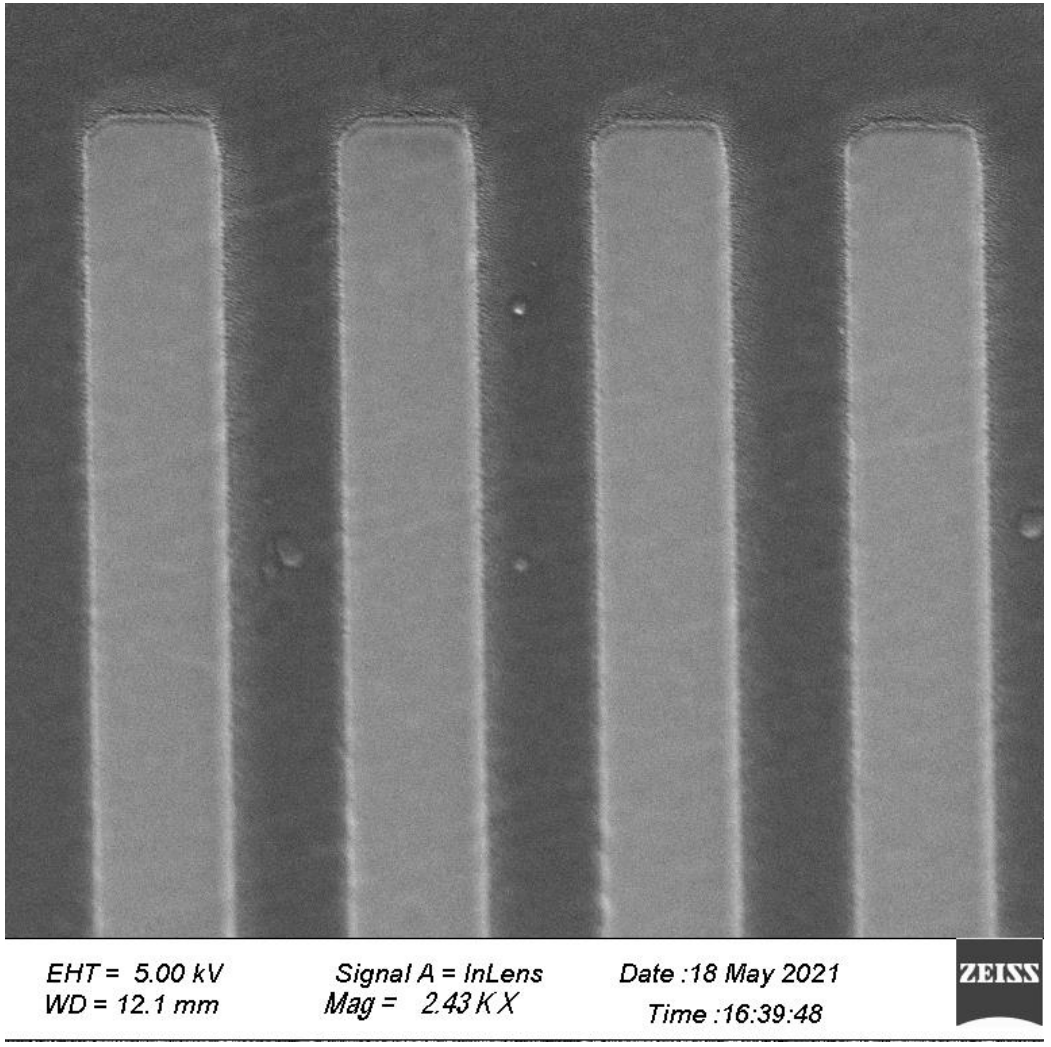




Task 2.1 - Tooling technologies

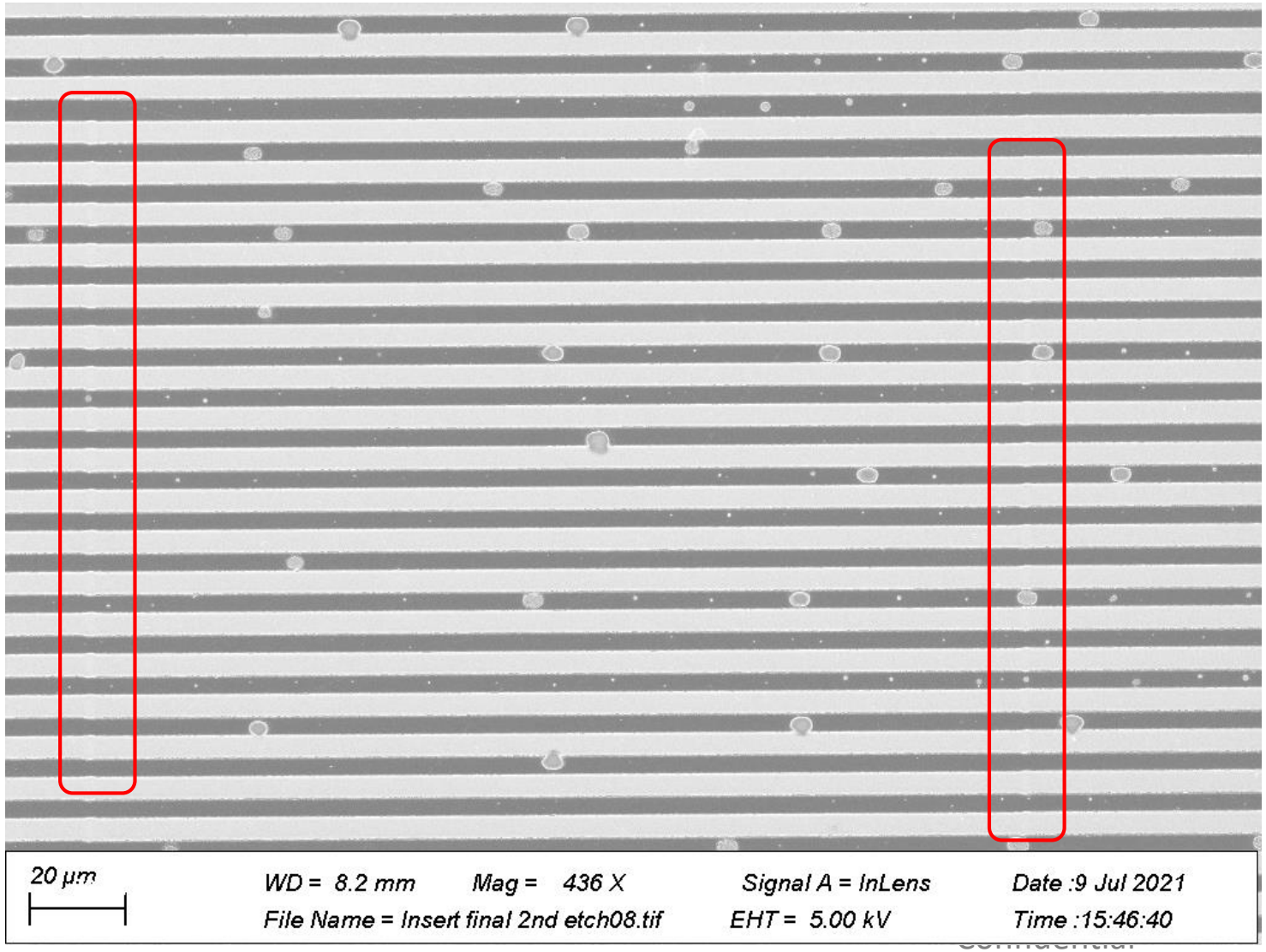
Last Iteration stitch free 3x1.8 mm 370 nm

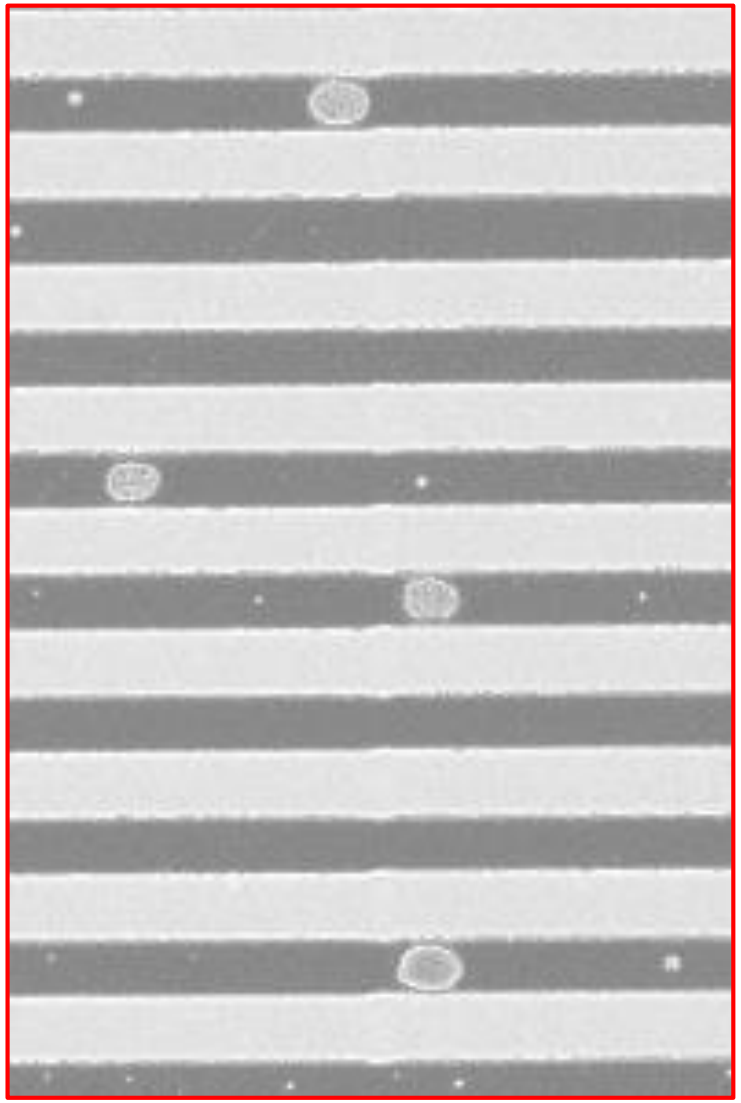




Task 2.1 - Tooling technologies

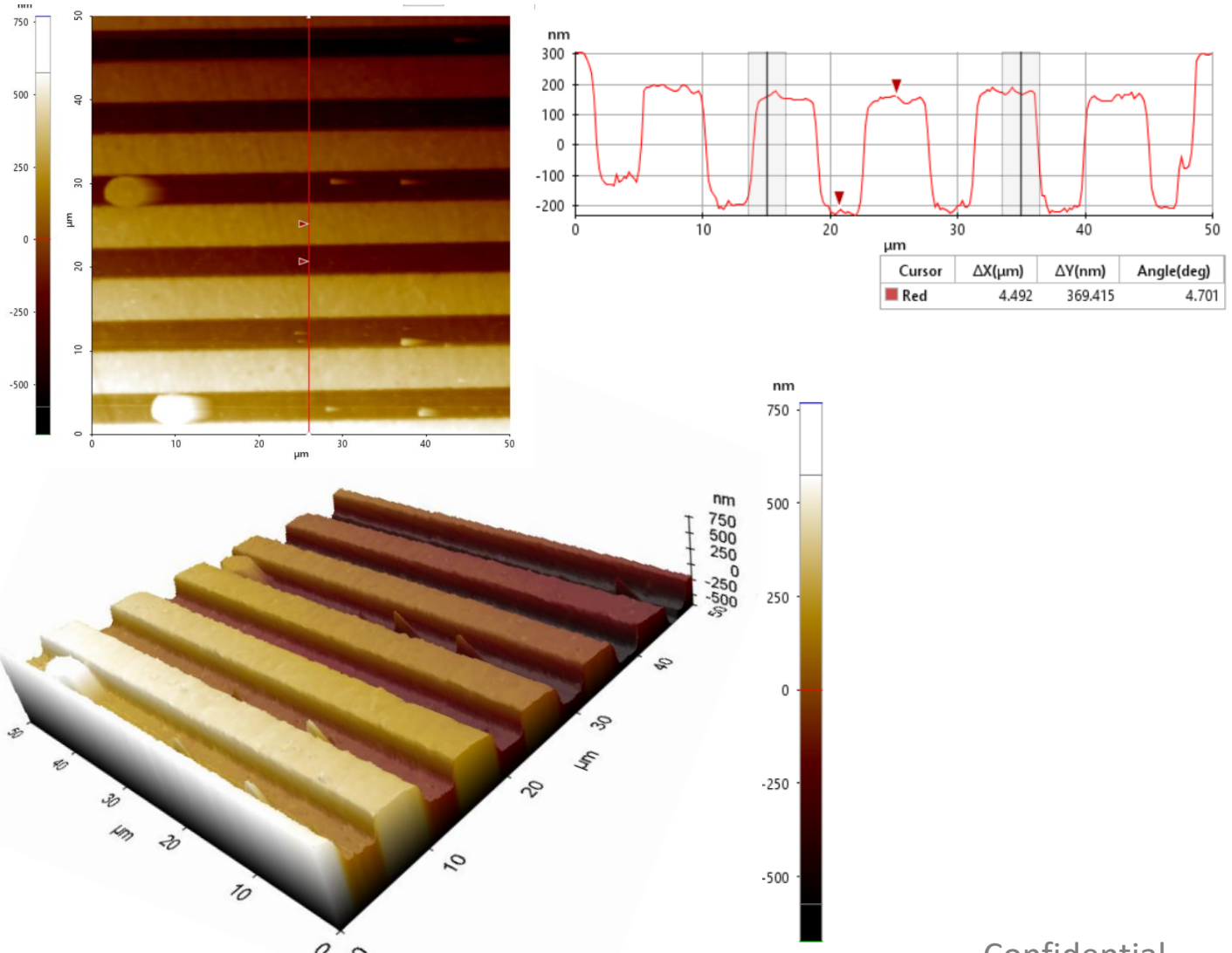
Stitching corrected, Pitch problem

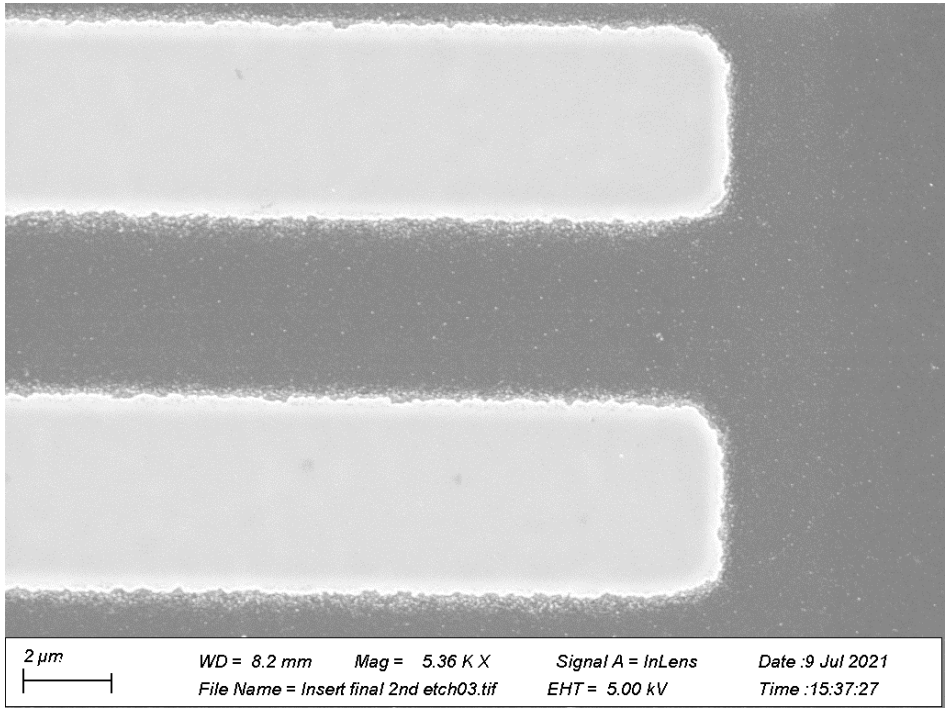




Task 2.1 - Tooling technologies

Mask quality and relief



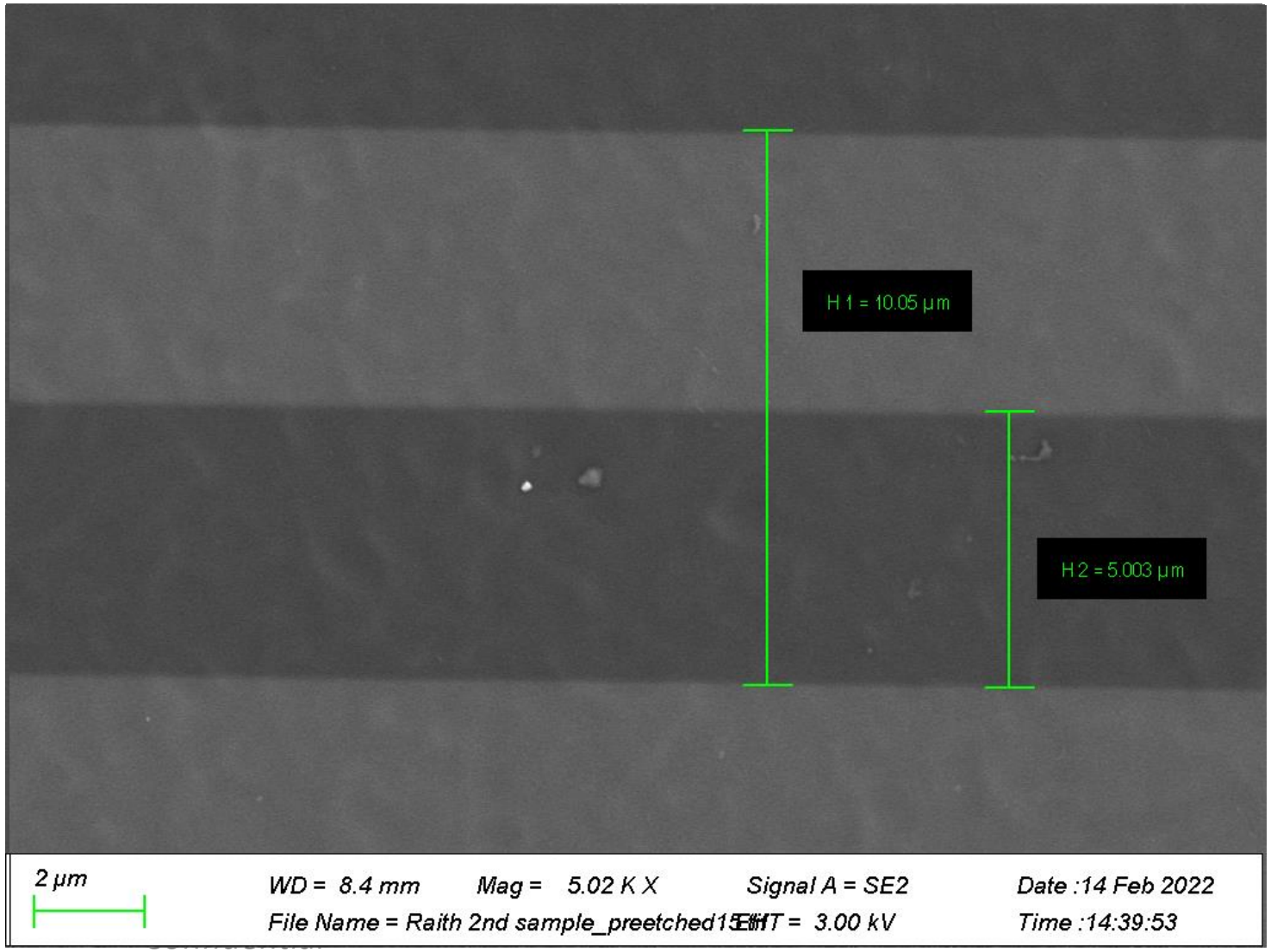


Correct dimensions and good quality of mask
Final relief depth of 370 nm after 2 step etching

Raith Velion ion lithography system with laser stage

- Ga^+ beam at 35 kV, Beam current: 1.35 nA
- Step size: 50 nm, Dose: 3200 µC/cm^2
- Write field (Stitch field) size: 100 µm
- Pitch: 10.05 µm, width: 5 µm
- Process time: 73 h

Stitch free, large 3x7 mm, pitch corrected 10.05 um



Summary

1. Stitching resolved for full grating
    - Stitching resolved in our Auriga system with conventional stage
    - Due to beam stability concerns over long writing time (around 70-90 hours), a version of full 3x7 mm grating was made with laser stage Velion FIB system in collaboration with Raith,
    - Two versions produced with dose area of 1600 and 3200 µC/cm^2 ready to etch. The FIB processing time for these gratings were 37 and 74 h respectively.
2. The etching equipment has been down for few month and we are optimising the etch parameter to use another system
3. After etching is done the inserts will be inspected by SEM, profilometer and AFM before they will be shipped to promolding for IM replication