

CROSS-SECTION SAMPLE PREPARATION USING FOCUSED ION BEAM SYSTEM (FIB) FOR TRANSMISSION ELECTRON MICROSCOPY (TEM)

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What is TEM?



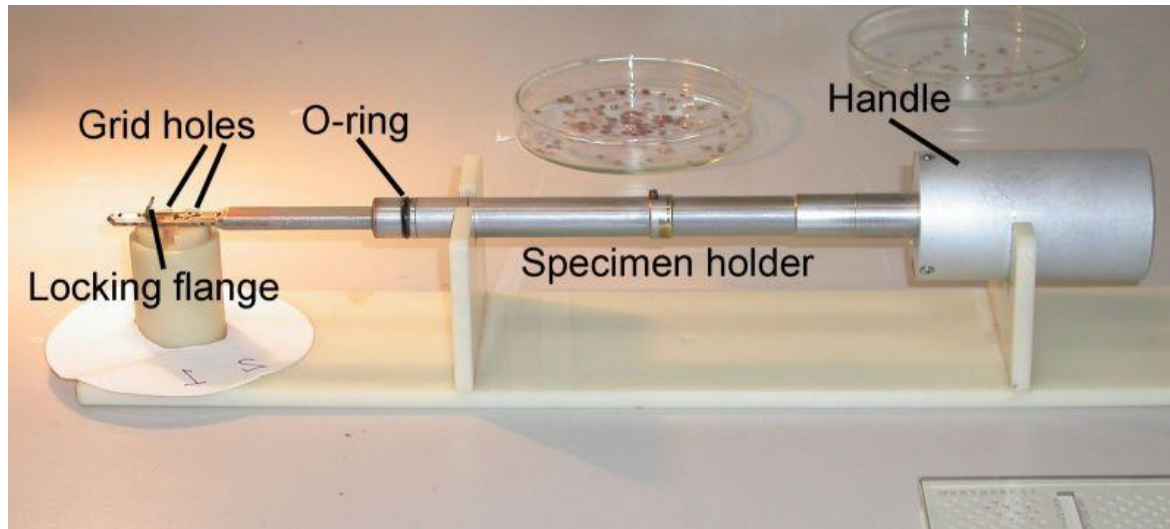
TEM Hitachi HT 7700

What can be observed by TEM:

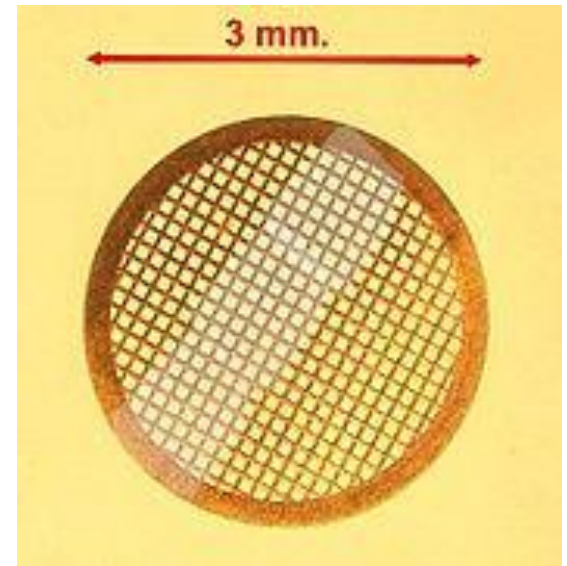
- Thin films and foils;
- meso- micro- and nanoparticles;
- biological specimens;

Basic requirements for TEM specimens:

- specimen thickness max 0.1 μm ;
- Stability under the electron beam and vacuum influence ;



TEM specimen holder



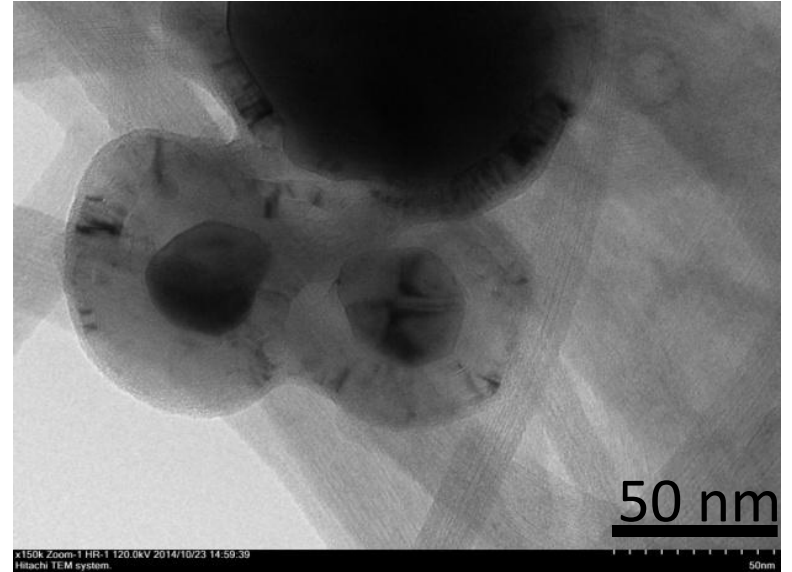
Supporting grid for TEM specimens



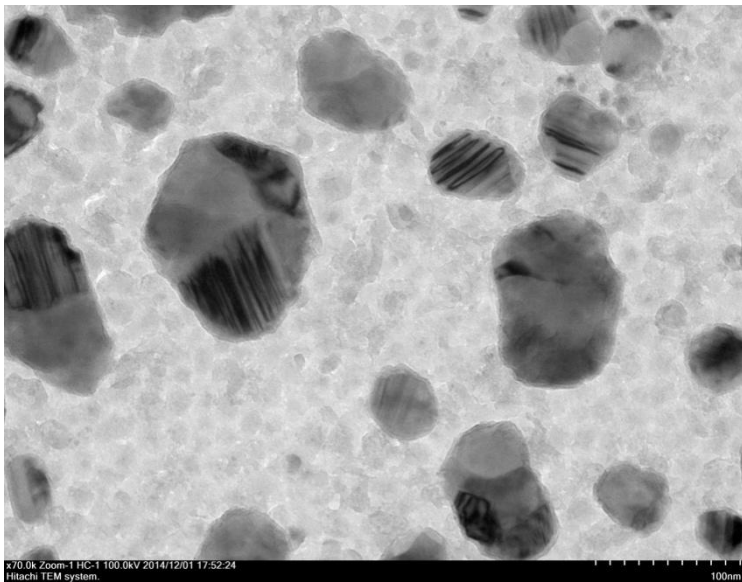
Examples



Ni-Ti thin foil



Ni nanoparticles (catalysts) and carbon nanotubes



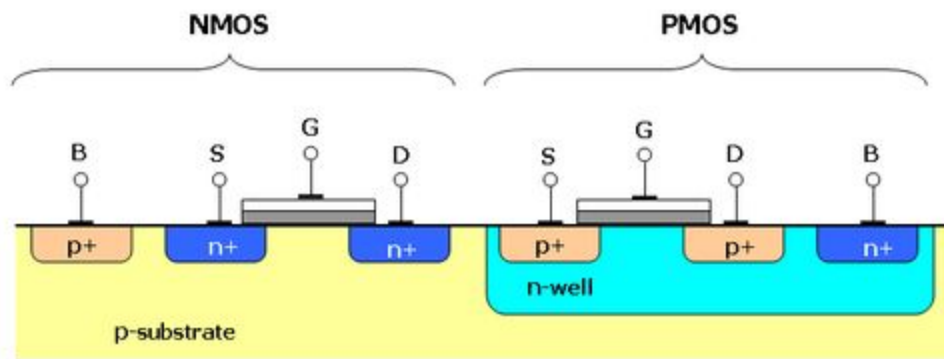
Co-Al₂O₃ thin film



Neothopanus nambi (lat.) biological specimen

What is “cross-section”?

cross-section is basic method of observation multi layers structures

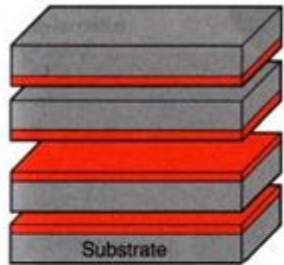


cross-section method allows to observe:

- Interface;
- Thickness of layers;
- Structural defects;
- Interlayer boundaries;

Classic method of cross-section sample preparation

1



Thin film

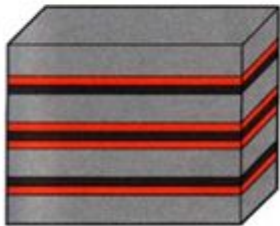
Four pieces of specimens on the silicon substrate are glued together.

Billet dimensions:

Length 10 mm

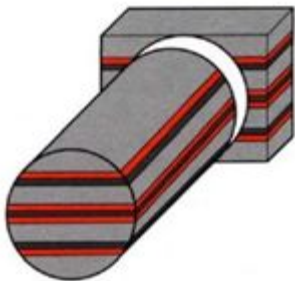
Width 5 mm

Height 5 mm



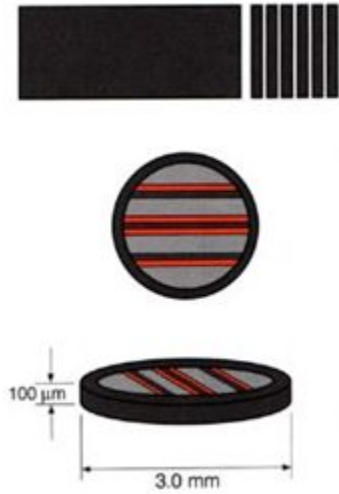
Glue

2



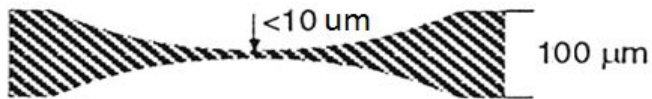
cutting 3 mm dia. cylinder for cross-section

3

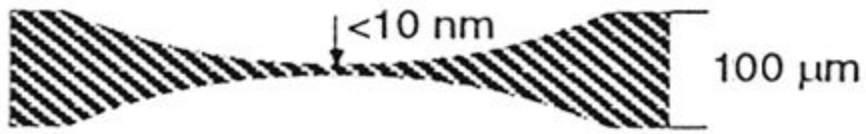


sawing disc of $100\ \mu\text{m}$ thickness

4 Thinning the disk up to 10 microns by Dimple Grinder System (Gatan)



5



Thinning the disk up to 10 nm by Precision Ion Polishing System (PIPS)



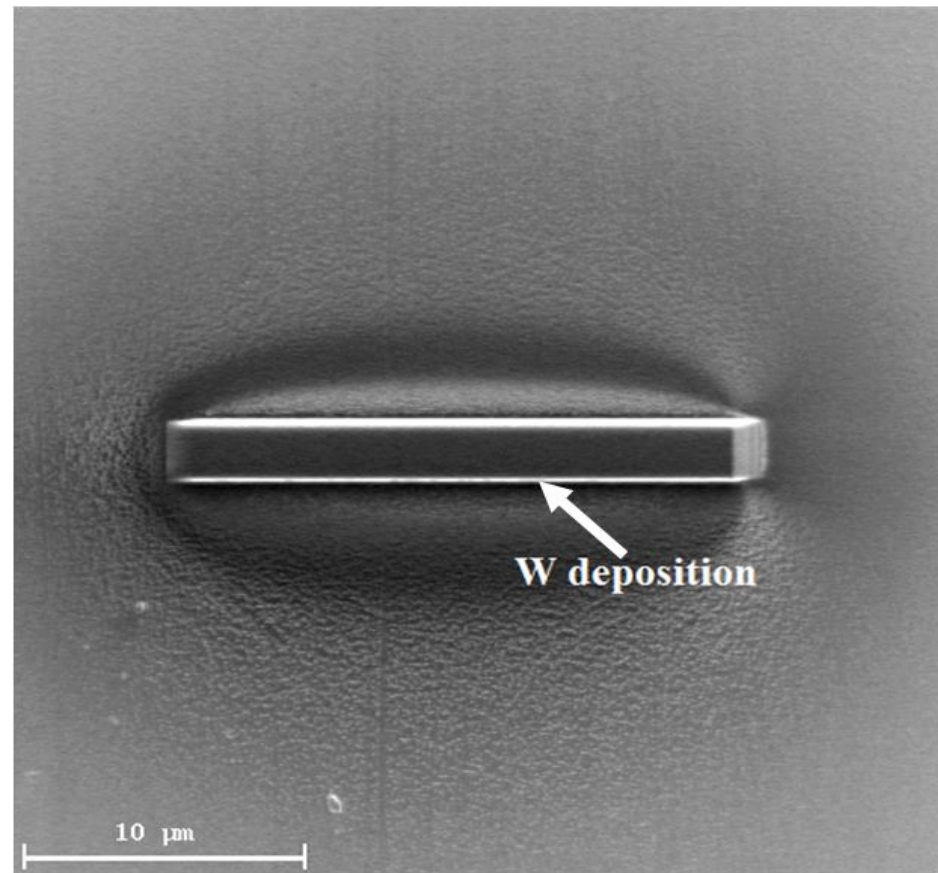
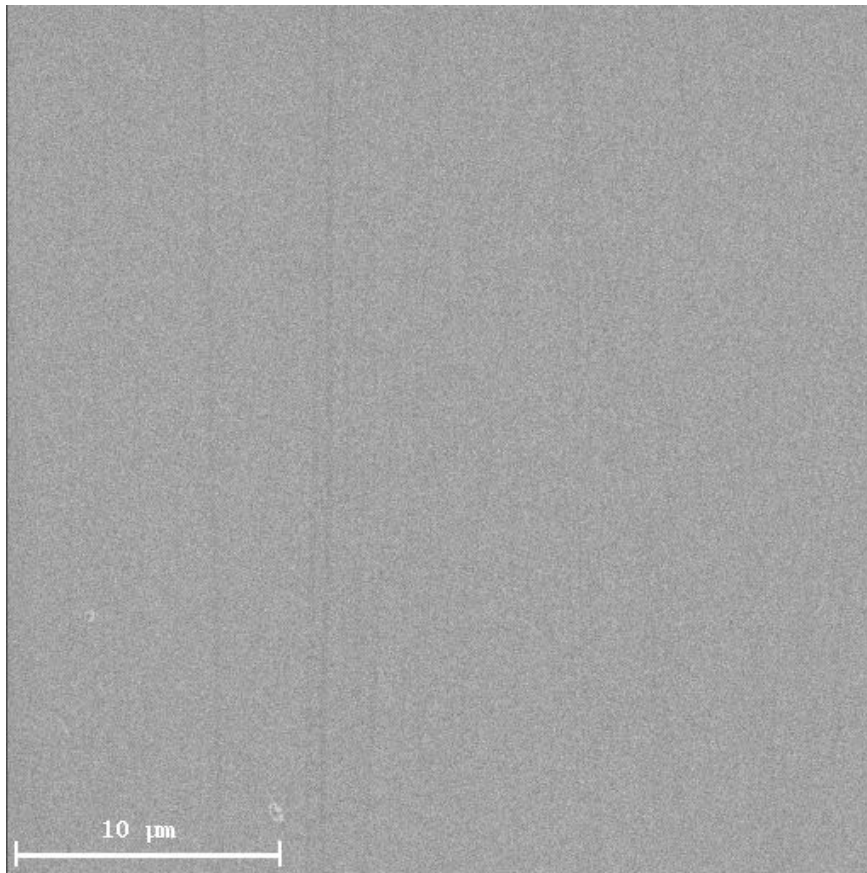
Modern method of cross-section sample preparation



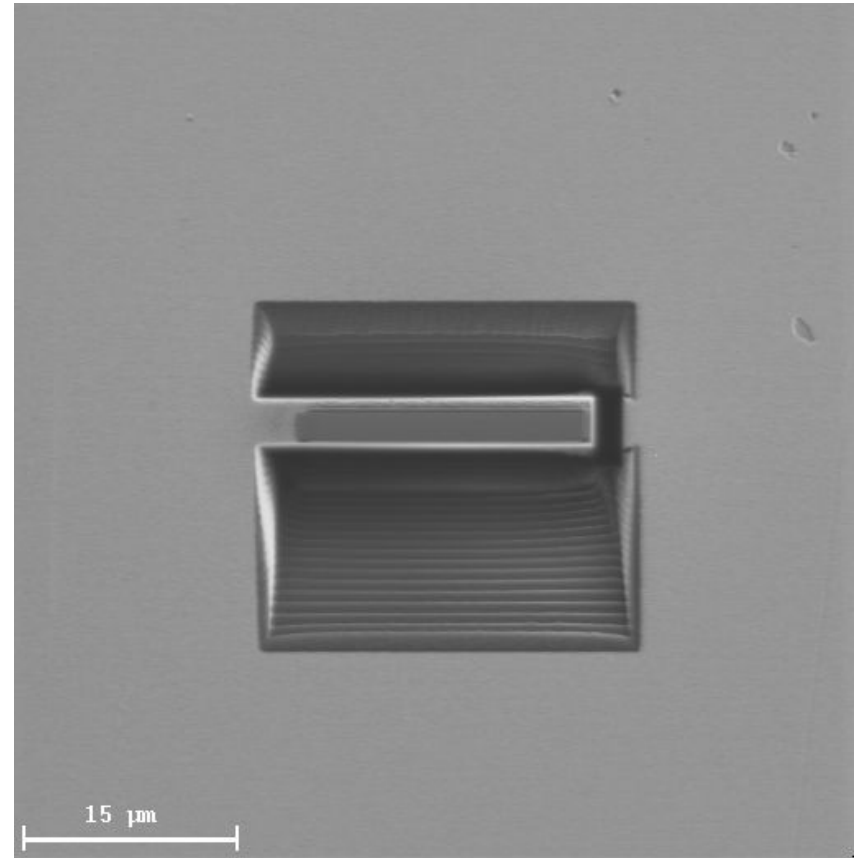
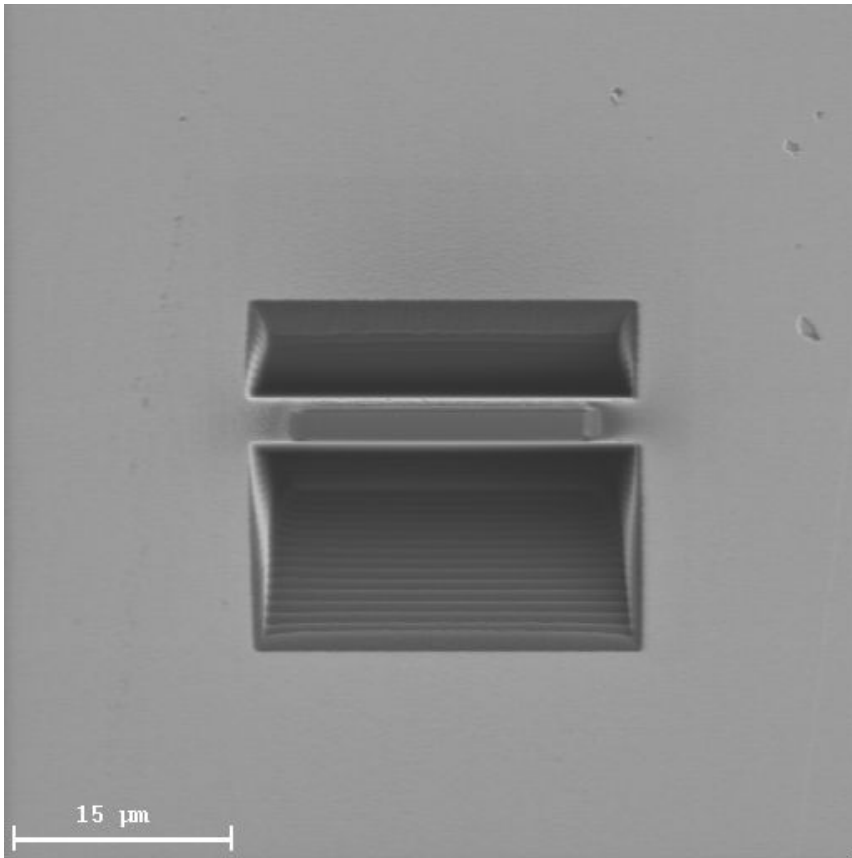
Focused Ion Beam System (FIB) Hitachi FB 2100

Basic steps of cross-section sample preparation by FIB

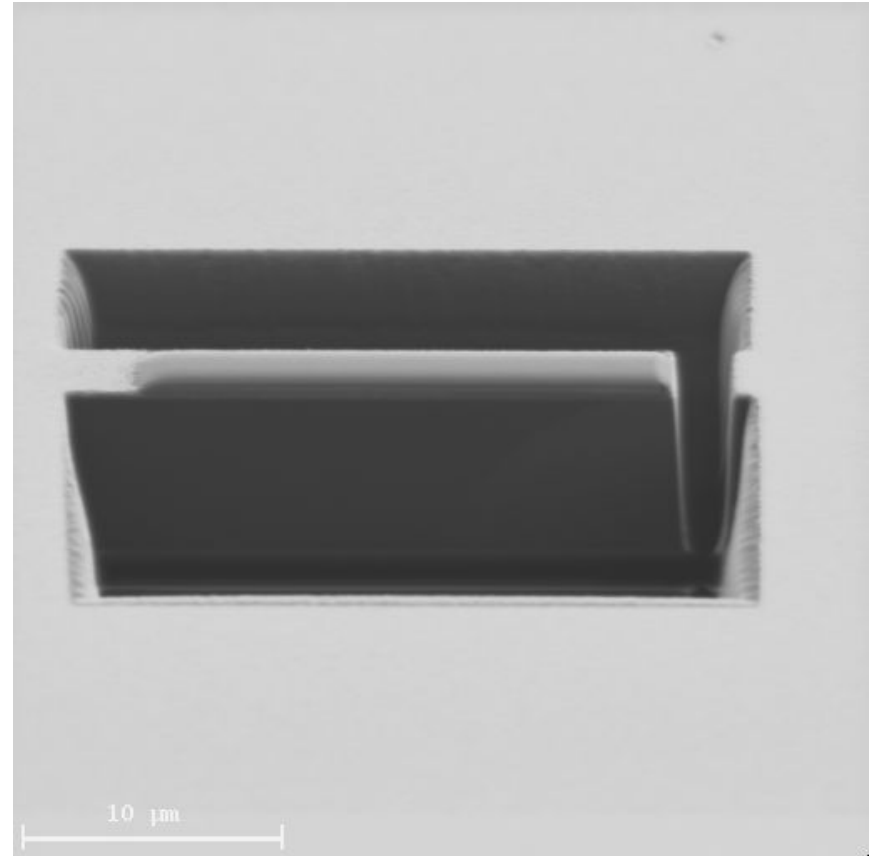
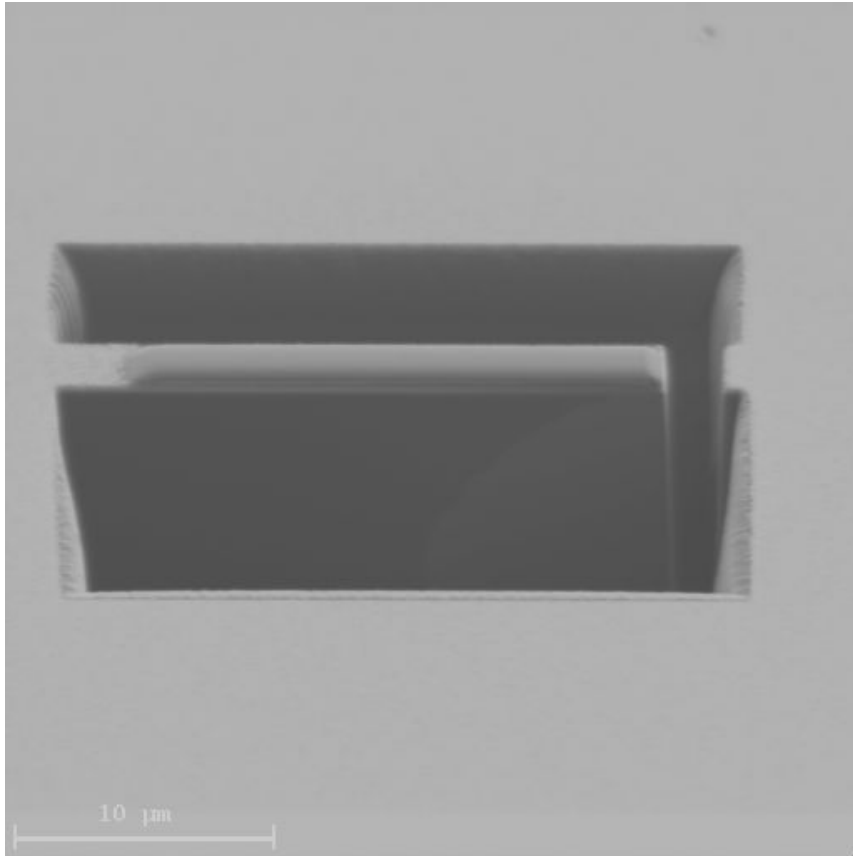
1. Deposition of protective tungsten coating on the sample surface



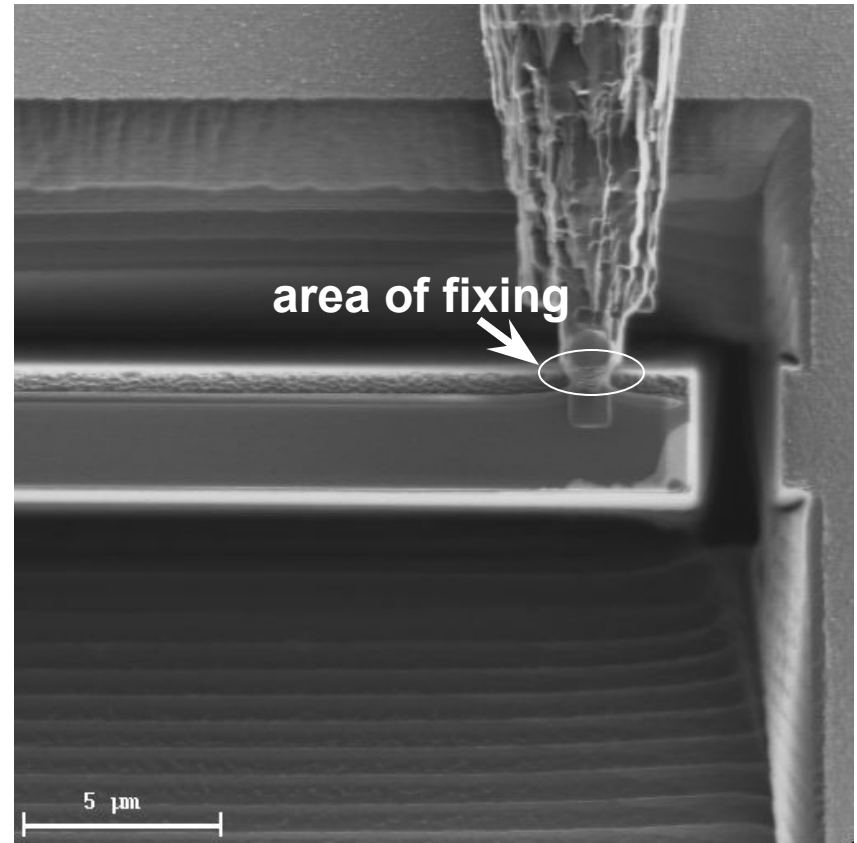
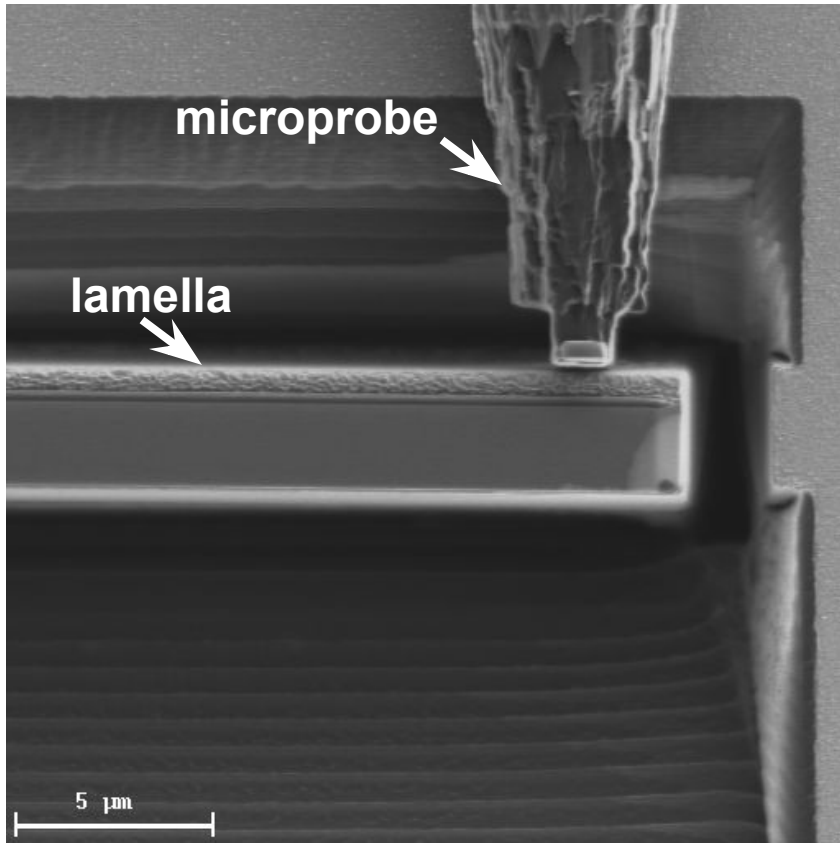
2. Cutting half-finished (lamella)



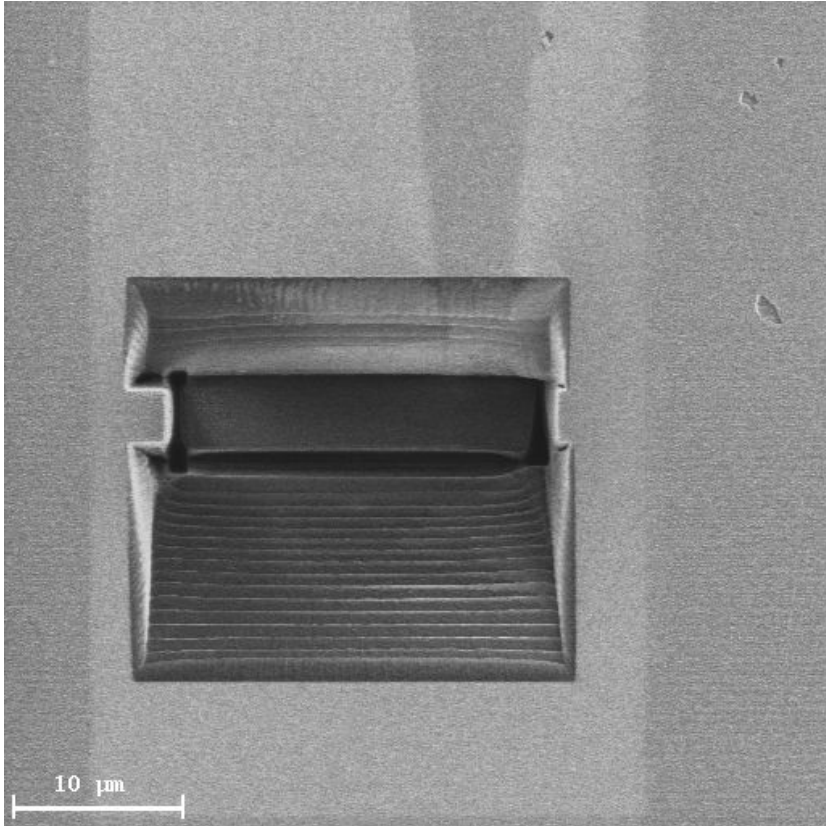
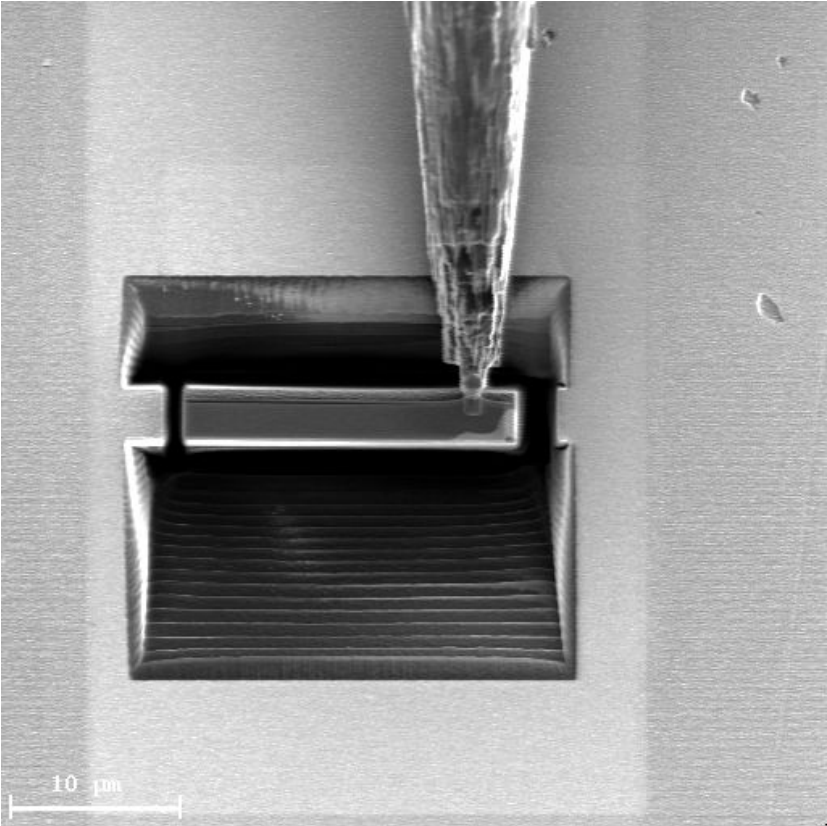
2. Cutting lamella (continuation)



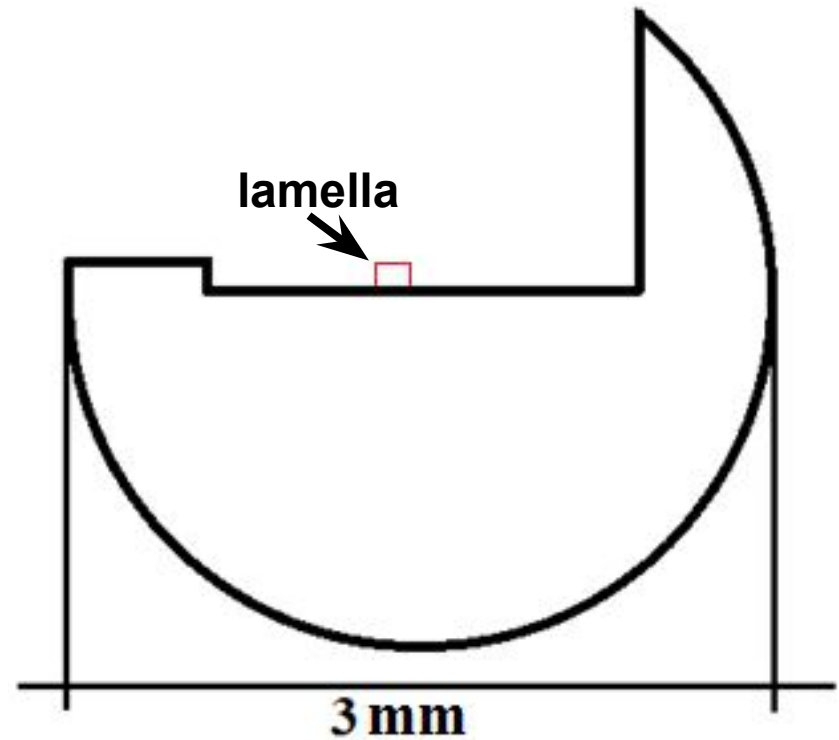
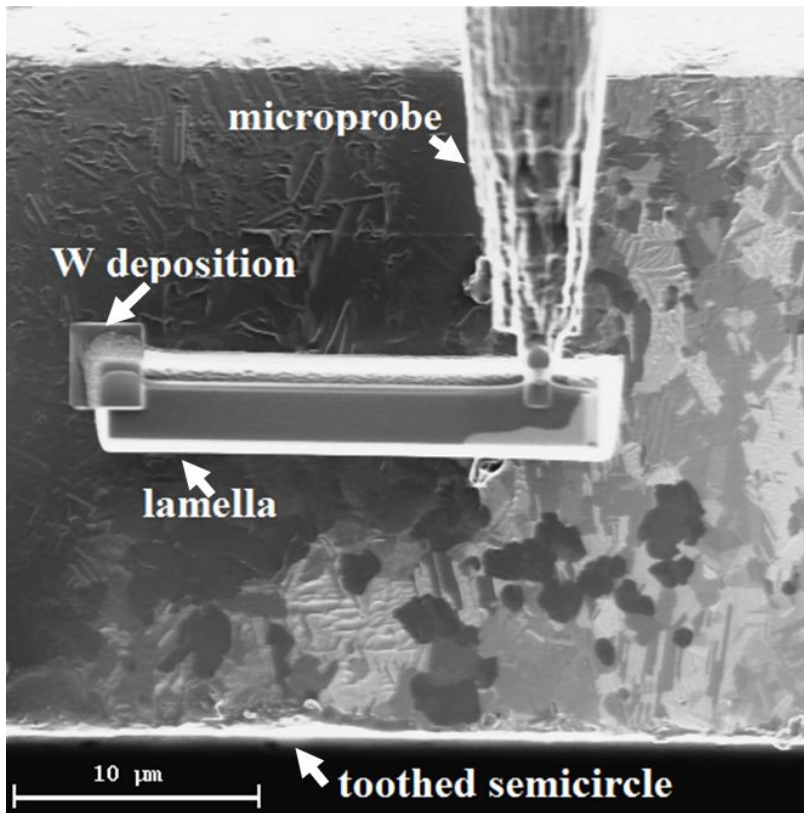
3. Fixing microprobe



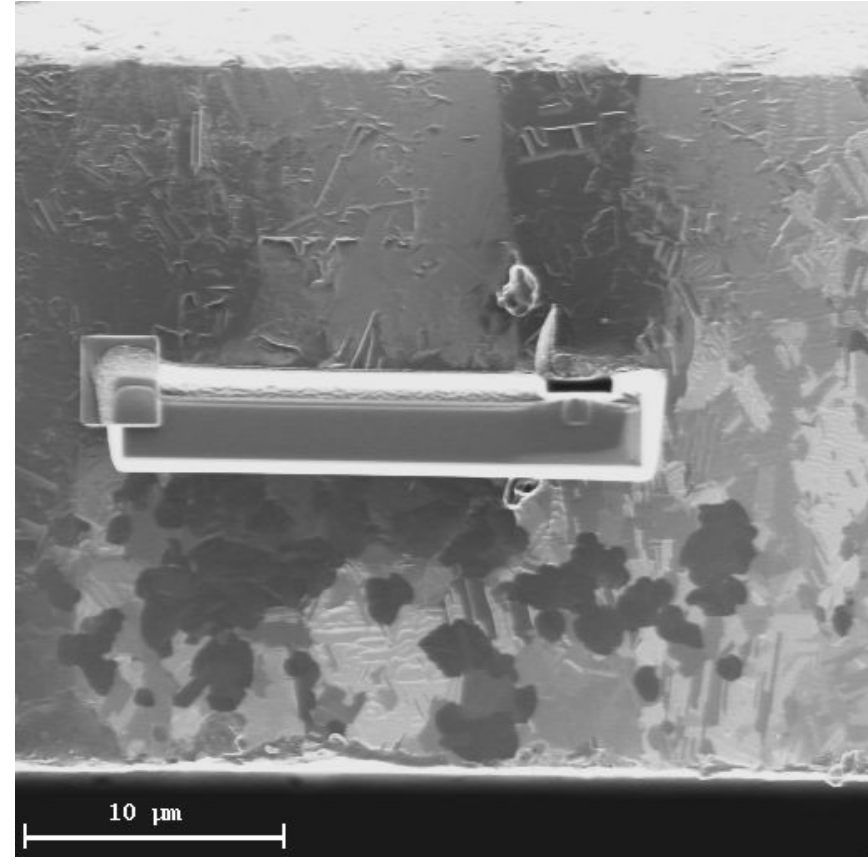
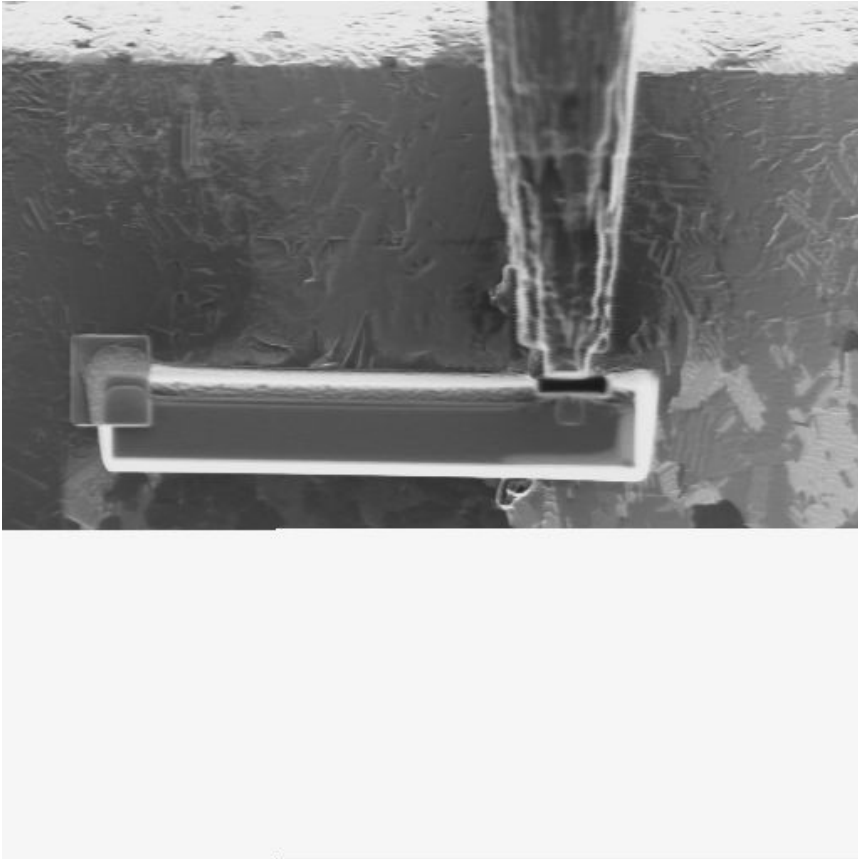
4. Cutting left side and removing lamella



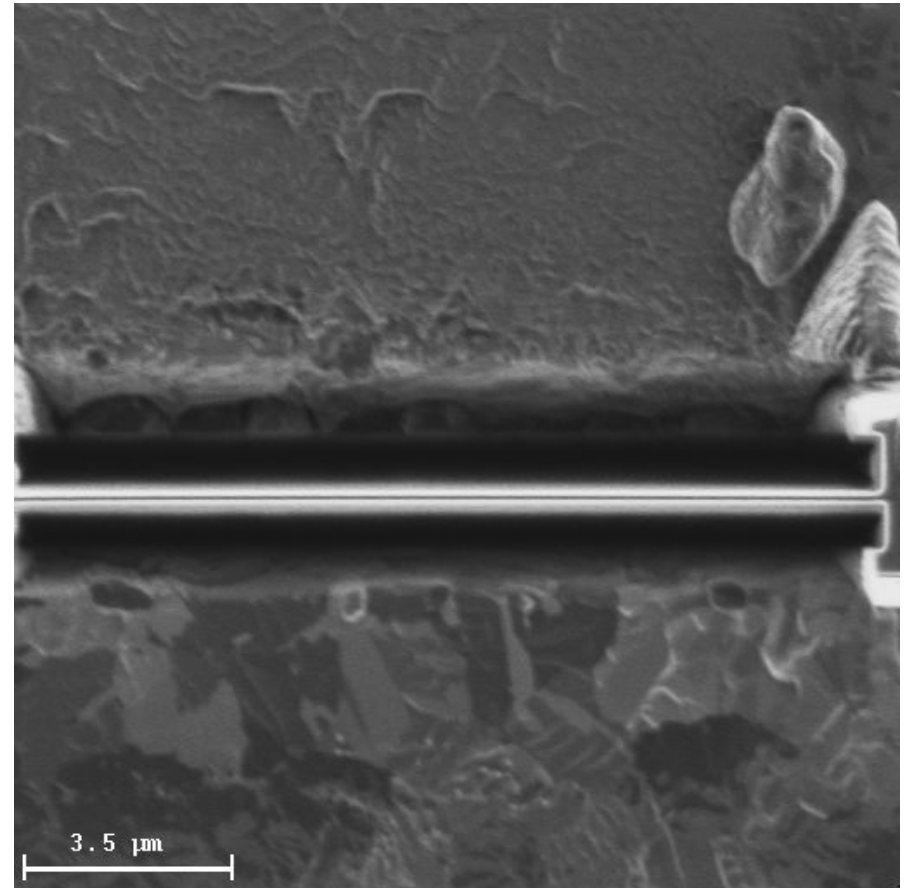
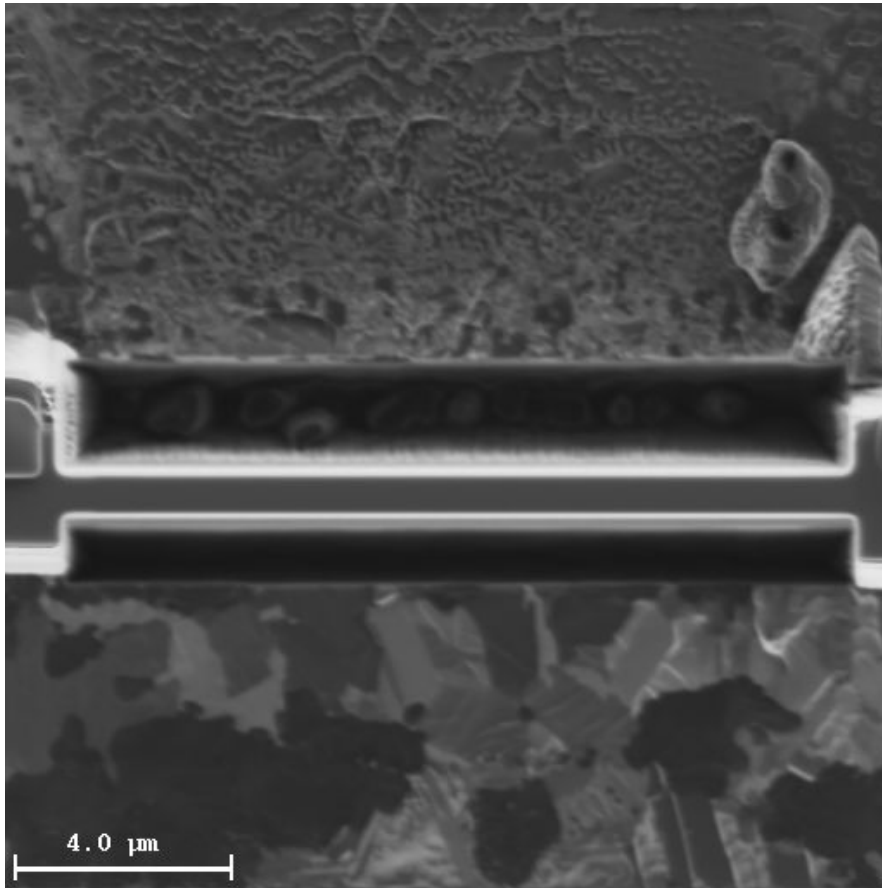
5. Fixing lamella on the toothed semicircle



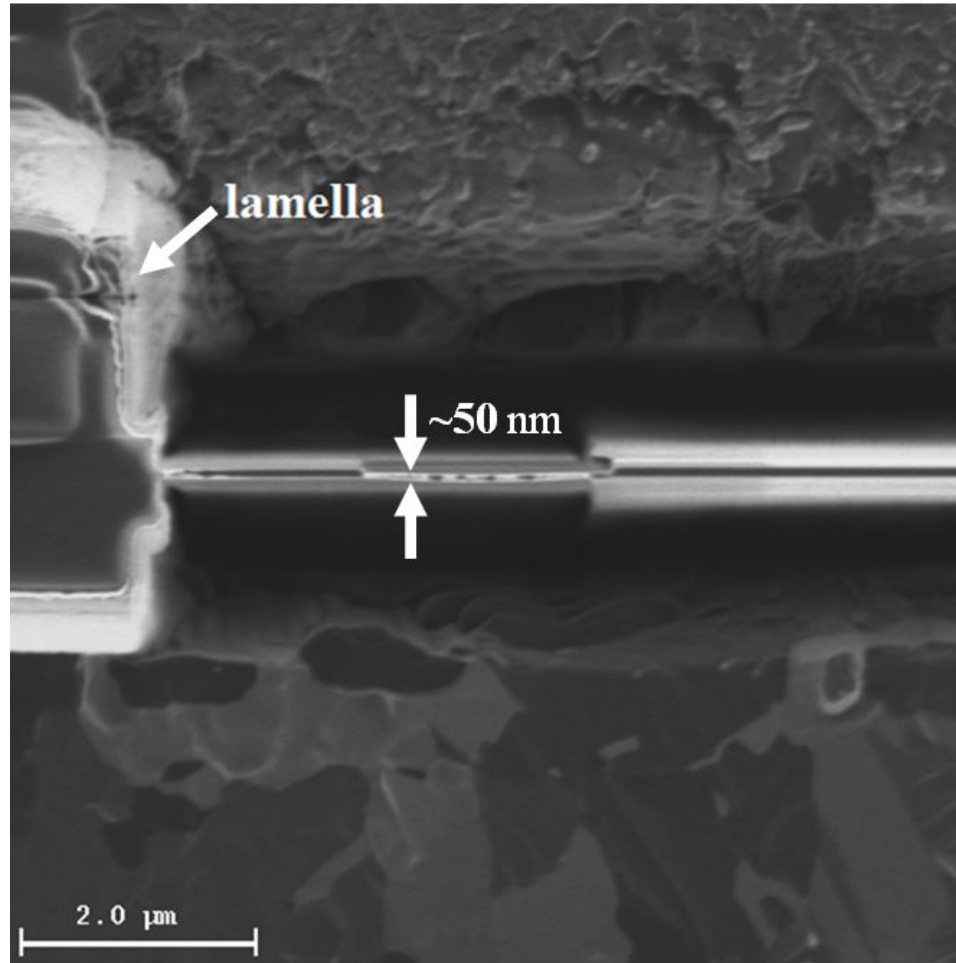
6. Cutting and removing microprobe



7. Thinning specimen to 50-100 nm

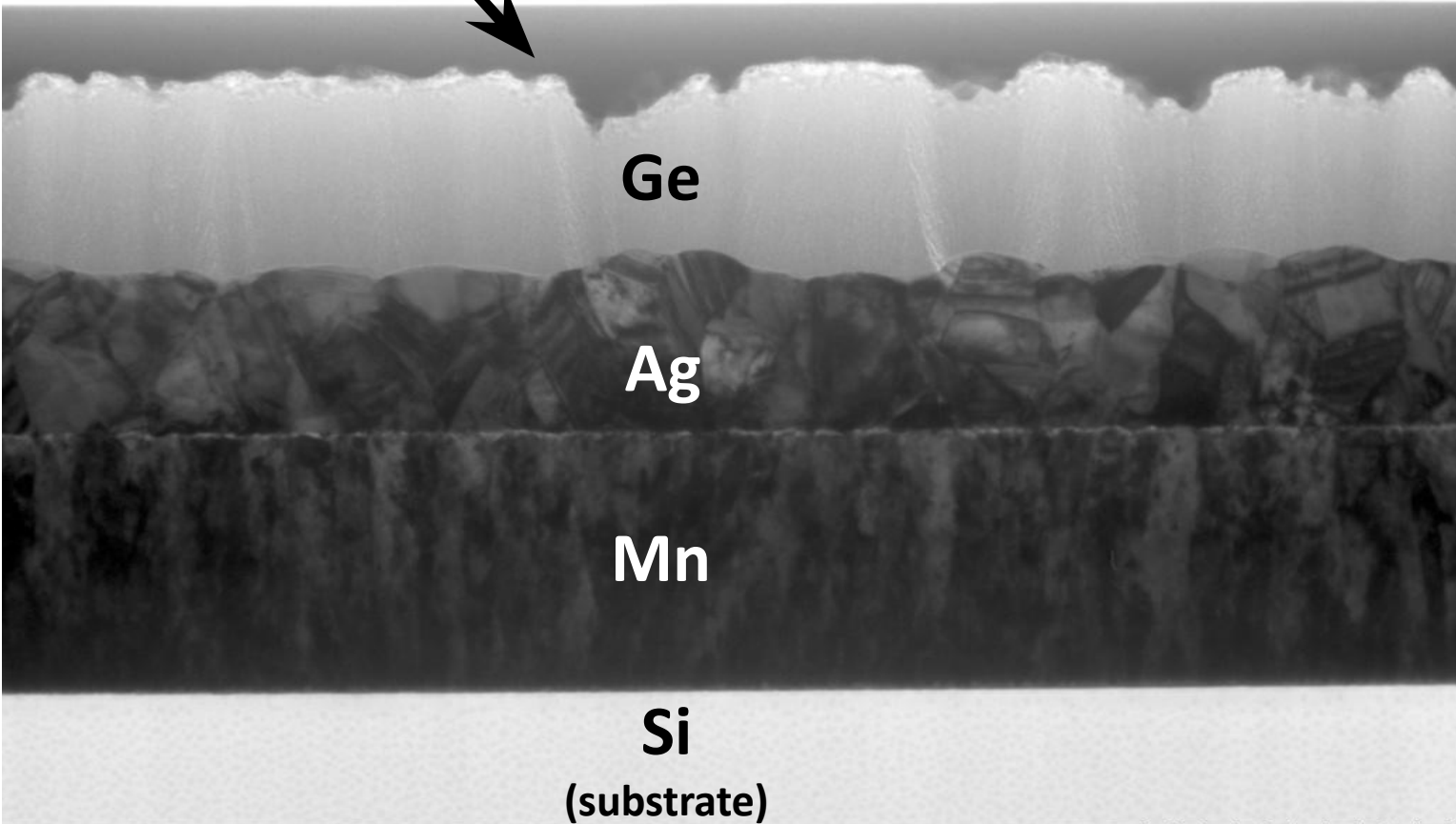


Finish result



Some features sample preparation with thin layers (thickness less than 300 nm)

Protective film (W)



Ge

Ag

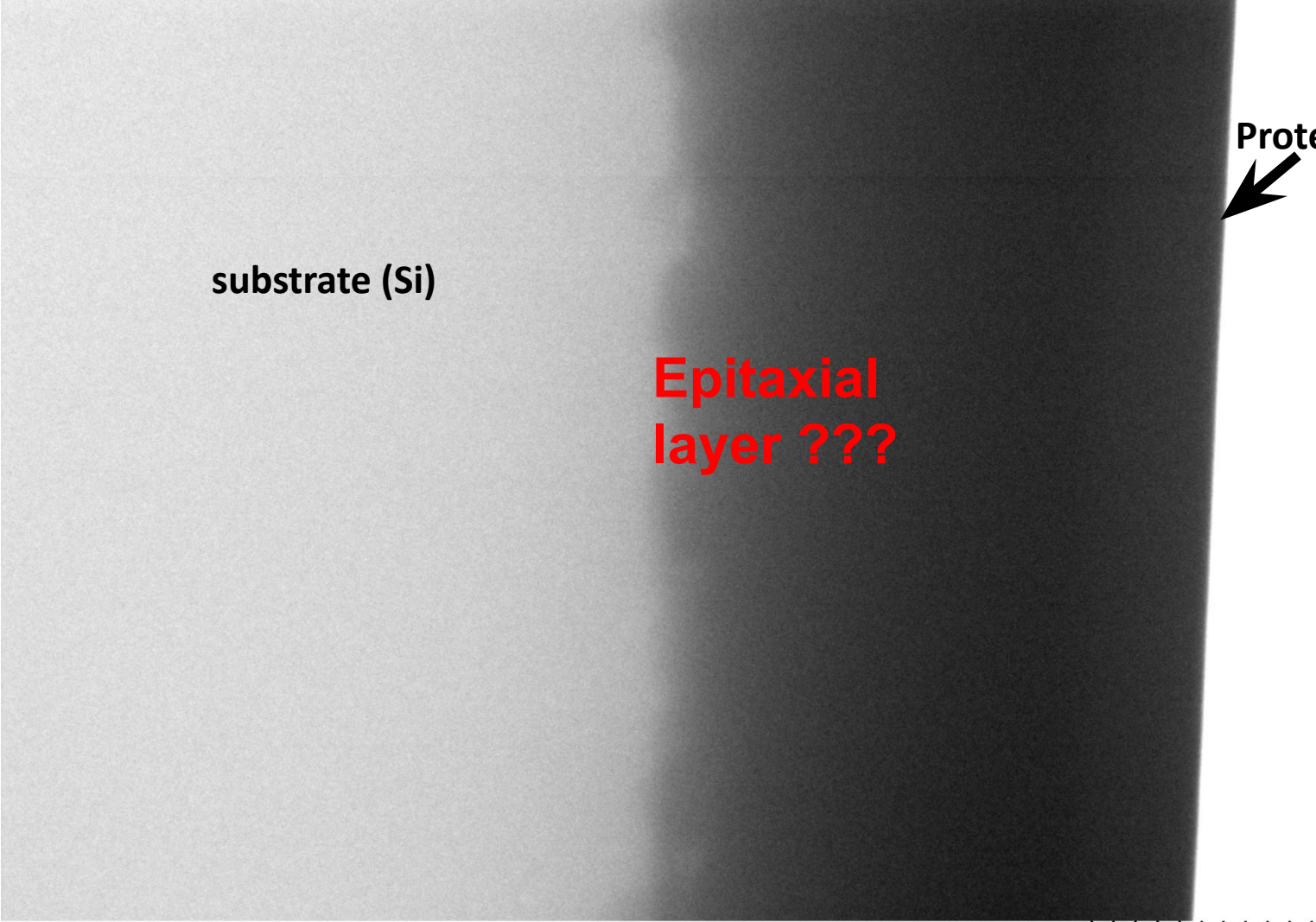
Mn

Si

(substrate)

File name=Img0932.jpg
Image comment=Hitachi TEM system.

500nm



substrate (Si)

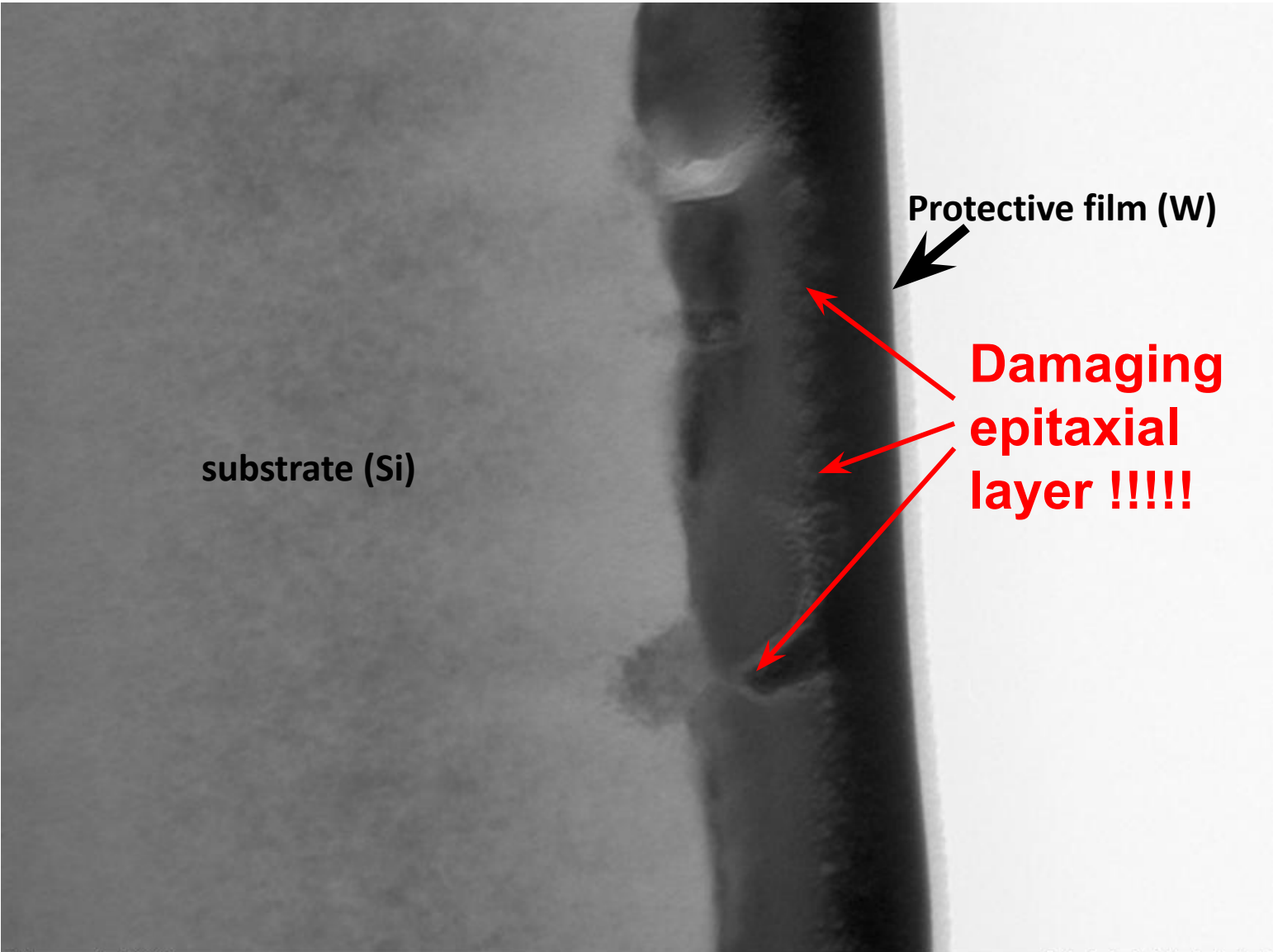
Epitaxial
layer ???

Protective film (W)



File name=Img0875.jpg
Image comment=Hitachi TEM system.

200nm



substrate (Si)

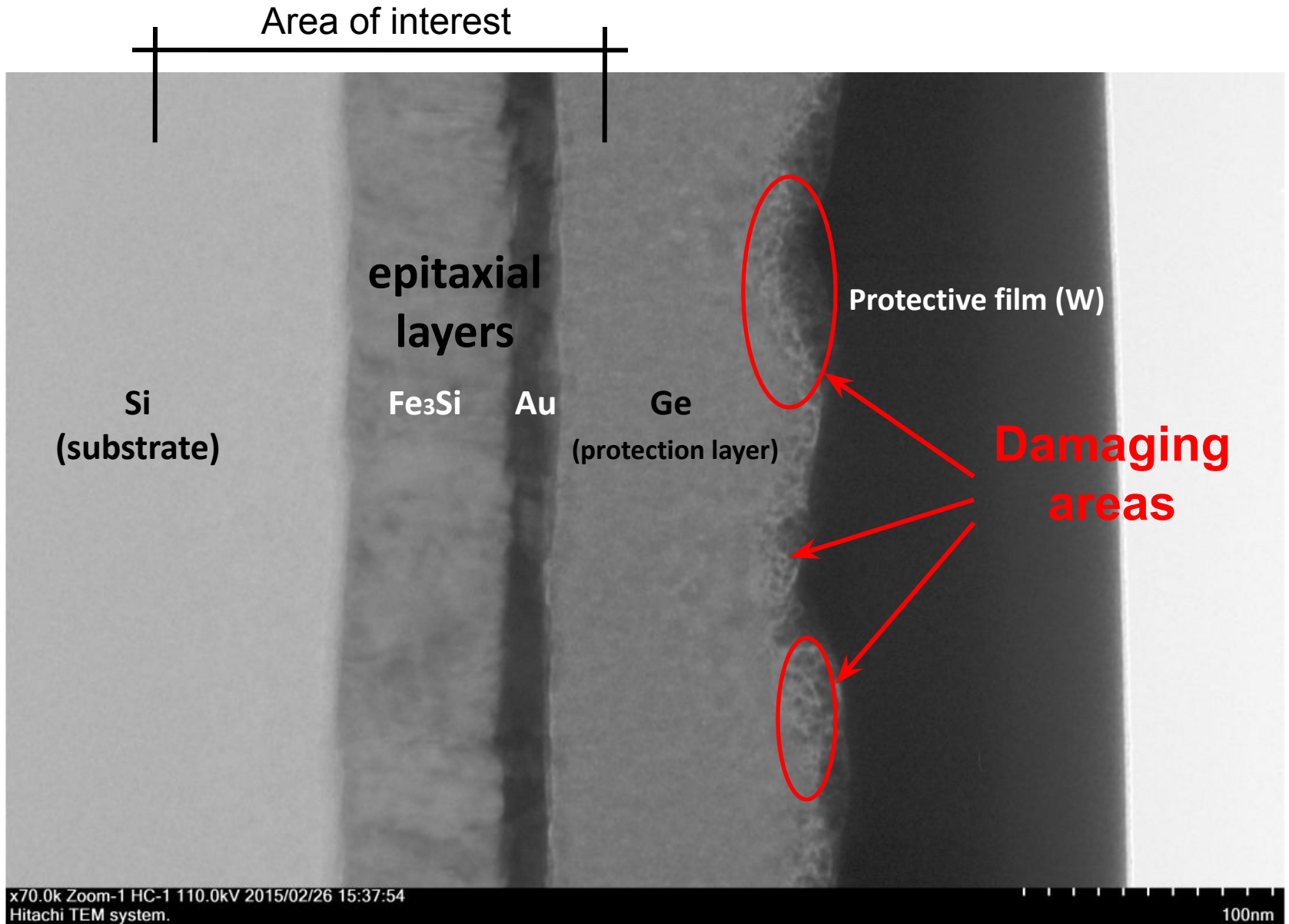
Protective film (W)

**Damaging
epitaxial
layer !!!!!**

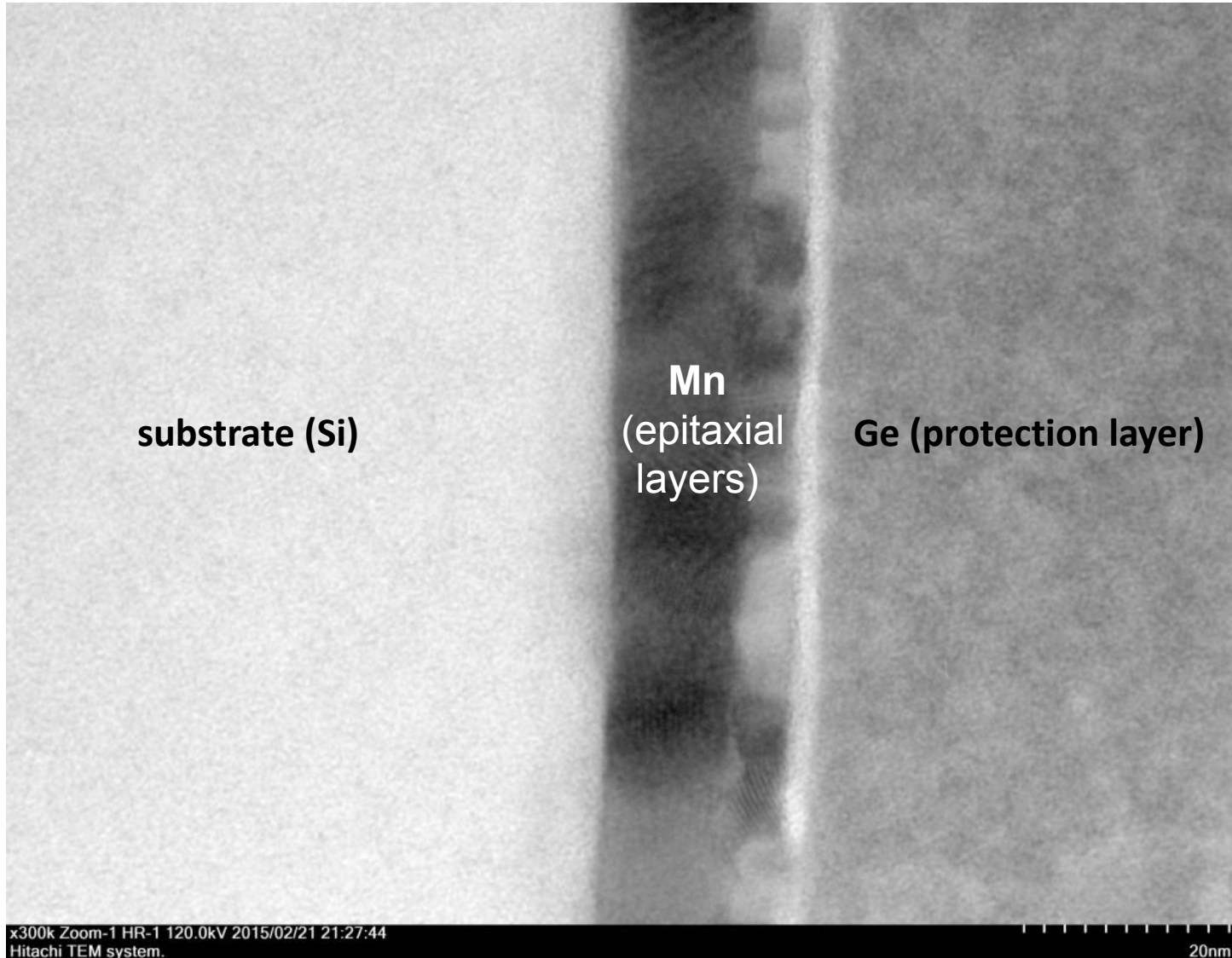
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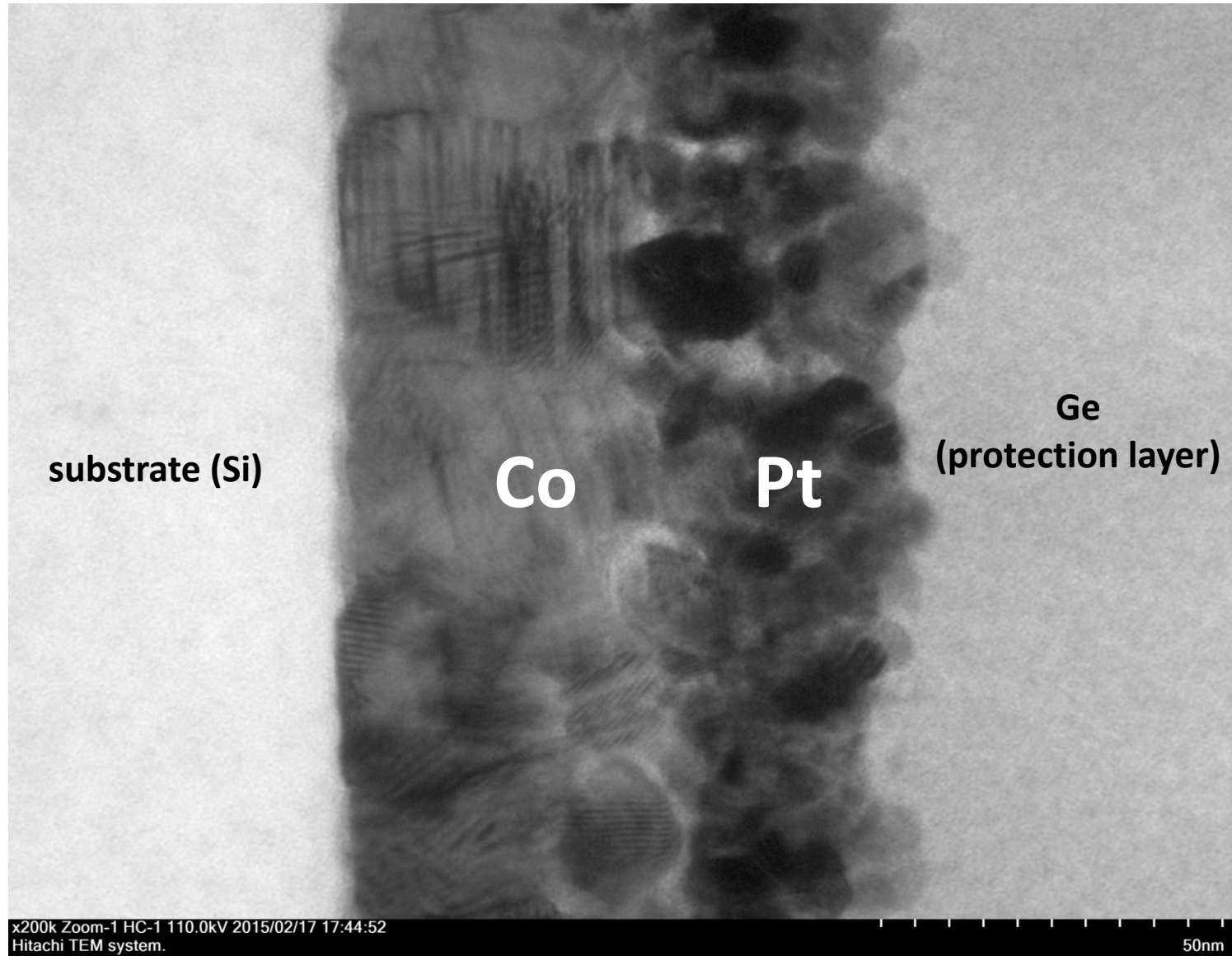
100nm

Pre-sputtering of Ge protective layer

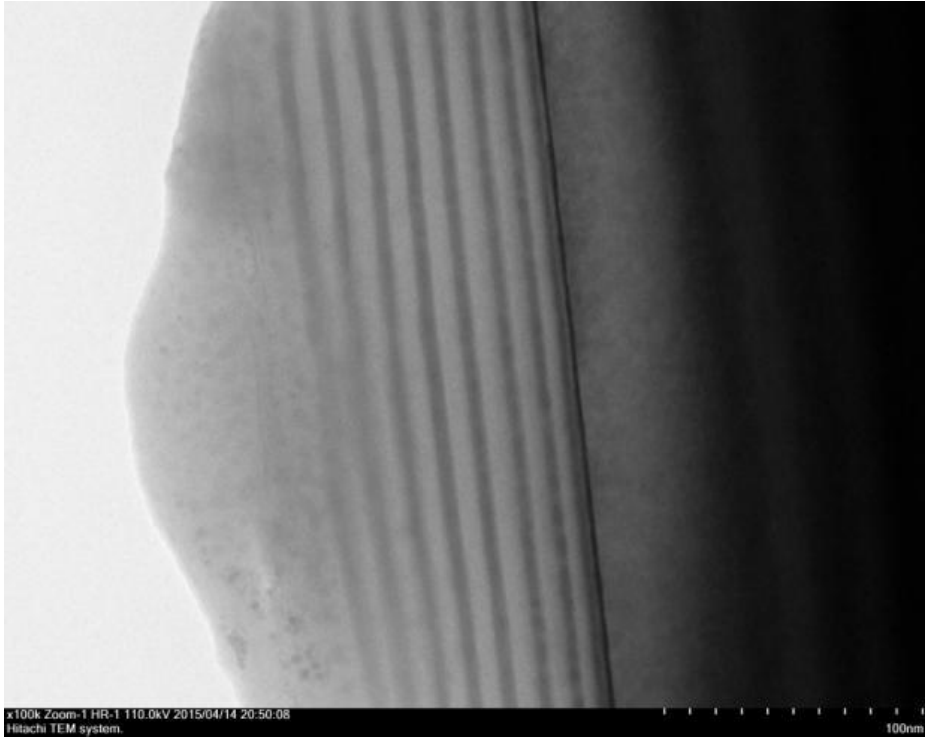


Examples

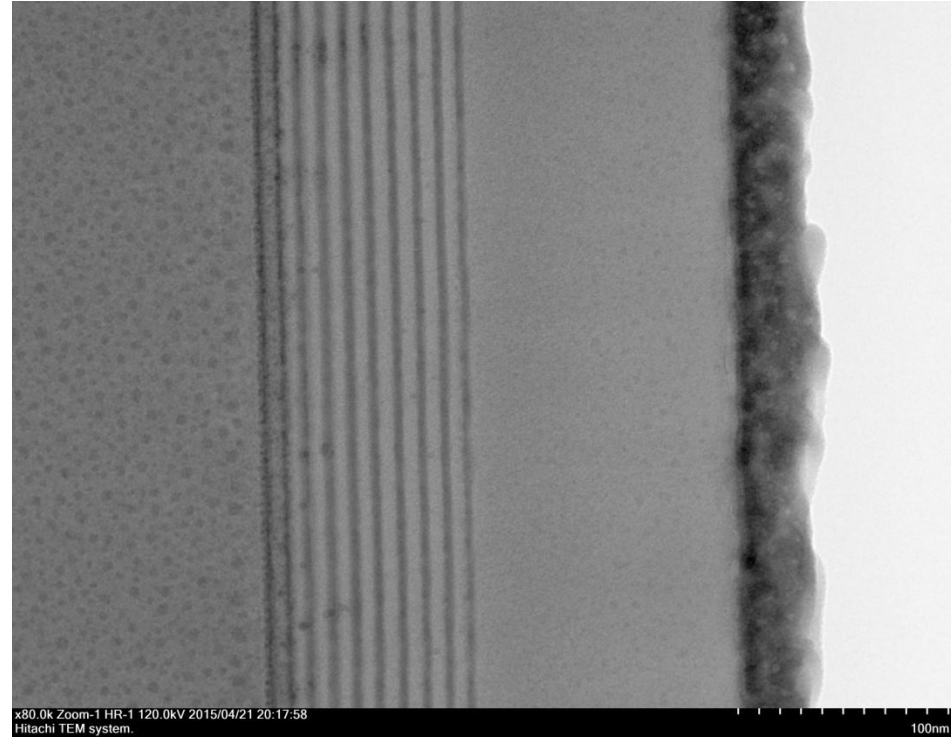




comparison of the two methods



Classic method



FIB method

**Thanks for your
attention!**