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Enabling Science and Technology through

European Electron Microscopy

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Deliverable 6.2

Report on protocols and standards developed in ESTEEM2

Deliverable leader 6 – Max Planck Institute for Intelligent Systems, Stuttgart

REPORT OF ACTIVITIES BY TU GRAZ

Input to Deliverable 6.2:

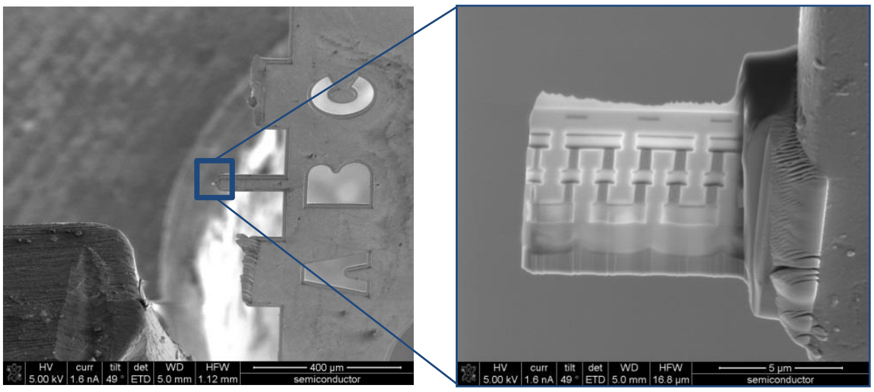
Double Cross section of FIB prepared semiconductor samples

Double Cross Section of FIB Prepared Semiconductor Samples

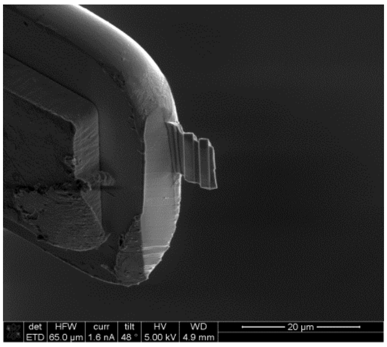
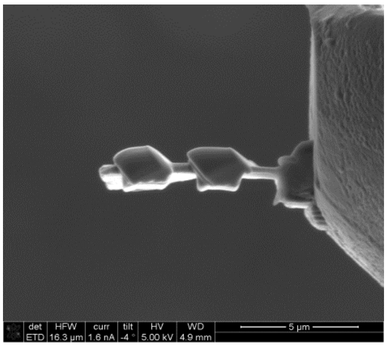
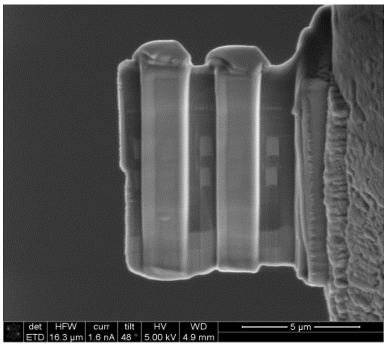
Double cross-sectioning of FIB lamellae is a technique, providing the possibility to evaluate and optimize TEM preparation results. Preparation induced artefacts such as selective milling, amorphisation or Ga implantation can be monitored.
Here, an example is given to assess the quality of a FIB preparation procedure for the fabrication of a thin TEM lamella from a semiconductor sample.
A movie (**https://www.youtube.com/watch?v=jy07QT4EmTA**) was prepared to visually aid the FIB operator for this sequence. It is recommended to watch this movie beforehand.

Preparation Procedure

In order to be able to perform the double cross section procedure, the FIB lamella is prepared conventionally but usually a bit thicker (~250 nm) than normal.
In this procedure described below, we recommend an "upside down" preparation, leading to a geometry with the sample mounted sideways on the top face of the middle position of the FIB grid (see protocol *TEM sample preparation of Semiconductors with a Focused Ion Beam System*).
However, if preferred otherwise, conventional mounting of the lamella on the grid is sufficient, as long as it is well centered, so that subsequent processing steps are simplified.
Optionally, a thin layer of Au or Au/Pd can be sputtered onto both milled surfaces of the lamella to generate more contrast during the TEM investigation or have additional protection during the preparation.

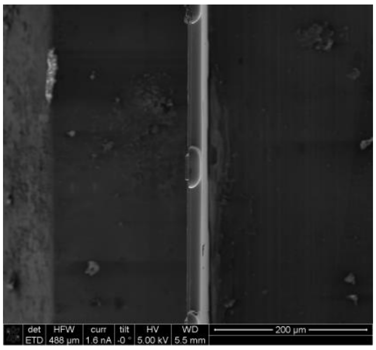


<u>Step 1:</u>
First, a 500 nm thick platinum layer is applied with the electron beam on both sides of the lamella. For a site-specific preparation, this layer could be deposited over the region of interest only, to quickly identify this area during the subsequent preparation steps.

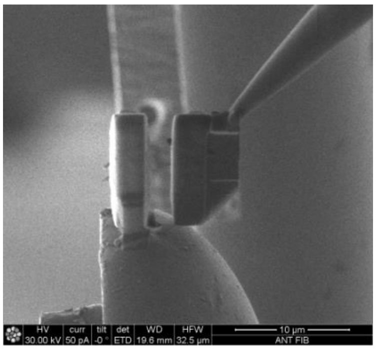
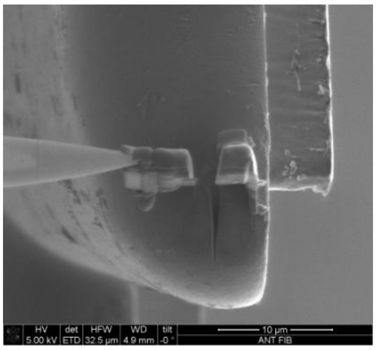




Step 2:
Then, the whole lamella is covered with an ion beam deposited Pt-layer. Its thickness should be at least 1µm. The purpose of this step is to produce a stable “intermediate” that can safely be handled during the next moves.

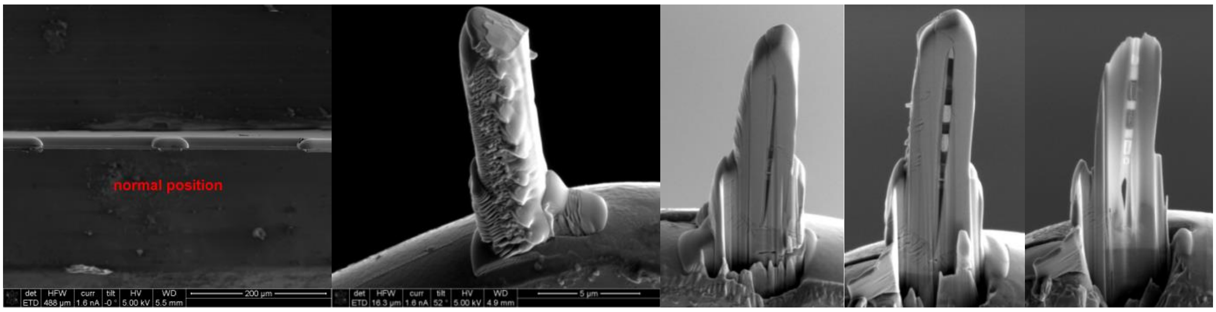
Step 3:
Now the lamella is reattached to the in-situ transfer needle and cut loose from the grid. The old grid is discarded. The new grid must now be rotated by 90° for sample mounting.



Step 4:
Then the lamella (or, alternatively, only one of the areas covered by the EB-deposited Pt) is attached to the top face of the center part of the grid.

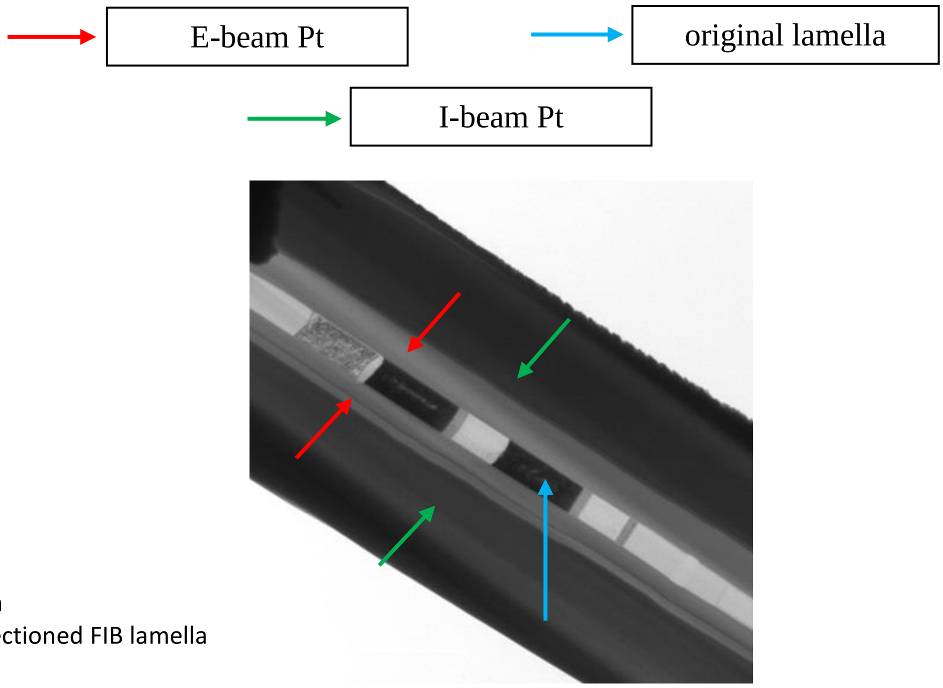



Step 5:
In the last step, the grid is again rotated by 90° and brought back to its “normal” position, at which it is thinned to electron transparency.



Conclusion

The double cross section preparation technique is very suitable to verify the quality of FIB prepared samples. If the result is not in accordance to the requirements, variations in preparation settings for example pattern strategy, beam current or milling angle can be made, so that -depending on the material- the best possible preparation result can be achieved. This method can be used in combination with other preparation techniques like wedge polishing or conventional ion milling with little variation.



TEM image of a
double cross sectioned FIB lamella

Visit the FELMI-ZFE YOUTUBE channel to see an animation of the double cross section preparation.
https://www.youtube.com/watch?v=jy07QT4EmTA