

## Automated TEM Sample Preparation

Focused ion beam sample preparation is fast, accurate, and allows higher utilization of your TEM

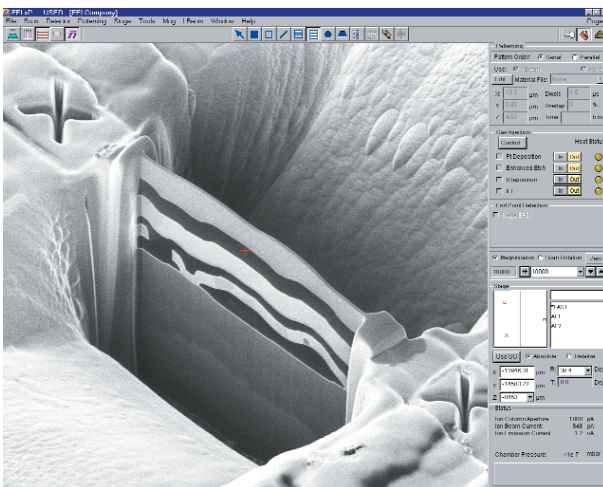
*Quick and easy TEM Sample preparation and removal*

- *Consistent sample preparation that is operator-independent*
- *Prepares multiple samples in a single session with unattended operation*
- *Reduces operator time on each sample*
- *Allows system to be used at off times*
- *FIB-prepared samples deliver excellent TEM images on our Tecnai series TEM system*

Preparing Transmission Electron Microscopy (TEM) samples for analysis is fast and simple when using FEI Company's TEM sample preparation software (known as AutoTEM™) on our Focused Ion Beam (FIB) or DualBeam™ tools. Two elements are provided for this purpose: one automates the task of milling a TEM sample from a sample that has been mechanically pre-thinned to approximately 50-100 μm thickness. The other prepares a sample to be removed from a full wafer or completely intact sample.

The software cuts trenches on either side of a pair of previously prepared fiducials for pattern recognition. The automated routines then mill the edges of the two trenches progressively closer to the area of interest, until the membrane between the trenches is electron transparent. These predefined scripts can thin a sample downward to approximately 75 nm. If a thinner sample is required, the final polishing is completed by the operator through direct control of the FIB.

An optimal TEM membrane is thin (=100nm), uniform, and deep (~ 8 μm from the surface through the substrate of an IC). The membrane needs to be free from ion beam damage, gallium implantation, and redeposition. Its shape should allow direct imaging by the TEM, or easy plucking from the wafer/die for transfer onto a TEM grid.



Intuitive AutoTEM™ graphical interface for ease of use and high productivity in automating TEM sample preparation.

The figures to the right show the preparation of a thin TEM sample:

- Milling of two fiducial crosses for site recognition.
- Initial platinum deposition to protect the top of sample and increase contrast for image recognition .
- Milling of trenches at high beam current on both sides.
- When the membrane is about 1 micron thick, the sample is nearly cut free.
- Fine polishing on both sides at low beam current with  $\pm 1.2^\circ$  tilt to avoid a tapered membrane.

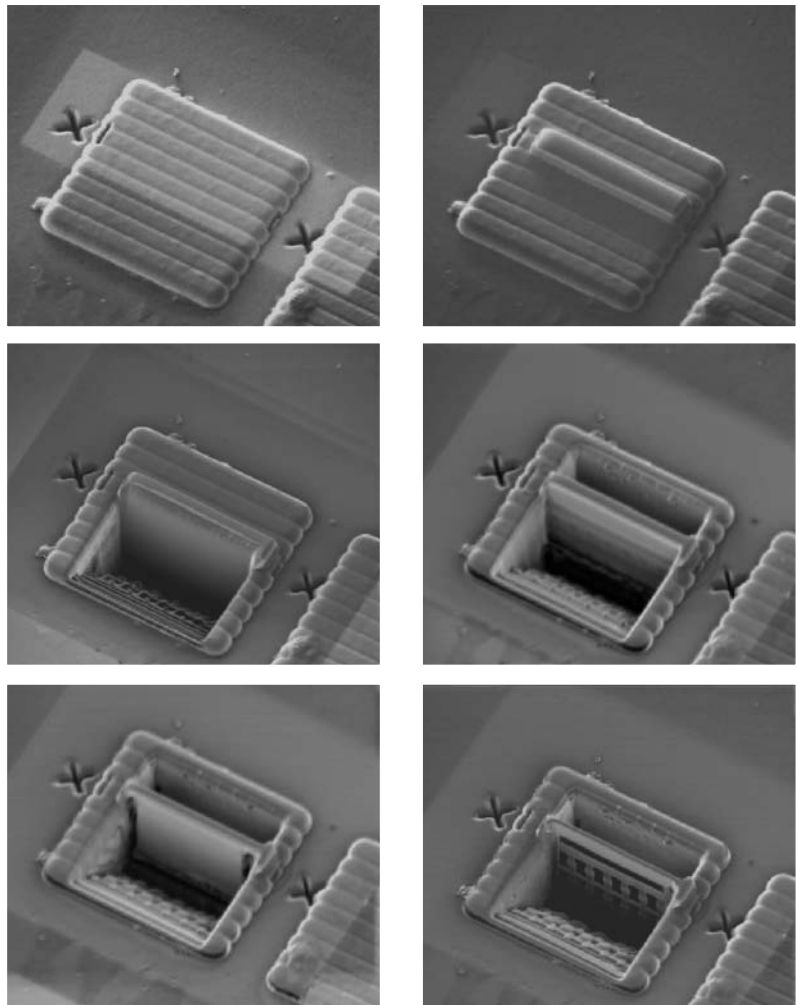
**DualBeam Advantage**

The DualBeam system offers several additional benefits for creating samples using AutoTEM. The eucentric point on multiple sites can be set using the electron beam. Eucentric point is where the beam focus, stage tilt axis, and sample feature of interest intersect. This minimizes steps, saving time and the chance of error.

Additionally, while the sample is being milled, the SEM can image the process for monitoring.

**Conclusion**

Automated TEM sample preparation using a FIB is meeting the increased demands for faster sample preparation and improved system utilization. This included unattended preparation of the initial mill cuts to the full automation of a sample preparation script. AutoTEM sample preparation presents the capability of high resolution imaging, metrology and sample-nondestructive chemical analysis in a short amount of time.



Sequence of an automated milling procedure for obtaining a TEM sample ready for removal. Total time for sample preparation is ion column dependent ranging from 35 to 14 minutes. (??? on fastest time, based on 35 min total less 3 min for dep 32, divided by 3= 10.66, plus the 3 minutes for dep)

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