thermo scientific

DATASHEET

AutoTEM 5 Software for the Helios 5 DualBeam

Automated TEM sample preparation

AutoTEM 5 Software brings automated, high-quality S/TEM lamella preparation to DualBeam (FIB-SEM) instruments – with AutoTEM 5 Software, you can perform automated multi-site chunking, sample lift-out, and thinning as well as low-kV cleaning.

Thermo Scientific™ AutoTEM™ 5 Software supports a range of lamella preparation techniques. These include *in situ* top-down, inverted, planar, and *ex situ* TEM sample preparation, which are named according to their orientation relative to the FIB and stage during mounting and thinning.

Successful automated lamella preparation is inherently defined by the lack of user intervention during all stages of the workflow, from substrate chunking to mounting of the sample on the TEM grid. AutoTEM 5 Software has been tested and verified on a range of semiconductor samples such as 3D NAND memory, logic, magnetic tunnel junction (MTJ), and blank silicon wafer samples.

Chunk milling with AutoTEM 5 Software

Lamella creation begins with chunk milling of the sample. First, a protective layer is applied over the area of interest along with a fiducial mark; these can be customized and automated using both electron and ion beam deposition. This is followed by trench milling along with undercutting and bulk cleanup. Chunk milling can also be used to create an array of cross-sections or *ex situ* lift-out samples.

Lift-out and sample thinning

For supported use cases, lift-out automation enables fully unattended lamella transfer from the bulk sample to the TEM grid (i.e. top-down and planar sample preparation).

Additionally, final thinning of the lamella can be done automatically on the grid. Different thinning strategies are available, including customizable windows, in order to assist with challenging samples. Automated, low-voltage final cleaning with AutoTEM 5 Software optimizes surface quality of the final ultra-thin TEM lamellas.

Key Benefits

Fully automated *in situ* sample preparation using different geometries: top down, plan view and inverted

High throughput with fully automated, unattended multi-site *in situ* and *ex situ* lift out and auto cross-section capabilities

Robust, predictable results for a wide range of semiconductor samples

Complete *in situ* S/TEM sample preparation workflow, including automated chunking, user guided lift-out and automated final thinning

1σ confidence level specifications

Process	Cut placement (nm)	Thickness (nm)	Robustness
Ex situ	0 ± 5	60 ± 5	95%
Top down		60 ± 5	95%
Planar			95%
Inverted		300 ± 5	95%

ThermoFisher SCIENTIFIC

Technical highlights

The following sample sizes are supported by AutoTEM 5 Software. Additional sample sizes outside of the given ranges may be supported. Contact your sales representative with any questions regarding your specific sample requirements.

Method	Width (µm)	Height (µm)	Thickness (µm)
Top down *ex situ*	8	4	0.06
	6.5	3	0.06
Top down *in situ*	12	5	2
	5	1	1
	8	2	2
	12	12	2
	5	1	1
	8	2	2
Inverted	6	4	0.3
	5	2	1.3
Planar	12	8	2
	10	12	2
	5	2	1.3

Lamella-thinning capabilities for the top-down *ex-situ* method:

Polishing voltage (kV)	Lamella thickness (nm)	Process capabiltiy index (Cp)
30	114	±10 nm
5	75	±10 nm

Throughput specifications

The following throughput numbers reflect specific lamella sizes and represent the full workflow without final polishing:

Workflow	Lamella size (µm x µm x µm)	Preparation time (hours:minutes: seconds)
Top-down side weld	5 x 1 x 1	0:16:33
Top-down top weld	8 x 2 x 2	0:18:09
Inverted	5 x 1.3 x 2	0:18:46
Planar	5 x 1.3 x 2	0:21:50

Figure 1. AutoTEM 5 Software user interface. Workflow steps are shown at the bottom, settings on the right. The intuitive UI with user guidance and instructive graphics helps users of any experience level create high-quality samples.

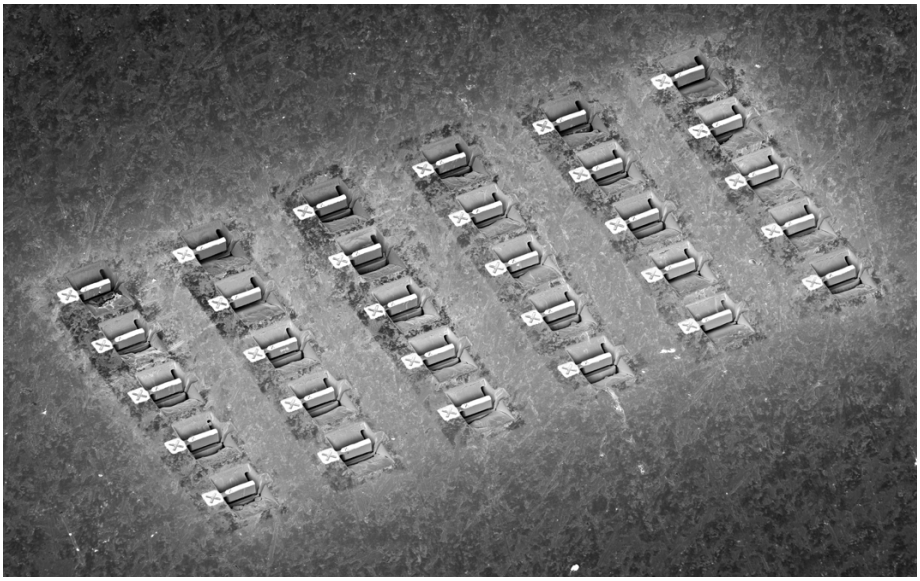

Figure 2. Aluminum sample with a 5 × 6 array of TEM lamellas created with AutoTEM 5 Software. Preparation was fully unattended, and samples were undercut and ready for lift-out in 6 hours. AutoTEM Software automatically defined the array and shifted to the individual locations, precisely positioning the lamella.

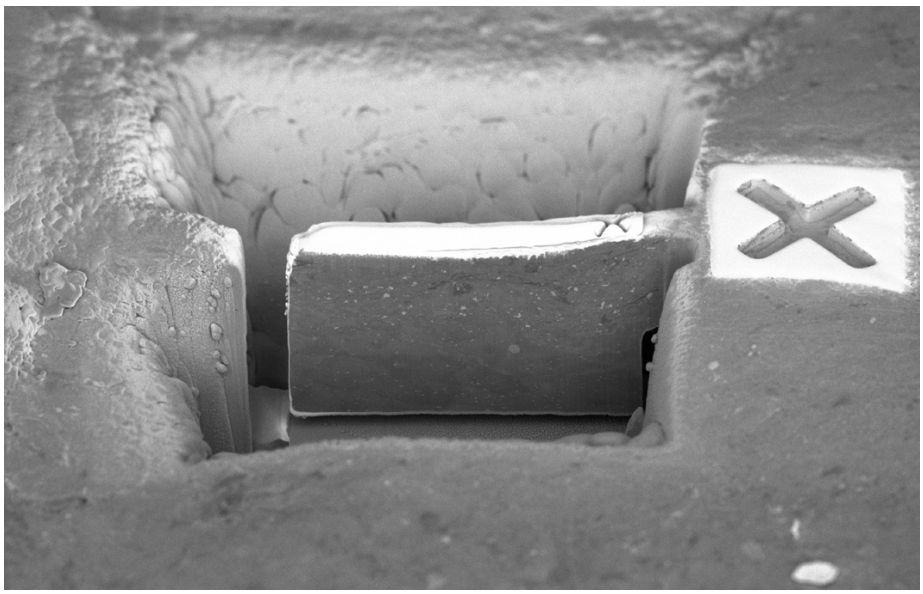

Figure 3. Example of a sample after chunking and undercutting, ready for *in-situ* lift-out. The large fiducial on the side is used for chunking automation, while the smaller one on the lamella will be used later for final thinning automation.

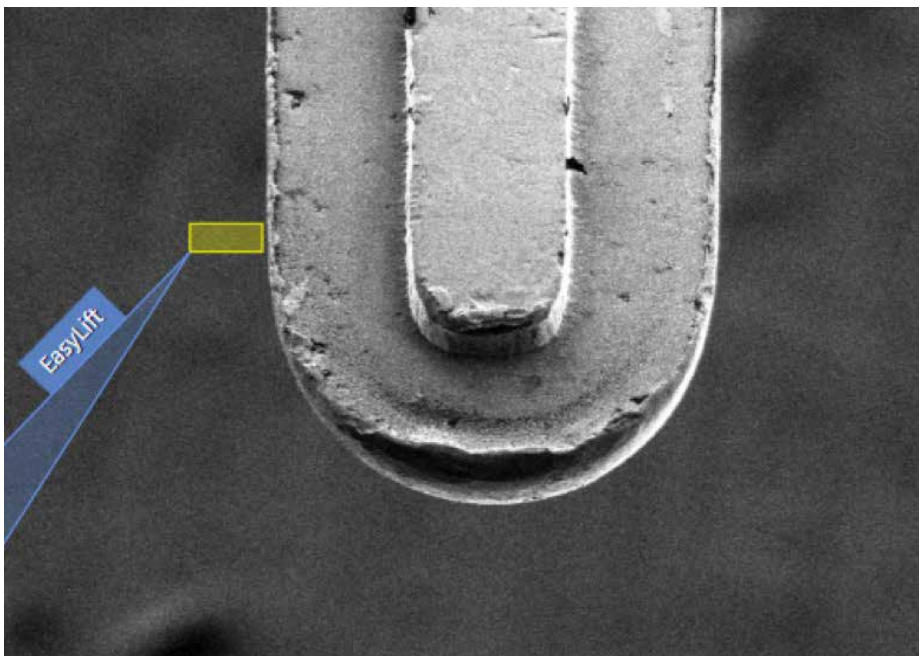

Figure 4. Defining a lamella position on a copper grid for *in-situ* lift-out using AutoTEM 5 Software.

thermo scientific

Notes

Find out more at **thermofisher.com/semiconductor**

ThermoFisher SCIENTIFIC