

Helios 5 PFIB HXe DualBeam

High throughput, planar/uniform large area deprocessing, sample preparation, and characterization for 7/5nm node logic and advanced memory devices

Helios 5 PFIB HXe DualBeam enables unique damage free delayering of 5nm and >196 Layer 3D NAND devices, failure analysis of advanced 3D packages, and a wide range of other large area FIB processing applications.

The Thermo Scientific™ Helios™ 5 PFIB HXe DualBeam™ is the fifth generation of the industry leading Helios DualBeam family for semiconductor device structural and failure analysis. The Helios 5 PFIB combines the new PFIB2.0 column and the monochromated Thermo Scientific Elstar™ SEM Column to deliver the most advanced focused ion- and electron beam performance. Intuitive software, an unprecedented level of automation, and ease-of-use provide observation and analysis of relevant subsurface volumes.

In addition to the most advanced electron and ion optics, the Helios 5 PFIB HXe DualBeam incorporates a suite of state-of-the-art software that enables simple and consistent deprocessing of advanced memory and logic devices, as well as the highest throughput and quality large volume subsurface and 3D characterization, even on the most challenging samples.

Most advanced DualBeam platform

The Helios 5 DualBeam platform delivers unmatched automation performance and system readiness. The latest technological innovations of the Helios 5 PFIB HXe DualBeam enable the fastest and easiest preparation of site-specific, high-quality HR-S/TEM samples, cross-sections, and damage free delayering of devices.

Key benefits

Automated large area deprocessing of copper/low-k/oxide interconnect layers with proprietary Dx and DE chemistries

Automated large area deprocessing of 3D NAND structures with proprietary chemistries & recipes

Sub-nanometer SEM imaging resolution at low landing energy

Higher milling throughput for advanced logic, high-aspect ratio memory and advanced packaging materials

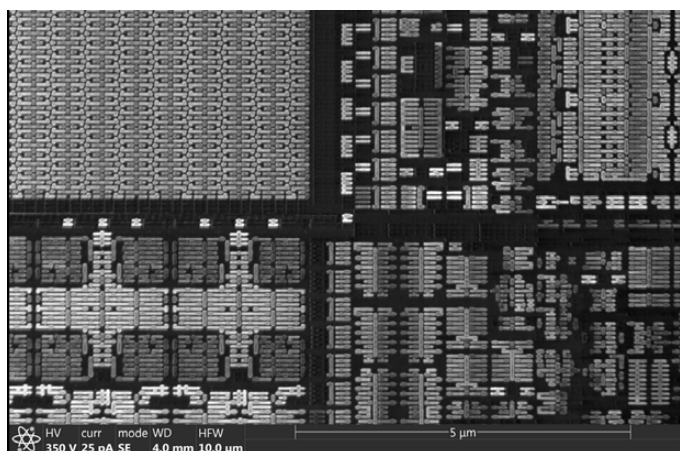
Ga+ free planar TEM sample preparation

Extensive deposition and etching capabilities utilizing optional MultiChem / GIS delivery systems

Curtain-free preparation of large area cross-section and TEM lamella

Five-axis, piezo-driven UHR stage with 100 mm XY travel; load lock provides full coverage of 70 mm samples

Optional EasyLift nanomanipulator and QuickFlip enables precise, site-specific preparation of large area lamellae while promoting high user confidence and yield



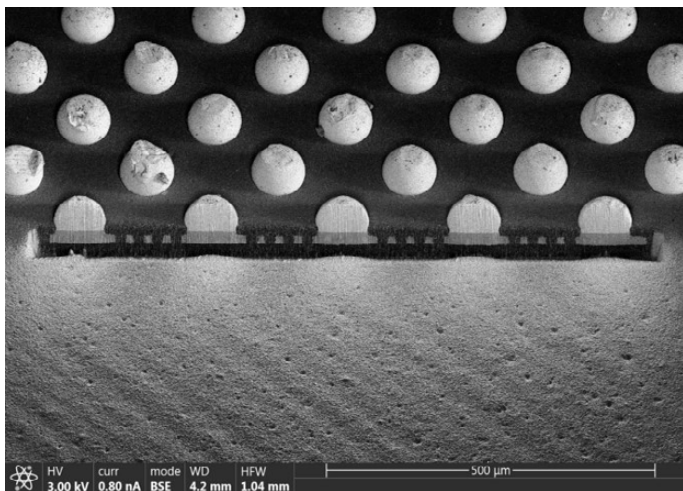


Figure 1. 800um bulk large area cross-section of bumps.

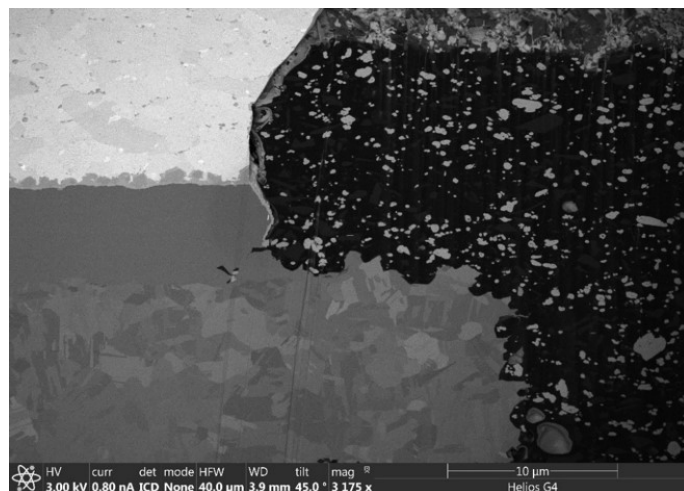


Figure 2. High resolution image of the ROI after rocking polish.

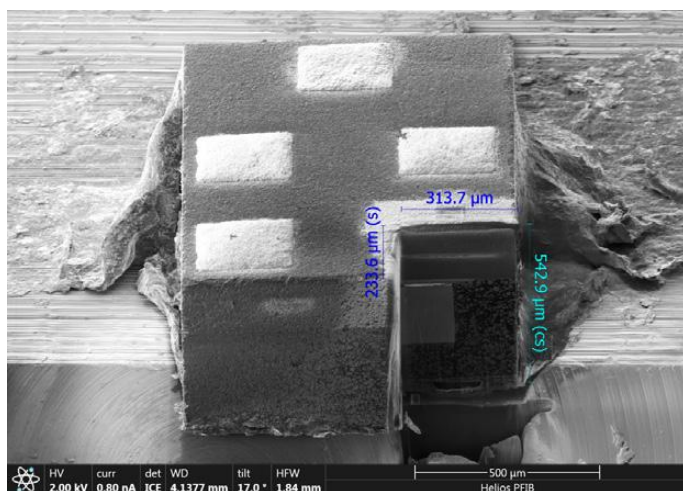


Figure 3. Large volume cross-section of ceramic material.

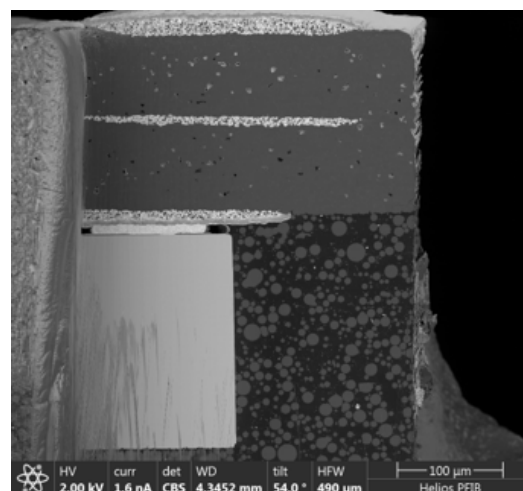


Figure 4. Cross-section of device after rocking polish.

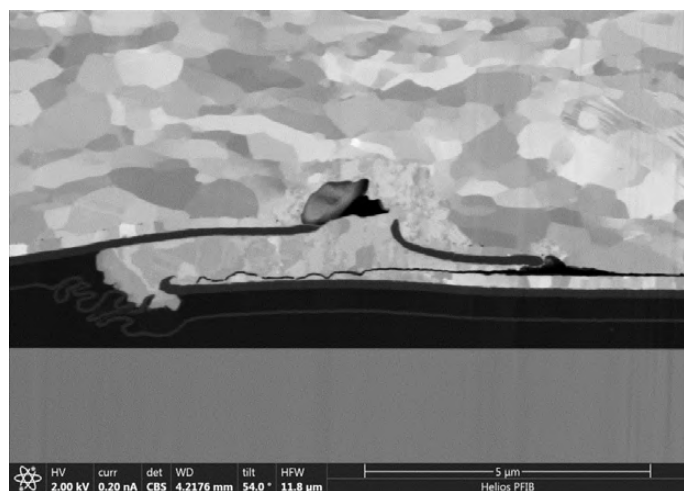
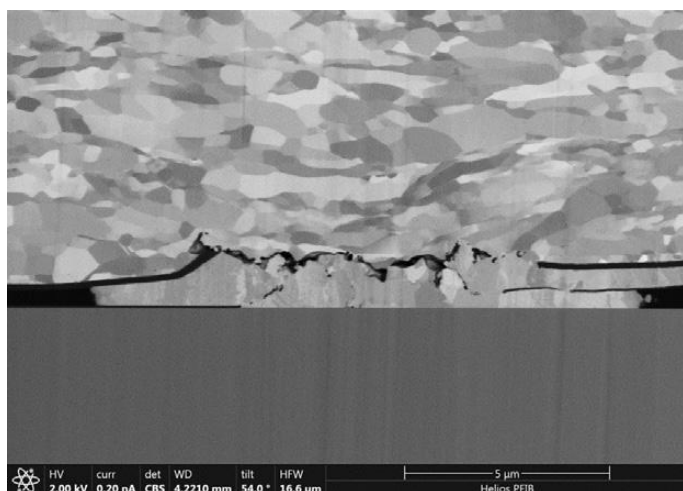


Figure 5 / Figure 6. BSE images of the Ceramic with Tungsten ROI using DBS/CBS detector.

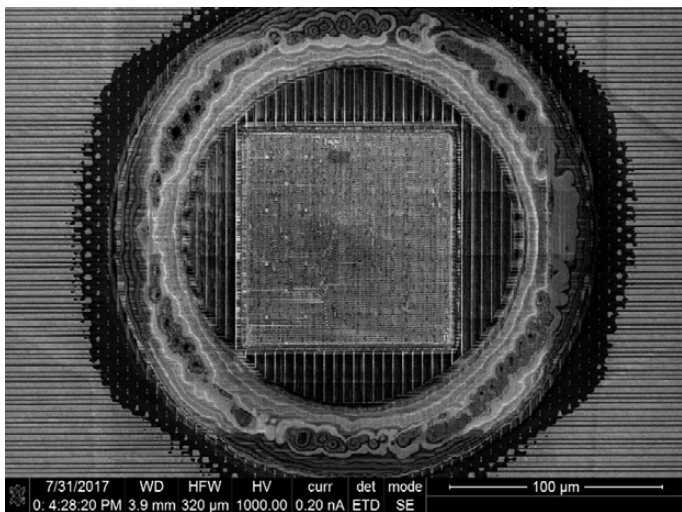


Figure 7. Thick layer removal for delayering of logic device in 100x 100um window.

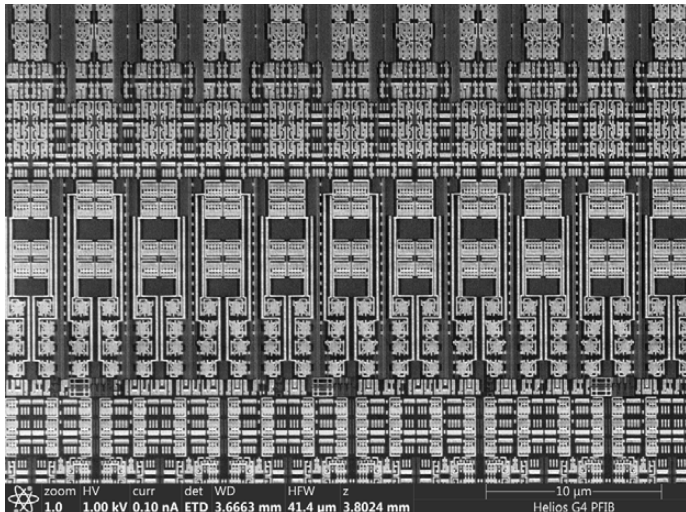


Figure 8. Close up view of delayered region of interest for SEM inspection and nanoprobe applications.

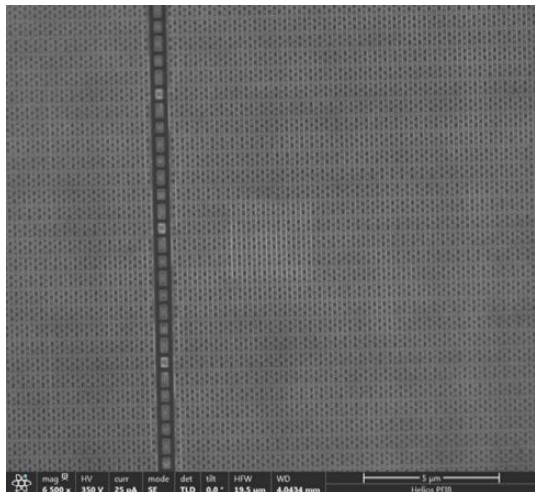
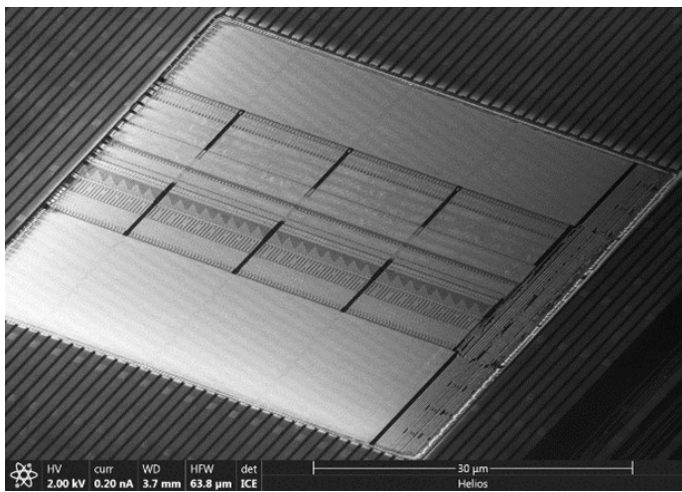


Figure 9. Deprocessing of logic devices with Dx (left) and imaged with SEM (right) for electrical fault isolation.

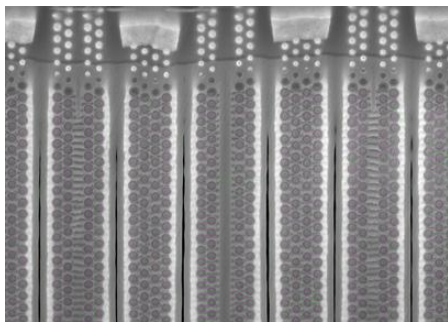
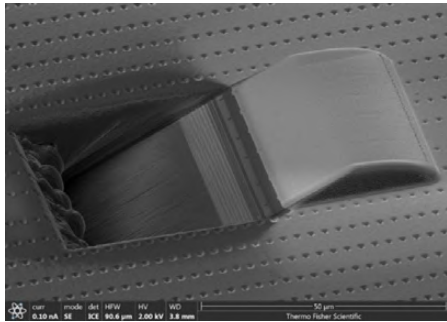


Figure 10. Diagonal mill preparation of 3D NAND devices (left) with SEM based memory cell metrology (right).

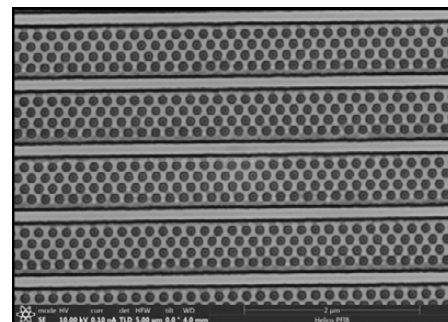
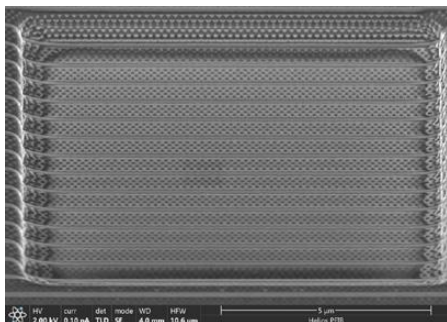


Figure 11. Bulk delayering of 3D NAND devices (left) and the resulting surface quality (right) for fault analysis.

Technical highlights:

Electron optics

- Extreme high-resolution field emission Elstar SEM Column with:
 - Magnetic immersion objective lens
 - High-stability Schottky field emission gun to provide stable high-resolution analytical currents
 - UC+ monochromator technology
- SmartAlign: user-alignment-free technology
- 60-degree dual objective lens with pole piece protection allows tilting larger samples
- Automated heated apertures to ensure cleanliness and touch-free aperture exchange
- Electrostatic scanning for higher deflection linearity and speed
- Thermo Scientific ConstantPower™ Lens Technology for higher thermal stability
- Integrated Fast Beam Blanker*
- Beam deceleration with stage bias from 0 V to -4 kV*
- Minimum source lifetime: 12 months

Electron beam resolution

- At optimum WD:
 - 0.7 nm at 1 kV
 - 1.0 nm at 500 V (ICD)
- At coincident point:
 - 0.6 nm at 15 kV
 - 1.2 nm at 1 kV

Electron beam parameter space

- Electron beam current range: 0.8 pA to 100 nA
- Accelerating voltage range: 350 V–30 kV
- Landing energy range: 20* eV–30 keV
- Maximum horizontal field width: 2.3 mm at 4 mm WD

Ion optics

High-performance PFIB column with Inductively coupled Xe₊ Plasma (ICP)

- Ion beam current range: 1.0 pA to 2.5 μA
- Accelerating voltage range: 500 V–30 kV
- Maximum horizontal field width: 0.9 mm at beam coincidence point
- Ion beam resolution at coincident point
 - <20 nm at 30 kV using preferred statistical method
 - <10 nm at 30 kV using selective edge method

Detectors

- Elstar in-lens SE/BSE detector (TLDSE, TLD-BSE)
- Elstar in-column SE/BSE detector (ICD)*
- Everhart-Thornley SE detector (ETD)
- High-performance in-chamber electron and ion detector (ICE) for secondary ions (SI) and electrons (SE)
- In-chamber Thermo Scientific Nav-Cam™ sample navigation camera*
- Retractable low-voltage, high contrast directional solid-state backscatter electron detector (DBS)*
- Integrated beam current measurement
- IR camera for viewing sample/column/gas injectors

Stage and sample / navigation

- UHR 5-axis all piezo motorized eucentric
- 100 mm XY motion
- Automated Loadlock
- NavCam+
- Sample types
 - Wafer pieces, packaged parts
 - TEM grids, whole wafers up to 100 mm
- Maximum sample size
 - 70 mm diameter with full travel

Vacuum system

- Complete oil-free vacuum system
- Chamber vacuum: <2.6×10⁻⁶ mbar (after 24 h pumping)
- Evacuation time: <5 minutes

Chamber

- E- and I-beam coincidence point at analytical WD (4 mm SEM)
- Ports: 21
- Inside width: 379 mm
- Integrated plasma cleaner

Gas delivery

- MultiChem integrated gas delivery system
 - Up to 6 chemistries can be installed
 - Up to 2 external gases can be installed
- GIS gas delivery system
 - Up to 4 independent GIS units can be installed

Software

- User interface
 - Windows® 10 GUI with integrated SEM, FIB, GIS, simultaneous patterning and imaging mode

- Auto Rocking Mill, Auto Chunking, Auto Deprocessing and Guided TEM prep

Key options

- MultiChem chemistries
 - Milling/Deprocessing: Dielectric-etch, Polyimide-etch, Dx, DE low-k Dielectric Etch
 - Conductor Deposition: Platinum, Tungsten, Carbon
 - Insulator Dep – IDEP2
- GIS chemistries
 - Milling/Deprocessing: Dielectricetch, Polyimide-etch, Dx, DE low-k Dielectric Etch
 - Conductor Deposition: Platinum, Tungsten, Carbon
 - Insulator Dep – IDEP3
 - Silicon Trenching Option with Co-axial nozzle for High Speed Trenching & Sample Prep

Application software options

- iFast Developers Kit Professional automation software
- Auto TEM5
- Guided Planar TEM Prep
- Auto Slice&View™ software
- NEXS CAD Navigation, Synopsys Avalon Connectivity

Hardware options

- Metrology Workstation
- *In situ* Chunk or TEM lamella sample liftout
 - Easylift EX nanomanipulator
- Dual QuipFlip sample holder shuttle
- STEM3+
- EBSD, EDS analysis
- IR Microscope
- Bulk Silicon Trenching
- Wide Area Bulk Silicon Trenching

* Optional

** Some Beam Chemistries may be available only on the MultiChem or on the Single

Find out more at thermofisher.com/EM-Sales

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S C I E N T I F I C