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DATASHEET

Helios 5 PFIB UXe DualBeam

Enabling high throughput, uniform large area deprocessing and analysis for advanced node logic and 3D memory devices

Helios 5 PFIB UXe DualBeam enables unique thick layer removal and damage free delayering of the latest generation of logic and high aspect ratio 3D NAND devices, failure analysis of advanced 3D packages, and a wide range of other large area FIB applications.

The Thermo Scientific™ Helios™ 5 PFIB UXe DualBeam is the fifth generation of the industry leading Helios DualBeam family for semiconductor large area sample preparation, logic and high-aspect ratio memory device failure analysis. Helios 5 PFIB combines the new PFIB 2.0 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.

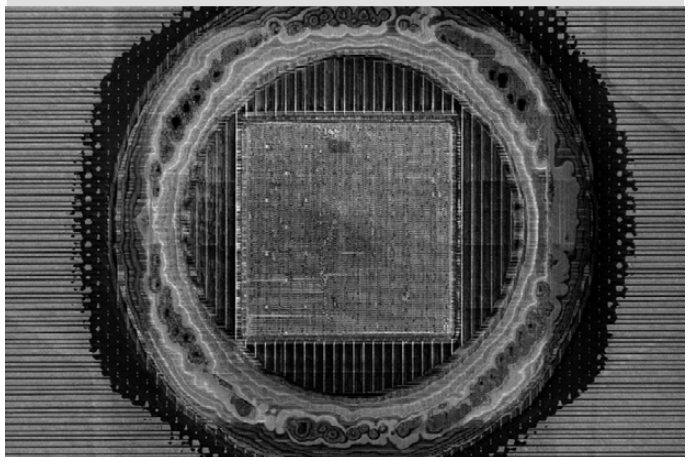
In addition to the most advanced electron and ion optics, the Helios 5 PFIB UXe DualBeam incorporates a suite of state-of-the-art software that enables simple and consistent high-resolution S/TEM) sample preparation, as well as the highest throughput and quality large volume subsurface and 3D characterization, 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 UXe 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 proprietarty Dx and DE chemistries
- **Automated large area deprocessing** of 3D NAND structures with proprietary chemistries and 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 sytems
- **Curtain-free preparation** of large area cross-section and TEM lamella
- **Five-axis, high precision piezo stage** provides full coverage of 150 mm samples and ability to navigate on 200 mm wafers



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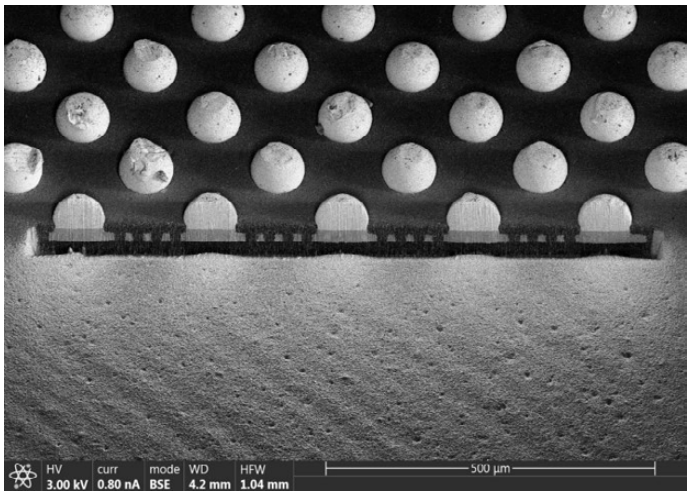


Figure 1. 800um bulk large area cross-section of bumps.

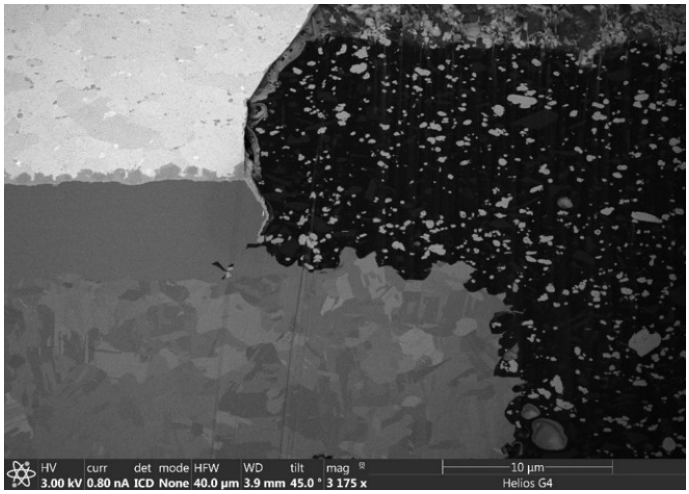


Figure 2. High resolution image of the ROI after rocking polish.

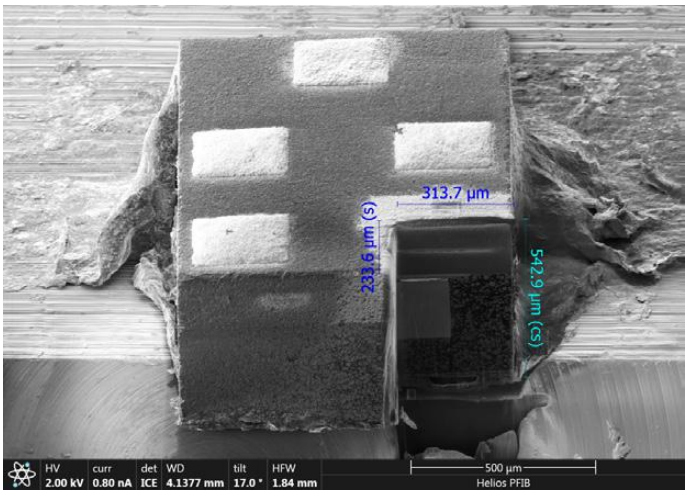


Figure 3. Large volume cross-section of ceramic material.

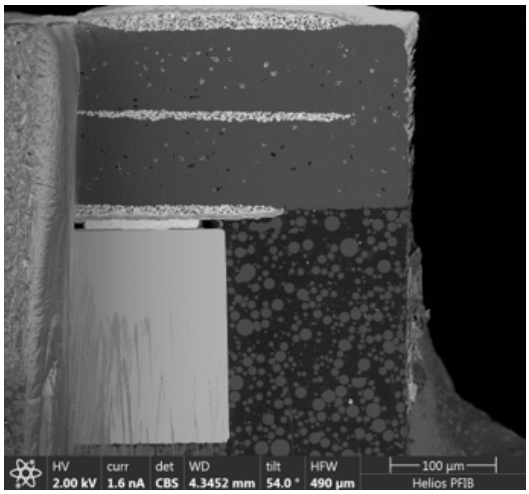
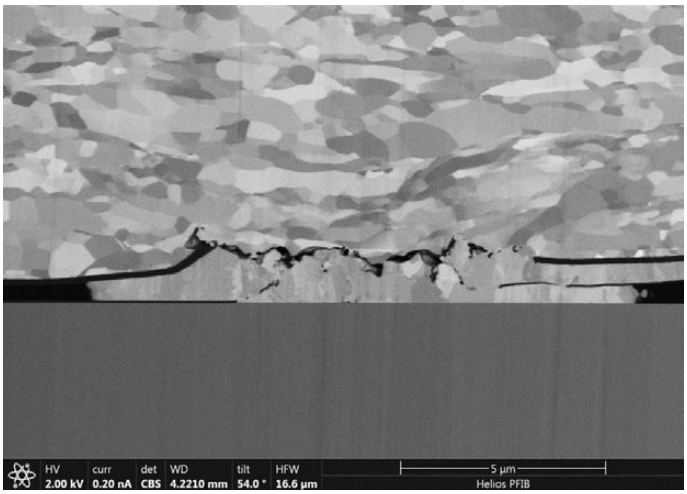


Figure 4. Cross-section of device after rocking polish.



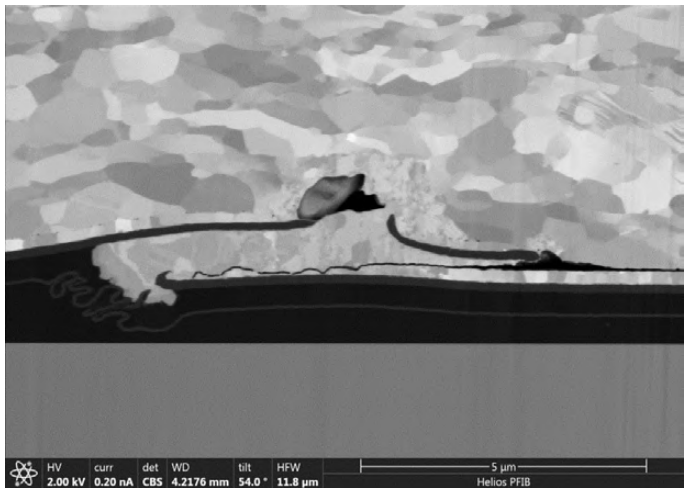


Figure 5 / Figure 6. BSE images of the Ceramic with Tungsten ROI using DBS/CBS detector.

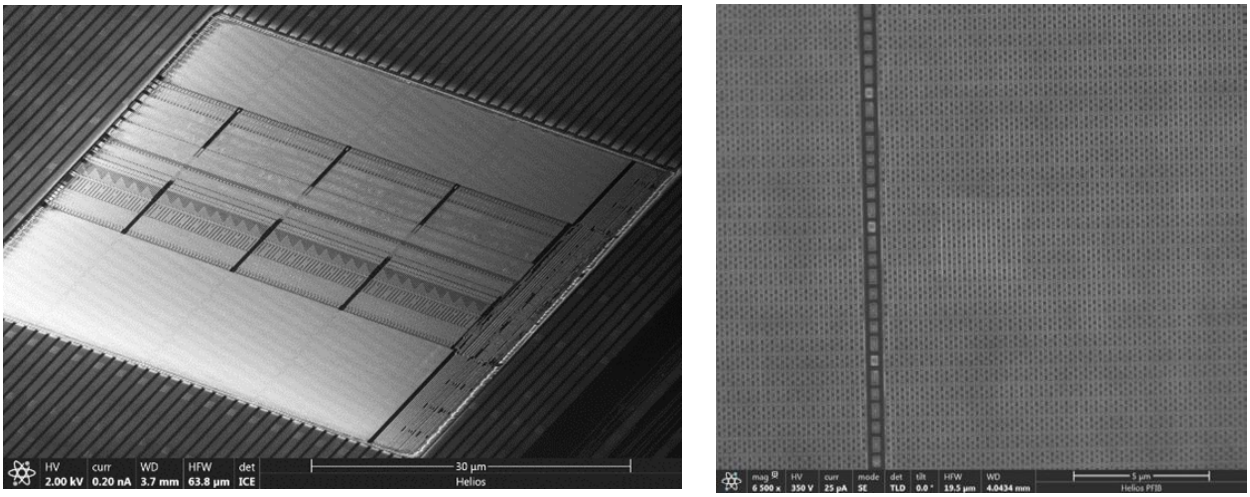


Figure 7. Deprocessing of logic devices with Dx (left) and imaged with SEM (right) for electrical fault isolation.

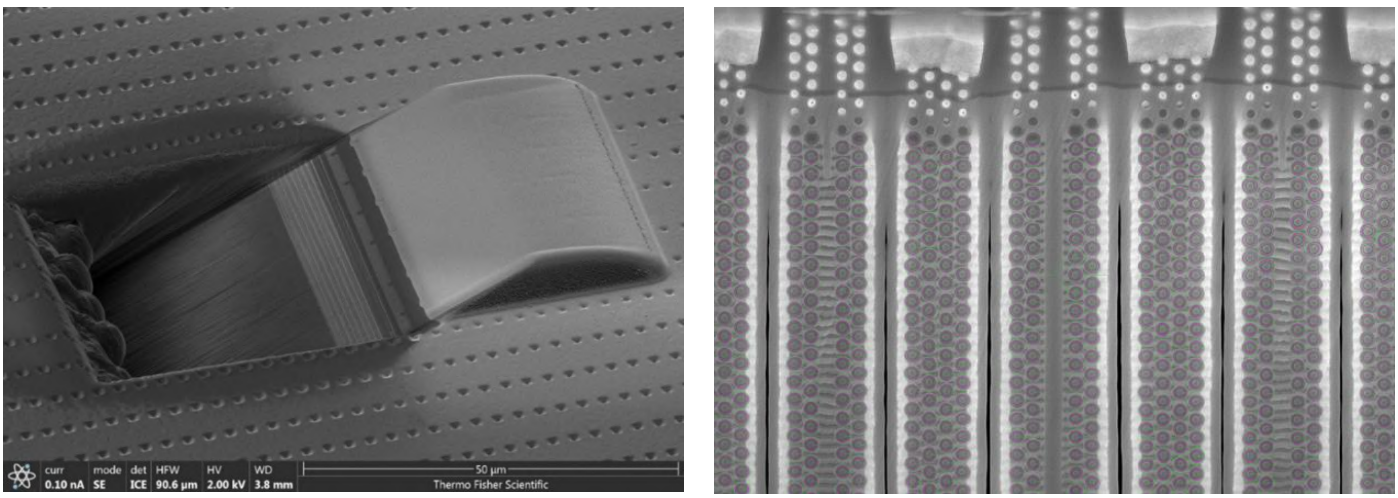


Figure 8. Diagonal mill preparation of 3D NAND devices (left) with SEM based memory cell metrology (right).

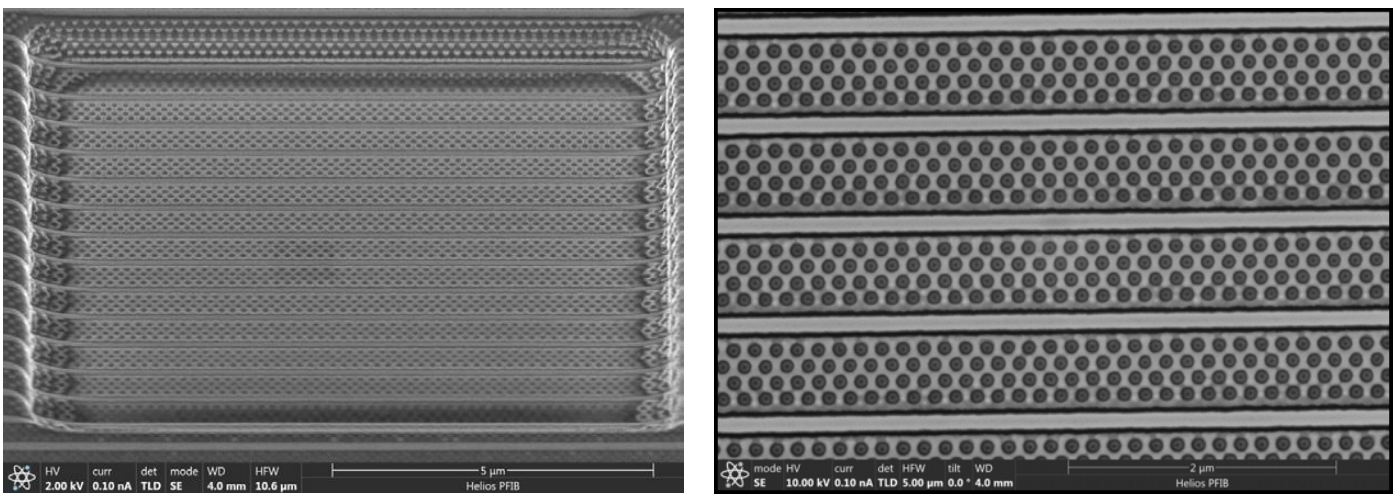


Figure 9. Bulk delayering of 3D NAND devices (left) and the resulting surface quality (right) for fault analysis.

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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
- Max. 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

High precision 5-axis motorized stage, with XYR axis piezo-driven

- XY range: 150 mm
- Z range: 10 mm
- Rotation: 360° (endless)
- Tilt range: -38° to +60°
- XY repeatability: 1 µm
- Max sample height: Clearance 55 mm to eucentric point
- Max sample weight at 0° tilt: 500 g (including sample holder)
- Max sample size: 150 mm with full rotation (larger samples possible with limited rotation)
- Compucentric rotation and tilt

Vacuum system

- Complete oil-free vacuum system
- Chamber vacuum: $<2.6\times10_{-6}$ 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

Sample holders

- Multi-purpose specimen holder with adjustable height
- Vise specimen holder to clamp irregular, large or heavy specimens to the specimen stage*
- Universal mounting base (UMB) for stable, flexible mounting of many combinations of samples and holders, such as flat and pretilt stubs, and row holders for TEM grids*
- Various wafer and custom holder(s) available by request*\

System control

- 64-bit GUI with Windows® 10, keyboard, optical mouse
- Up to four live images showing independent beams and/or signals. Live color signal mixing
- Local language support: Check with your local Thermo Fisher Sales rep for available language packs
- Two 24-inch widescreen monitors (1920×1200 pixels) for system GUI and full-screen image
- Microscope controlling and support computers seamlessly sharing one keyboard, mouse and monitors
- Joystick*
- Multifunctional control panel*
- Remote control and imaging*

Accessories:

- GIS (Gas Injection System) Solutions:
  - Single GIS: up to four independent units for enhanced etching or deposition
  - MultiChem: up to six chemistries on the same unit for advanced etching and deposition control
- 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 s
  - More beam chemistries available upon request
- Thermo Scientific EasyLift™ NanoManipulator - fully integrated for precise in situ sample manipulation
- FIB Charge Neutralizer
- Analysis: EDS, EBSD, WDS
- Thermo Scientific QuickLoader™ Load Lock for fast sample exchange without breaking system vacuum
- Automated Loadlock
- Cryo solution for DualBeam
  - Exclusive Thermo Scientific CryoMAT for material science cryo applications
  - Solutions from external vendors
- Thermo Scientific acoustic enclosure
- Thermo Scientific CryoCleaner

Software options*

- Thermo Scientific AutoTEM5™ Software
- Guided planar TEM Prep
- Thermo Scientific Maps™ Software for automatic acquisition of large images and optional correlative work
- Thermo Scientific NanoBuilder™ – advanced proprietary CAD-based (GDSII) solutions for FIB and beam deposition optimized nanoprototyping of complex structures
- Auto Slice and View Software – automated sequential mill and view to collect series of slices images, EDS or EBSD maps for 3D reconstruction
- Avizo Software – 3D reconstruction and analysis software
- CAD navigation

* Optonal
** 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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