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DATASHEET

Helios 5 PFIB CXe DualBeam

High throughput, large area sample preparation and analysis of advanced packaging materials and deprocessing of advanced memory and logic devices

Helios 5 PFIB CXe DualBeam provides advanced failure analysis of advanced 3D packages, delayering of 5nm and >196L 3D NAND devices, and a wide range of other large area FIB processing applications.

The Thermo Scientific™ Helios™ 5 PFIB CXe DualBeam is the fifth generation of the industry leading Helios DualBeam family for semiconductor device structural and failure analysis of high-aspect ratio memory devices and large area failure analysis. The 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. .

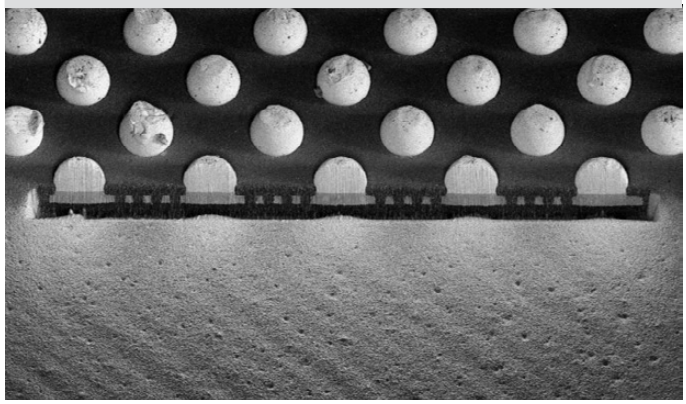
In addition to the most advanced electron and ion optics, the Helios 5 PFIB CXe DualBeam incorporates a suite of state-of-the-art software that enables simple site-specific cross-sectioning with the highest throughput and quality large volume subsurface and 3D characterization, even on the most challenging 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 CXe DualBeam, in combination with the easiest to use, most comprehensive software and our application expertise, 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
- **Precise sample navigation** tailored to individual application needs thanks to the high flexibility 110 mm stage and optional in-chamber Nav-Cam



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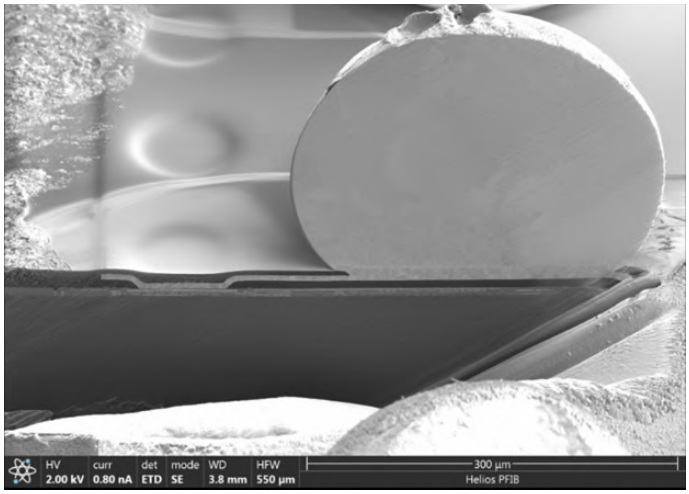


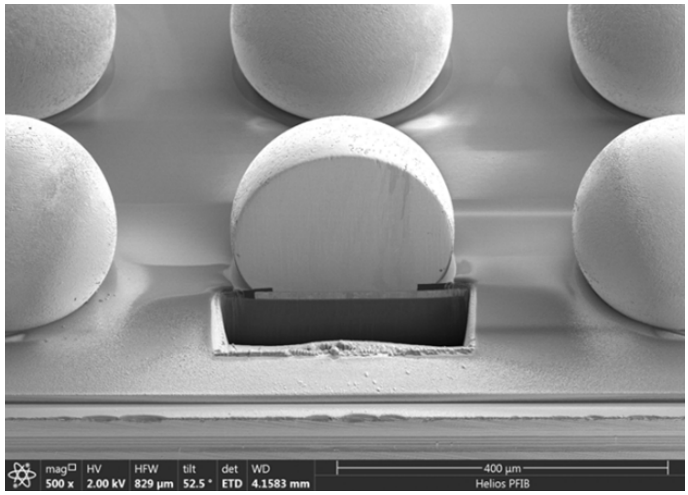


Figure 1 / Figure 2. Cross-sections of large solder bump using diagonal mill (left) and traditional cross-section method (right).

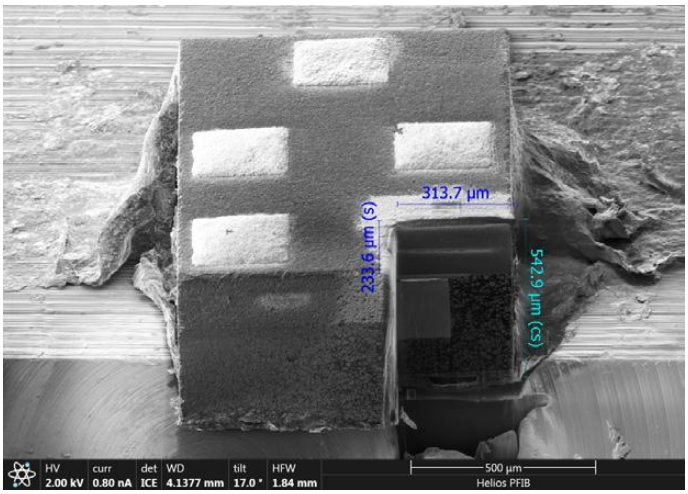


Figure 3. Large volume cross-section of ceramic material.

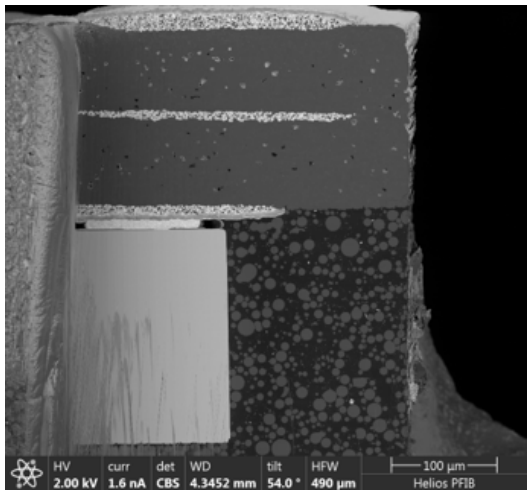
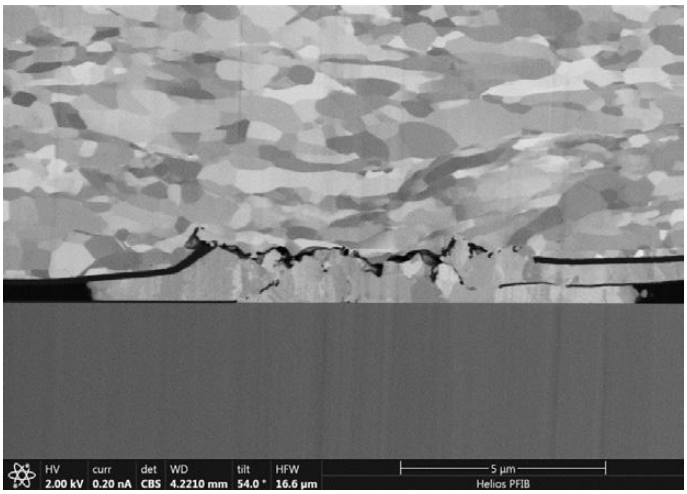


Figure 4. Cross-section of device after rocking polish.



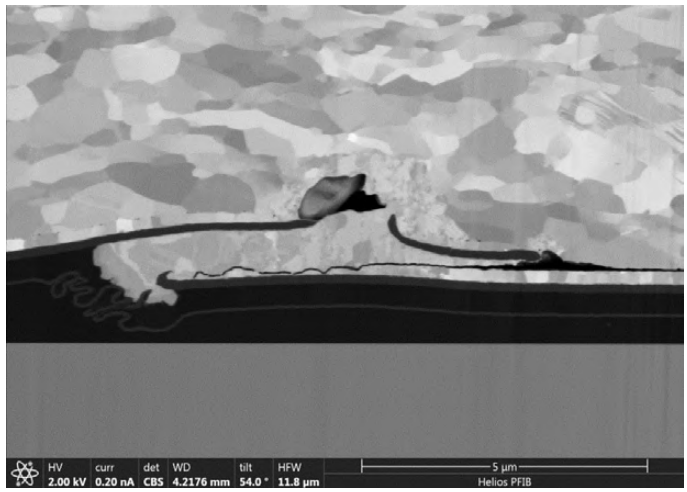


Figure 5 / Figure 6. BSE images of the Ceramic with Tungsten ROI using DBS/CBS detector.

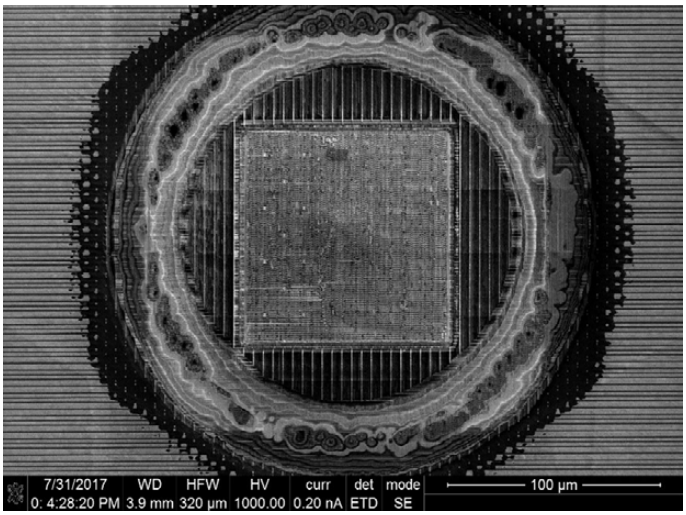


Figure 7. Thick layer removal for delayering of logic device in 100x 100um window.

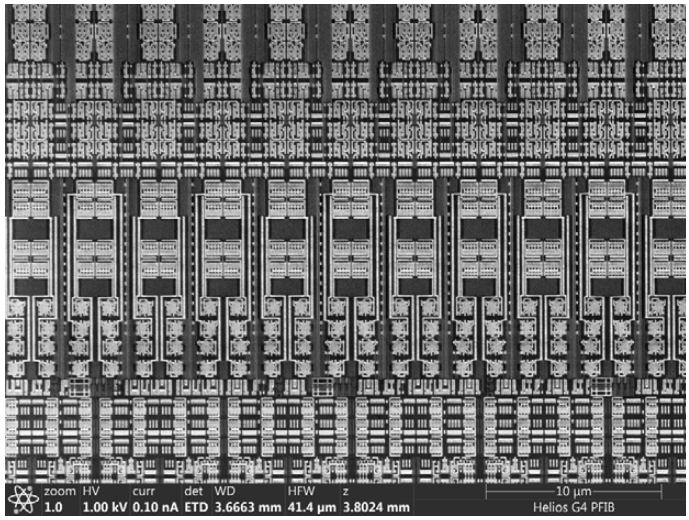
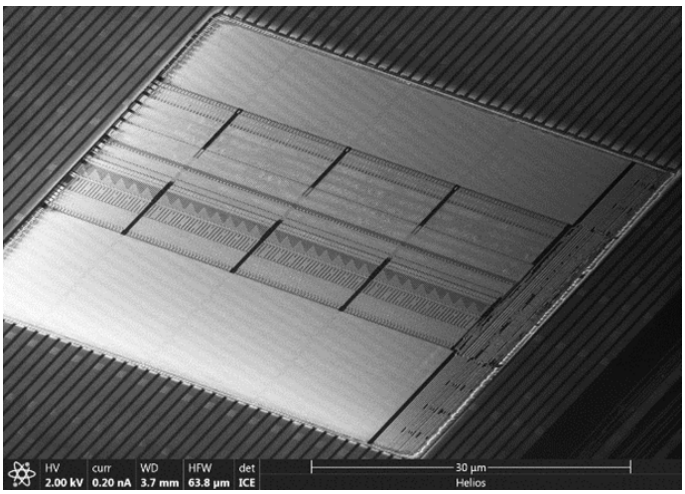


Figure 8. Close up view of delayered region of interest for SEM inspection and nanoprobing applications.



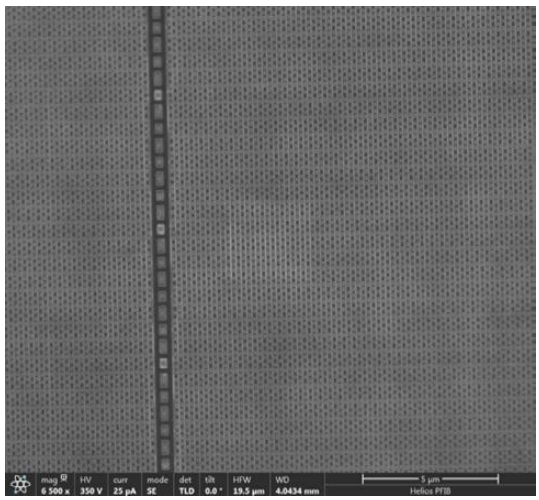
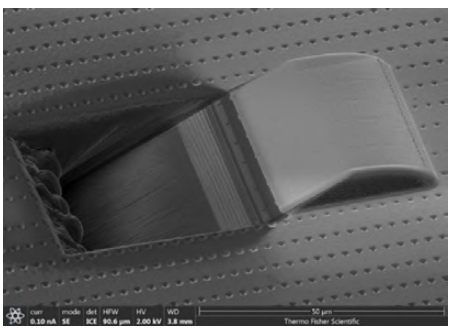


Figure 9. Deprocessing of logic devices with Dx (left) and imaged with SEM (right) for electrical fault isolation.



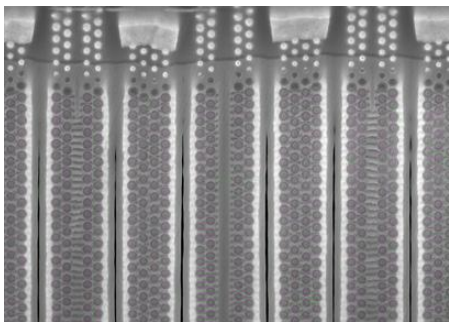
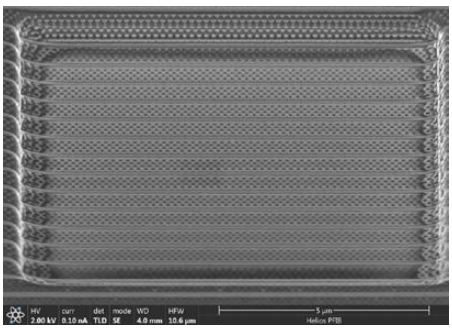


Figure 10. Diagonal mill preparation of 3D NAND devices (left) with SEM based memory cell metrology (right).



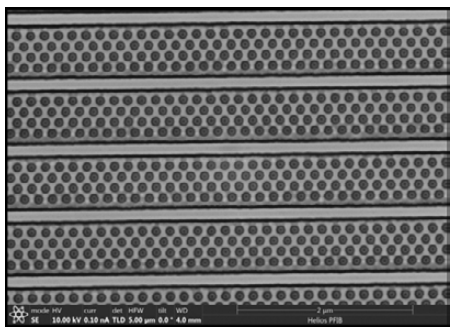


Figure 11. Bulk delayering of 3D NAND devices (left) and the resulting surface quality (right) for fault analysis.

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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
- 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

- Flexible 5-axis motorized stage:
  - X, Y range: 110 mm
  - Z range: 65 mm
  - Tilt: -40° to +65°
  - Rotation: 360° (endless)
  - X,Y repeatability: 3.0 µm
  - Max sample height: 85mm
  - Max sample size: 110mm with full rotation (larger samples possible with limited rotation)
  - Compucentric rotation and tilt
- NavCam+
- Sample types
  - Wafer pieces, packaged parts, system modules

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
- 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, Guided TEM prep and Auto Deprocessing

Key options

- MultiChem chemistries
  - Milling/Deprocessing: Dielectricetch, 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
- AutoTEM5
- Guided TEM Prep
- Auto Slice&View™ software
- WaferNav
- EBS3™ and EDS3™
- NEXS CAD Navigation, Synopsys Avalon Connectivity

Hardware options

- Metrology Workstation
- *In situ* Chunk or TEM lamella sample liftout
  - Easylift LT or EX nanomanipulator
- EBSD, EDS, WDS, SIMS analysis
- Bulk Silicon Trenching
- Wide Area Bulk Silicon Trenching
- Quick Loader

* 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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