Thermo Fisher
S C I E N T I F I C

Helios 5 UC DualBeam for Semiconductors

Enabling breakthrough innovations in the semiconductor industry with DualBeam Technology

The Helios 5 UC DualBeam redefines the standard in sample preparation and three-dimensional characterization through advanced focused-ion- and electron-beam performance, exclusive software, and an unprecedented level of automation and ease-of-use.

The Thermo Scientific™ Helios™ 5 UC DualBeam is carefully designed to meet the needs of scientists and engineers. The Helios 5 UC DualBeam combines the innovative Thermo Scientific™ Elstar™ Electron Column with high-current UC+ technology (for extremely high-resolution imaging and high materials contrast) with the Thermo Scientific Tomahawk Ion Column for fast, easy, and precise high-quality sample preparation. In addition to advanced electron and ion optics, the Helios 5 UC DualBeam incorporates a suite of industry-leading technologies that enables simple and consistent high-resolution S/TEM and atom probe tomography (APT) sample preparation, as well as high-quality subsurface and 3D characterization, even on highly challenging samples.

High-quality TEM sample preparation

Scientists and engineers constantly face new challenges that require highly localized characterization of increasingly complex samples with ever smaller features. The latest technological innovations of the Helios 5 UC DualBeam, in combination with easy-to-use, comprehensive software and Thermo Fisher Scientific application expertise, allow for fast and easy preparation of site-specific high-resolution (scanning) transmission electron microscopy (S/TEM) samples for a wide range of materials. In order to achieve high-quality results, final polishing with low-energy ions is required to minimize surface damage on the sample. The Tomahawk HT FIB Column delivers not only high-resolution imaging and milling at high voltages, but also has excellent low-voltage performance, enabling the creation of high-quality TEM lamella.

| Key Benefits |
|---|
| High-quality, site-specific sample preparation for TEM and APT using the high-throughput Tomahawk HT Ion Column |
| Fast and easy, fully automated, unattended, multi-site *in situ* and *ex situ* TEM sample preparation and cross-sectioning using optional AutoTEM 5 Software |
| Users of any experience level can quickly capture nanoscale information using the innovative Elstar Electron Column featuring SmartAlign and FLASH technologies |
| Reveal fine details with next-generation, higher-current UC+ monochromator technology, enabling sub-nanometer performance at low energies |
| Obtain complete sample information with sharp, refined , , and charge-free contrast from up to six integrated in-column and below-the-lens detectors |
| Access high-quality, multi-modal subsurface and 3D information with precise targeting of the region of interest using optional Auto Slice & View 4 Software |
| Fast, accurate, and precise milling and deposition of complex structures with critical dimensions less than 10 nm |
| Precise sample navigation tailored to individual application needs thanks to the high stability and accuracy of the 150 mm Piezo stage and in-chamber navigation camera |
| Artifact-free imaging based on integrated sample cleanliness management and dedicated imaging modes such as SmartScan and DCFI |

The Helios 5 UC DualBeam with Thermo Scientific AutoTEM™ 5 Software enables fully automated in situ TEM sample preparation. This allows users with any experience level to achieve high-quality results and significantly increases productivity through unattended sample preparation during the day or overnight.

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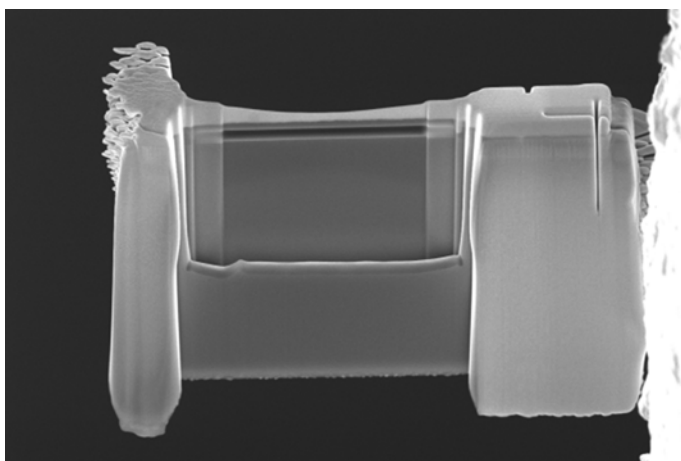
High-quality TEM lamella produced in less than one hour with the Helios DualBeam and AutoTEM 5 Software, which enables easy and automated TEM sample preparation.

High resolution with precise materials contrast

The Helios 5 UC DualBeam features an ultra-high-brightness electron source with next-generation UC+ monochromator technology that reduces the beam energy spread below 0.2 eV for beam currents up to 100 pA. This enables sub-nanometer resolution and high surface sensitivity at low landing energies. The Elstar Electron Column provides the foundation of the system's high-resolution imaging capability. It offers excellent nanoscale details across a wide range of working conditions, whether operating at 30 keV in S/TEM mode (to access structural information) or at lower energies (to obtain charge-free, detailed information from the surface). With its immersion mode and unique triple detection system located inside the column, the system is designed for simultaneous detector acquisition for angular and energy-selective secondary electron (SE) and backscattered electron (BSE) imaging. Quickly access detailed nanoscale information, not only top-down, but also on tilted specimens or cross-sections. Additional below-the-lens detectors and the electron beam deceleration mode ensure simultaneous collection of all signals to reveal nanoscale features in material surfaces or cross-sections. Fast, accurate, and reproducible results are obtained from the unique column design of the Elstar Column, which includes constant power lenses for higher thermal stability and electrostatic scanning for high deflection linearity and speed.

The Helios 5 UC DualBeam introduces novel SmartAlign Technology, which eliminates the need for any user alignments of the electron column. This minimizes maintenance and increases your productivity. In general, to achieve the best results on different materials, fine tuning of the beam would be required. This is typically done through an alignment sequence (focusing, lens centering, and stigmation), which can be challenging and time consuming. To address this, the Helios 5 UC DualBeam introduces FLASH Technology, a new image fine-tuning capability. With FLASH Technology, you only need to perform a simple mouse-gesture in the graphical user interface (a procedure similar to focusing the image) and the instrument will perform any necessary corrections "on-the-fly" to the stigmators and lens centering; it will also bring the image into focus. On average, FLASH Technology can result in up to a 10x improvement in the time required to obtain an optimized image.

High-quality subsurface and 3D information

Subsurface or 3D characterization are often required to better understand the structure and properties of a sample. Optional Thermo Scientific Auto Slice & View™ 4 Software offers high-quality, fully automated acquisition of multi-modal 3D datasets, including, among others, BSE imaging for maximum materials contrast, energy dispersive spectroscopy (EDS) for compositional information, and electron backscatter diffraction (EBSD) for microstructural and crystallographic information. Combined with Thermo Scientific Avizo™ Software, it delivers a unique workflow solution for high-resolution, advanced 3D characterization and analysis at the nanometer scale.

Full 200-mm wafer capability

The high-precision 150-mm stage with ≤1 µm accuracy allows for safe, precise, and automated XY and rotational navigation across the whole ≤200-mm wafer area including inspection of wafer edges. Combining Thermo Scientific™ iFast™ Software with the "Wafer Defects Navigation" package extends navigational functionality with automated recipes for SEM imaging, cross-sectional or lift-out sample preparation, and serial sectioning tomography (Slice & View)

Specifications
Electron optics

- Elstar extreme high-resolution field emission 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-alignments-free technology
- 60-degree dual objective lens with pole piece protection allows tilting of 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:
  - 0.6 nm at 30 kV STEM
  - 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

Tomahawk HT Ion Column with superior high-current performance

- Ion beam current range: 1 pA – 100 nA
- Accelerating voltage range: 500 V – 30 kV
- Two-stage differential pumping
- Time-of-flight (TOF) correction
- 15-position aperture strip
- Max. horizontal field width: 0.9 mm at beam coincidence pt.
- Minimum source lifetime: 1,000 hours

Ion beam resolution at coincident point

- 4.0 nm at 30 kV using preferred statistical method
- 2.5 nm at 30 kV using selective edge method

Detectors

- Elstar in-lens SE/BSE detector (TLD-SE, TLD-BSE)
- Elstar in-column SE/BSE detector (ICD)
- Elstar in-column BSE detector (MD)
- Everhart-Thornley SE detector (ETD)
- IR camera for viewing sample/column
- High-performance in-chamber electron and ion detector (ICE) for secondary ions (SI) and electrons (SE)*
- Thermo Scientific In-chamber Nav-Cam Camera for sample navigation
- Retractable, low-voltage, high-contrast, directional, solid-state backscatter electron detector (DBS)*
- Retractable STEM 3+ detector with BF/ DF/ HAADF segments*
- Integrated beam current measurement

Stage and sample

- High-precision five-axis motorized stage with Piezo-driven XYR axis:
- XY range: 150 mm
- Z range: 10 mm
- Rotation: 360° (endless)
- Tilt range: -10° to +60°
- XY repeatability: 1 μm

- Max sample height: Clearance 55 mm to eucentric point
- Max sample weight: 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: <2.6×10^{-6} mbar (after 24-hour 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

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 holders available by request*

Image processor

- Dwell time range from 25 ns/pixel to 25 ms/pixel
- Up to 6144 × 4096 pixels
- File type: TIFF (8-, 16-, 24-bit), BMP or JPEG standard
- SmartSCAN Modes (256 frame average or integration, line integration and averaging, interlaced scanning)
- DCFI (Drift Compensated Frame Integration)

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 Scientific Sales representatives 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*

Supporting software

- "Beam per view" graphical user interface concept, with up to four simultaneously active quads
- Thermo Scientific™ SPI™ (simultaneous FIB patterning and SEM imaging), iSPI™ (intermittent SEM imaging and FIB patterning), iRTM™ (integrated real time monitor) and FIB

Immersion Modes for advanced, real-time SEM and FIB process monitoring and endpointing

- Patterns supported: lines, rectangles, polygons, circles, donut, cross-section and cleaning cross-section
- Directly imported BMP file or stream file for 3D milling and deposition
- Material file support for "minimum loop time," beam tuning and independent overlaps
- Image registration enabling sample navigation in an imported image
- Sample navigation on an optical image

Accessories*

- GIS (Gas Injection System) Solutions:
    - Single GIS: up to 5 independent units for enhanced etching or deposition
    - Thermo Scientific™ MultiChem™ Gas Delivery System: up to six chemistries on the same unit for advanced etching and deposition controls
- GIS – Beam chemistry options**
    - Platinum deposition
    - Tungsten deposition
    - Carbon deposition
    - Insulator deposition II
    - Gold deposition
    - Thermo Scientific™ Enhanced Etch™ Gas Chemistry Solution (iodine, patented)
    - Insulator enhanced etch (XeF$_2$)
    - Thermo Scientific™ Delineation Etch™ Gas Chemistry Solution (patented)
    - Selective carbon mill (patented)
    - Empty crucibles for Thermo Fisher Scientific-approved user-supplied materials
    - More beam chemistries available upon request
- Thermo Scientific™ EasyLift™ NanoManipulator for precise *in situ* sample manipulation
- FIB charge neutralizer
- Analysis: EDS, EBSD, WDS
- Thermo Scientific™ QuickLoader™ Vacuum Technology: Loadlock for fast sample exchange without breaking system vacuum

- Exclusive Thermo™ Scientific CryoMAT™ Kit for material science cryo applications
- Cryo solutions from external vendors
- Thermo Scientific™ Acoustic Enclosure
- Thermo Scientific™ CryoCleaner™ Decontamination Device

Software options*

- Thermo Scientific™ AutoTEM™ Software for automated S/TEM sample preparation
- Thermo Scientific™ AutoScript™ 4 Software: advanced automation suite for DualBeams
- Thermo Scientific™ Maps™ Software for automatic acquisition of large images and optional correlative work
- Thermo Scientific™ NanoBuilder™ Software: advanced proprietary CAD-based (GDSII) solutions for FIB and beam deposition optimized nanoprototyping of complex structures
- Thermo Scientific™ Auto Slice and View™ 4 Software: automated sequential mill and view to collect series of slices images, EDS or EBSD maps for 3D reconstruction
- Thermo Scientific™ Avizo™ Software for 3D reconstruction and analysis
- Thermo Scientific™ NEXS for CAD navigation
- Web-enabled data archive software

Warranty and training

- 1 year warranty
- Choice of service maintenance contracts
- Choice of operation/application training contracts

Documentation and support

- Online user guidance
- User operation manual
- Prepared for Thermo Scientific™ RAPID™ Service (remote diagnostic support)

* Optional

** Some beam chemistries may be available only on the MultiChem or Single GIS

Learn more at **thermofisher.com/helios-5**

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