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Helios 5 UX DualBeam

Enabling breakthrough innovations with DualBeam technology—faster and easier than ever before

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

The Thermo Scientific™ Helios™ 5 UX DualBeam is part of the fifth generation of the industry-leading Helios DualBeam family. It is carefully designed to meet the needs of scientists and engineers, combining the innovative Thermo Scientific™ Elstar™ Electron Column with high-current UC+ technology for extreme high-resolution imaging and the highest materials contrast with the superior Thermo Scientific™ Phoenix™ Focused Ion Beam (FIB) Column for the fastest, easiest and most precise high-quality sample preparation. In addition to the most advanced electron and ion optics, the Helios 5 UX DualBeam incorporates a suite of state-of-the-art technologies that enables simple and consistent high-resolution S/TEM and atom probe tomography (APT) sample preparation, as well as the highest-quality subsurface and 3D characterization, even on the most challenging samples.

Highest-quality, ultra-thin 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 UX DualBeam, in combination with the easiest to use, comprehensive software and Thermo Fisher Scientific application expertise, allow for the fastest and easiest preparation of site-specific, ultra-thin HR-S/TEM samples for a wide range of materials. In order to achieve the highest quality results, final polishing with very low-energy ions is required to minimize surface damage on the sample. Our most advanced Phoenix FIB Column not only delivers high-resolution imaging and milling at high voltages, it now extends unmatched FIB performance down to accelerating voltages as low as 500 V, enabling the creation of ultra-thin TEM lamella with sub-nm damage layers.

Key benefits

Highest-quality, site-specific, ultra-thin sample preparation for TEM and APT using the new Phoenix Ion Column with unmatched low-voltage performance

Fastest and easiest, fully automated, unattended, multi-site *in situ* and *ex situ* TEM sample preparation and cross-sectioning using optional AutoTEM 5 Software

Shortest time to nanoscale information for users with any experience level using best-in-class Elstar Electron Column featuring SmartAlign and FLASH technologies

Reveal the finest details with the next-generation UC+ monochromator technology with higher current, enabling sub-nanometer performance at low energies

The most complete sample information with sharp, refined and charge-free contrast obtained from up to six integrated in-column and below-the-lens detectors
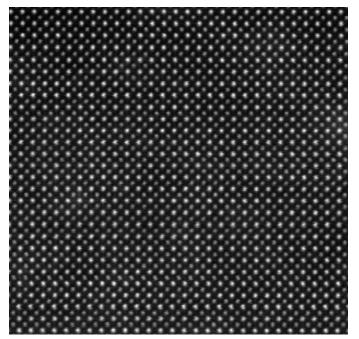
The highest-quality, multi-modal subsurface and 3D information with the most precise targeting of the region of interest using optional Auto Slice & View 4 (AS&V4) Software

Fast, accurate and precise milling and deposition of complex structures with critical dimensions of less than 10 nm

Precise sample navigation tailored to individual application needs thanks to the high stability and accuracy of 150 mm Piezo stage and in-chamber Nav-Cam Camera

Artifact-free imaging based on integrated sample cleanliness management and dedicated imaging modes such as DCFI and SmartScan Modes

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60kV HR-STEM image of highest-quality, ultra-thin lamella (<100> $SrTiO_3$) produced with Helios 5 UX DualBeam.

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

Highest resolution, most precise materials contrast

The Helios 5 UX DualBeam features an ultra-high-brightness electron source with next-generation UC+ monochromator technology to reduce the beam energy spread below 0.2 eV for beam currents up to 100 pA. This enables sub-nanometer resolution and highest surface sensitivity at low landing energies. The innovative Elstar Electron Column provides the foundation of the system's unprecedented high-resolution imaging capability. It offers the best nanoscale details, using the widest range of working conditions, whether operating at 30 keV in STEM 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 SE and BSE imaging. Fast access to the most detailed nanoscale information is guaranteed, not only top-down, but also on tilted specimens or cross sections. Additional below-the-lens detectors and the electron beam deceleration mode ensure the fast and easy simultaneous collection of all signals to reveal the smallest features in material surfaces or cross sections. Fast, accurate and reproducible results are obtained thanks to the unique column design of the Elstar Column, which includes constant power lenses for higher thermal stability and electrostatic scanning for higher deflection linearity and speed.

The Helios 5 UX DualBeam introduces novel SmartAlign technology. It eliminates the need for any user alignments of the electron column, which not only minimizes the maintenance, but also increases the operator's productivity. In general, to achieve the best results on different materials, fine tuning of the beam would be required.

It is typically done by the alignment sequence of focusing, lens centering and stigmation, which can be challenging and time consuming. To address this, the Helios 5 UX DualBeam introduces FLASH technology, a new fine image 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 introduce any necessary corrections "on-the-fly" to the stigmators and lens centering, as well as bring the image to focus. On average, FLASH technology can result in up to a 10x improvement in the time required to obtain an optimized image.

Highest quality subsurface and 3D information

Subsurface or three-dimensional characterization is often required to better understand the structure and properties of a sample. The Helios 5 UX DualBeam with optional Thermo Scientific™ Auto Slice & View™ 4 Software allows for the highest-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 highest-resolution, advanced 3D characterization and analysis at the nanometer scale.

Enabling real-world experimentation

Designed for the most challenging electron microscopy tasks in materials science, the Helios 5 UX DualBeam can be equipped with a fully integrated, extremely fast, MEMS-based heating stage for sample characterization in closer to real-world working conditions. The Helios 5 UX DualBeam combines expanded deposition and etching capabilities, enhanced sample flexibility and control, and Thermo Scientific™ AutoScript 4™ Software for customized automation to create the most advanced DualBeam™ system ever assembled—all backed by our expert application and service support.

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

Phoenix Ion Column with superior high-current and low-voltage performance

- Ion beam current range: 1 pA – 65 nA
- Accelerating voltage range: 500 V – 30 kV
- Two-stage differential pumping
- Time-of-flight (TOF) correction
- 23-position aperture strip
- Max. horizontal field width: 0.7 mm at beam coincidence point
- 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)

- Sample navigation with in-chamber Thermo Scientific Nav-Cam Camera
- 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

- AS&V4 Software: automated sequential mill and view to collect series of slices images, EDS or EBSD maps for 3D reconstruction

- Avizo Software for 3D reconstruction and analysis

- 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

Find out more at **thermofisher.com/EM-Sales**

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