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DATASHEET

Helios 5 Hydra CX DualBeam

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

The Helios 5 Hydra CX DualBeam opens a new, unexplored application space and delivers unmatched capabilities for large volume 3D characterization, Ga^+ free sample preparation and precise micromachining.

The Thermo Scientific™ Helios™ 5 Hydra CX DualBeam is part of the fourth generation of the industry-leading Helios DualBeam family. It combines the new, innovative multiple ion species PFIB column with the monochromated Thermo Scientific Elstar™ SEM Column to provide the most advanced focused ion- and electron-beam performance. Intuitive software and an unprecedented level of automation and ease-of-use allow observation and analysis of relevant subsurface volumes by scientists and engineers.

The unique multiple ion species PFIB column enables the four ion species (Xe, Ar, O, N) to be used as a primary beam with a patented, automated, fast and easy switching capability. This enables you to explore new application space and optimize existing use cases. For example, S/TEM sample quality can be improved by using Ar^+ for the final low-energy polishing. At the same time, the PFIB column provides superior performance at all operating conditions, enabling you to perform the most challenging and demanding tasks at the micro scale.

The Helios 5 Hydra CX DualBeam is an all-in-one instrument without the constraint of choosing between ion columns suited for limited applications or a requirement for complex accessories to improve cut face quality (e.g., milling curtain mitigation). The innovative Elstar Electron Column with high-current UC+ technology provides extreme high-resolution imaging and the highest materials contrast. The newest chemistries developed by Thermo Fisher Scientific, which are available via the optional Thermo Scientific MultiChem™ or GIS Gas Delivery Systems, further enhance the milling throughput, precision and control.

In addition to the most advanced electron and ion optics, the Helios 5 Hydra CX DualBeam incorporates a suite of state-of-the-art software that enables simple and consistent high-resolution S/TEM and atom probe tomography (APT) sample preparation, as well as the highest throughput and high-quality large volume subsurface and 3D characterization, even on the most challenging samples.

Key benefits

Largest application space with unique ion source delivering four fast, switchable ion species: Xe, Ar, O, N

Highest quality Ga^+ free TEM and APT sample preparation with Xe, O or Ar thanks to the new PFIB column enabling 500 V final polishing and delivering superior performance at all operating conditions

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

Highest throughput and quality statistically relevant 3D characterization, cross-sectioning and micromachining using next-generation 2.5 µA Plasma FIB column

Access high-quality, multi-modal subsurface and 3D information with precise targeting of the region of interest using optional Auto Slice & View 4 (AS&V4) Software

Shortest time to nanoscale information for users with any experience level with SmartAlign and FLASH technologies

Reveal the finest details using the best-in-class Elstar Electron Column with high-current UC+ monochromator technology, 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

Most advanced capabilities for electron and ion beam-induced deposition and etching on DualBeam systems with optional MultiChem or GIS Gas Delivery Systems

Precise sample navigation tailored to individual application needs thanks to the high-flexibility 110 mm stage and optional in-chamber Nav-Cam Camera

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

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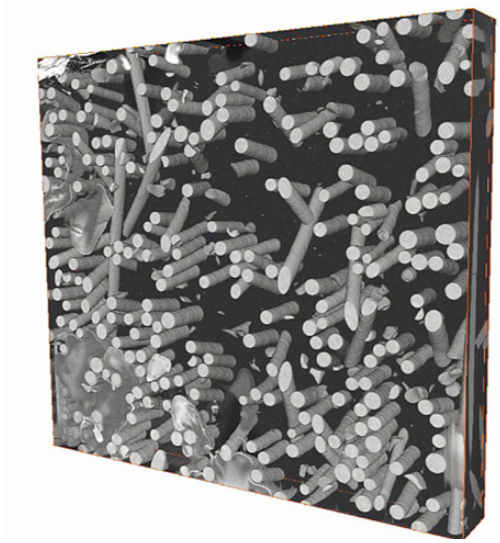
Highest quality large-volume subsurface and 3D information for the widest range of materials

Subsurface or three-dimensional characterization is often required to better understand the material properties of a sample. In many cases, large volumes, inaccessible by conventional Ga^+ FIB instruments, are necessary to obtain representative and relevant results. The excellent high-current performance of the Helios 5 Hydra CX DualBeam with optional Thermo Scientific Auto Slice & View™ 4 (AS&V4) Software enables the highest quality, fully automated acquisition of large-volume 3D datasets in a multitude of modalities, including BSE imaging for maximum materials contrast, energy dispersive spectroscopy (EDS) for compositional information, and electron backscatter diffraction (EBSD) for microstructural and crystallographic information. Experimentation with different ion species can help optimize the throughput and cut face quality, as some materials are more difficult to process with traditional Ga or Xe FIBs. The combination of the newest generation of PFIB technology with Thermo Scientific Avizo™ Software for visualization delivers a unique workflow solution for the highest-resolution, advanced 3D characterization and analysis at the nanometer scale.

Highest quality Ga^+ free TEM sample preparation

To understand new materials or to find the root causes of failures, you 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 Hydra CX 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 for a wide range of materials. To achieve the highest quality results, final polishing with low-energy ions is required to minimize surface damage on the sample. Our new Multiple Ion Species PFIB column not only provides high-resolution imaging and milling at all operating conditions, it now extends the capabilities to deliver a focused Ar^+ ion beam and accelerating voltages as low as 500 V, enabling the creation of highest quality, ultra-low-damage TEM lamella.

The combination of the Helios 5 Hydra CX DualBeam with Thermo Scientific AutoTEM™ 5 Software enables 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.



3D reconstruction of an automotive oil filter casing (polymer/glass fiber composite) acquired with a Helios Hydra CX DualBeam using O^+ focused ion beam and AS&V4 Software for automated serial sectioning. HFW is 350 µm.



Highest resolution with the most precise materials contrast

The Helios 5 Hydra CX 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 the highest surface sensitivity, even below 1 kV. 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 to access structural information or at lower energies to obtain charge-free, detailed information from the surface. With its unique detection system located inside the column and its immersion mode, 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 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 Elstar Column's unique design, which includes advanced auto alignments, constant power lenses for higher thermal stability, and electrostatic scanning for higher deflection linearity and speed.

The Helios 5 Hydra CX 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 Hydra CX 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 technolgy can result in up to a 10x improvement in the time required to obtain an optimized image.

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 at all accelerating voltages
- 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 unique Inductively Coupled Plasma (ICP) source supporting four ion species with fast switching capability

- Ion species (primary ion beam): Xe, Ar, O, N
- Switching time <10 minutes, only software operation
- Ion beam current range: 1.5 pA to 2.5 µA
- Accelerating voltage range: 500 V - 30 kV
- Maximum horizontal field width: 0.9 mm at beam coincidence point

Xe 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 Column in-lens SE/BSE detector (TLD-SE, TLD-BSE)
- Elstar Column in-column SE/BSE detector (ICD)*
- 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)
- 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

Stage and sample
Flexible, five-axis motorized stage:

- XY range: 110 mm
- Z range: 65 mm
- Rotation: 360° (endless)
- Tilt range: -38° to +90°
- XY repeatability: 3 µm
- Max sample height: Clearance 85 mm to eucentric point
- Max sample weight at 0° tilt: 5 kg (including sample holder)
- Max sample size: 110 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 holder(s) available by request*

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

System control
- 64-bit GUI with Windows 7, 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 representatives for available language packs
- Two 24-inch widescreen monitors (1920×1200 pixels) for system GUI and full-screen image
- Microscope control and support computers seamlessly share 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 4 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, donuts, cross-sections and cleaning cross-sections
- 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 enables sample navigation in an imported image
- Sample navigation on an optical image

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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 controls
- GIS – Beam chemistry options**
  - Platinum deposition
  - Tungsten deposition
  - Carbon deposition
  - Insulator deposition II
  - Gold deposition
  - Thermo Scientific Enhanced Etch™ System (iodine, patented)
  - Insulator enhanced etch (XeF_2)
  - Thermo Scientific Delineation Etch™ System (patented)
  - Dx Delayering
  - Empty crucibles for Thermo Fisher Scientific-approved user supplied materials
  - More beam chemistries available upon request
- FIB Charge Neutralizer
- Analysis: EDS, EBSD, WDS
- Thermo Scientific EasyLift™ NanoManipulator for precise *in situ* sample manipulation
- Thermo Scientific QuickLoader™ Loadlock for fast sample exchange without breaking system vacuum
- Cryo solution for DualBeam
  - Exclusive Thermo Scientific CryoMAT Module for materials science cryo applications
  - 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
- 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

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™ Support (remote diagnostics)

* Optional

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

Find out more at **thermofisher.com/HeliosHydra**

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