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DATASHEET

Apreo 2 SEM

Unmatched versatility powered by ColorSEM Technology

Resolve gray areas with the Thermo Scientific Apreo 2 SEM, a high-performance field emission gun (FEG) SEM with unique, live elemental imaging and an advanced, automated optics system that enables you to focus on your research rather than microscope performance.

The Thermo Scientific™ Apreo SEM has earned a reputation for its versatility and high-quality imaging performance—even on magnetic or other traditionally difficult samples. The new Apreo 2 SEM improves upon the original by expanding its already impressive resolution specifications as well as adding a number of new features designed to make the power of the Apreo SEM's advanced capabilities even more accessible.

Multi-purpose labs see a wide spectrum of users looking to image an equally wide range of sample types. Typically, this would mean that users are required to navigate a range of alignments before acquiring data. The Apreo 2 SEM introduces SmartAlign Technology on a workhorse SEM platform. SmartAlign Technology virtually removes the need for user alignments. With the broad base of alignment automation covered, you can focus on obtaining data, as the system is always aligned and ready to image. Even with alignments covered via automation, fine tuning of the beam is typically required to obtain the best image. Enter FLASH technology. FLASH automates the fine-tuning process. With a few mouse movements, the Apreo 2 SEM will execute any necessary corrections to lens centering, the stigmators, and final focus of the image. Combining SmartAlign and FLASH Technologies means that even users new to electron microscopy can access the high-end performance of the Apreo 2 SEM.

Key benefits

All-round nanometer or sub-nanometer resolution performance on materials ranging from nanoparticles, powders, catalysts, and nanodevices to bulk magnetic samples, even at long (10 mm) working distances

Extreme flexibility for handling a wide range of sample types, including insulators, sensitive materials, or magnetic samples, and for collecting the data that matters most to your application

Less time spent on maintenance with an optics system that aligns itself (SmartAlign Technology)

Elemental information at your fingertips with ColorSEM Technology; live quantitative elemental mapping for unprecedented time to result and ease of use

Advanced automation including FLASH Technology for automatic image fine tuning, undo, user guidance, maps tiling, and stitching



Microstructure of copper-silver alloy revealed with ColorSEM technology. Silicate contamination is immediately recognized when inspecting samples with live compositional imaging via ColorSEM.

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The Apreo 2 SEM's feature set also expands to analytical capability by integrating Thermo Scientific ColorSEM Technology into the main microscope UI. ColorSEM Technology integrates compositional mapping with the traditional imaging capabilities of the SEM. Once ColorSEM Technology is enabled, the result is an instant, colorized image showing the high-fidelity microstructural details overlain with compositional information in the same image. ColorSEM Technology improves the time to data for basic EDS information and makes moving to key areas of interest a quick trip rather than a long journey. The live color information is complimented by the addition of other conventional EDS functionality (point, line scan, area mapping, and reporting) directly integrated into the main UI. The result is an easy-to-use system that allows you to focus on discovery rather than manipulating multiple software packages.

The Apreo SEM's unique Trinity in-column detection system is present, but now with improved performance. The Apreo 2 SEM remains the platform of choice for research on nanoparticles, catalysts, powders, and nanodevices, thanks to its innovative final lens design that does not compromise on magnetic sample imaging performance. The electrostatic final lens (both Apreo 2 C and Apreo 2 S systems) enables simultaneous in-column detection at high resolution, while the Apreo 2 S SEM combines the electrostatic final lens with magnetic immersion into a compound lens. The compound final lens further boosts resolution performance, providing a resolution of 0.9 nm at 1 kV without additional beam deceleration, while offering unique options for signal filtering.

The Apreo 2 SEM ensures a short time to data with its T1 in-lens backscatter detector, which is positioned close to the sample to collect the maximum amount of signal. Unlike other backscatter detectors, this fast detector makes materials contrast available at all times, even when navigating, while tilted, or at short working distances. On sensitive samples, the detector provides clear backscatter images at currents as low as a few pA. The compound final lens on the Apreo 2 S SEM extends the possibilities of the T1 BSE detector even further, with energy filtering that enables more precise materials contrast as well as charge-free imaging of insulating samples.

Every Apreo 2 SEM comes standard with the widest range of features to address insulating samples, including high-vacuum techniques such as SmartScan mode, drift compensated frame integration (DCFI), and charge filtering. The Apreo 2 S SEM introduces PivotBeam mode, an integrated routine for inducing selected area channeling pattern (SACP) for orienting materials based on crystallography. PivotBeam mode is fully automated and available with a single click.

For the most challenging applications, the Apreo 2 SEM charge mitigation routines can include optional low vacuum (up to 500 Pa) to mitigate charge on any sample while providing excellent resolution and large analytical currents with field-proven through-the-lens differential pumping and dedicated LoVac detectors. The Apreo 2 S SEM with the low Vacuum (lowVac) option now comes standard with an automated routine to insert and remove the pressure limiting aperture (PLA). This allows you to focus on choosing the right conditions for imaging rather than stopping to manually adjust the system for lowVac imaging performance.

Additionally, the Apreo 2 SEM comes standard with a flexible chamber that accommodates up to three EDS/WDS ports for fast and sensitive X-ray measurements. It also features a coplanar EDS/EBSD/TKD arrangement and compatibility with (cryo) CL, Raman, EBIC, and other techniques.

All these capabilities are complemented by easy sample handling and the familiar xT user interface, saving time for novice and expert users alike. A customizable UI provides many options for user guidance, automation, and remote operation. With unique technologies like SmartAlign, FLASH, and ColorSEM Technology added to an already advanced microscope, the Apreo 2 SEM adds additional flexibility to any lab while providing advanced imaging capability for all users.



Electron optics

- High-resolution field emission SEM column with:
  - High-stability Schottky field emission gun to provide stable high-resolution analytical currents
  - Compound final lens: a combined electrostatic, field-free magnetic and immersion magnetic objective lens*
  - 60° objective lens geometry: allows tilting larger samples
  - Automated heated apertures to ensure cleanliness and touch-free aperture changes
- SmartAlign Technology: user-alignment-free technology
- Through-the-lens differential pumping for low vacuum* reduces beam skirting for the most accurate analysis and highest resolution
- Beam deceleration with stage bias from -4,000 V to +600 V
- Continuous beam current control and optimized aperture angle
- Double stage scanning deflection
- Easy gun installation and maintenance: auto bake-out, auto start, no mechanical alignments
- PivotBeam Mode for selected area electron channeling, also known as "rocking beam" mode (Apreo 2 S model only)
- Guaranteed minimum source lifetime: 24 months

Electron beam resolution

Model	Apreo 2 C	Apreo 2 S
Final lens	Electrostatic	Compound
High vacuum		
30 kV (STEM)	0.7 nm	0.7 nm
15 kV (BD)	0.9 nm	0.5 nm
15 kV (6.4 nA, WD 10 mm)		1.9 nm
1 kV	1.2 nm	0.9 nm
1 kV (BD)	1.0 nm	0.8 nm
1 kV (BD, WD 10 mm)		1.0 nm
500 V (BD)	1.2 nm	0.8 nm
200 V (BD)		1.2 nm
Low vacuum*		
3 kV (30 Pa)	1.8 nm	1.8 nm
15 kV (30 Pa)	1.2 nm	1.2 nm

BD: beam deceleration mode. WD: working distance. Resolutions are at optimum working distance unless specified otherwise. By default, upon final installation, the resolution is proven in the systems acceptance test at 1 kV and 30 kV in high vacuum and with immersion switched on if applicable.

Electron beam parameter space

- Beam current range: 1 pA to 50 nA (400 nA configuration also available)
- Accelerating voltage range: 200 V – 30 kV
- Landing energy range: 20 eV – 30 keV
- Max. horizontal field width: 3 mm at 10 mm WD (corresponds to 29x minimum magnification)

Chamber

- Inner width: 340 mm
- Analytical working distance: 10 mm
- Ports: 12
- EDS take-off angle: 35°
- Three simultaneous EDS detectors possible, two at 180°
- Coplanar EDS/EBSD orthogonal to the tilt axis of the stage

Detectors

The Apreo 2 SEM detects up to four signals simultaneously from any combination of the available detectors or detector segments*:

- Trinity Detection System (in-lens and in-column)
  - T1 segmented lower in-lens detector
  - T2 upper in-lens detector
  - T3 in-column detector*
- ETD—Everhart-Thornley SE detector
- DBS—Retractable segmented under-the-lens BSED*
- Low-vacuum SE detector*
- DBS-GAD—Lens-mounted gaseous analytical BSED*
- STEM 3+—Retractable segmented detector (BF, DF, HADF, HAADF)*
- IR-CCD
- Thermo Scientific Nav-Cam+™ Camera (chamber-mounted)

ColorSEM Technology*

ColorSEM Technology provides real-time quantitative compositional information by coloring the SEM image. ColorSEM Technology is based on energy dispersive X-ray spectroscopy (EDS) with reliable Noran quantification. Conventional EDS functions (point & ID, linescan, region, element maps) are included and can directly be applied to the SEM image.

- EDS detector size: 10, 30, or 60 mm^2
- Light element sensitivity down to beryllium
- 127 eV or 129 eV spectral resolution
- Optional motorized slide available
- Advanced mode with Pathfinder*

Vacuum system

- Complete oil-free vacuum system
- 1 × 240 l/s TMP
- 1 × PVP-scroll
- 2 × IGP
- Chamber vacuum (high vacuum) <6.3 × 10^{-6} mbar (after 12 hours pumping)
- Evacuation time: ≤3.5 minute
- Optional low-vacuum mode
- 10–500 Pa chamber pressure
- Automatic Pressure Limiting Aperture (PLA) Loader

Sample holders

- Standard multi-purpose holder uniquely mounts directly onto the stage, hosts up to 18 standard stubs (Ø12 mm), three pre-tilted stubs, cross-section samples, and two pre-tilted row-bar holders* (38° and 90°). Tools are not required to mount a sample.
- Each optional row-bar accommodates 6 S/TEM grids
- Wafer and custom holders*

Stage and sample	
Type	Eucentric goniometer stage, 5 axes motorized
XY	110×110 mm
Repeatability	<3.0 µm (@ 0° tilt)
Motorized Z	65 mm
Rotation	n × 360°
Tilt	-15° / +90°
Max. sample height	Clearance 85 mm to eucentric point
Max. sample weight	• 500 g in any stage position • Up to 5 kg at 0° tilt (some restrictions apply)
Max. sample size	122 mm diameter with full X, Y, rotation (larger samples possible with limited stage travel or rotation)

System control

- 64-bit GUI with Windows 10, keyboard, optical mouse
- 24-inch LCD display, WUXGA 1920×1200 (second monitor optional)
- Customizable graphical user interface, with up to 4 simultaneously active views
- FLASH automated image tuning for focus, lens align, and stigmator
- Image registration
- Navigation montage
- Image analysis software
- Undo / Redo functionality
- User guidance for basic operations / applications
- Optional joystick
- Optional manual user interface (knob board)

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Image processor
- Dwell time range from 25 ns to 25 ms/pixel
- Up to 6144×4096 pixels
- File type: TIFF (8-, 16-, 24-bit), JPEG or BMP
- Single-frame or 4-view image display
- SmartScan Mode (256-frame average or integration, line integration and averaging, interlaced scanning)
- DCFI (drift compensated frame integration) Mode
- Digital image improvement and noise reduction filter

Accessories (optional)
- Sample / chamber cleaning: CryoCleaner, Integrated Plasma Cleaner
- Analysis: EDS, EBSD, WDS, CL, Raman
- Thermo Scientific QuickLoader™ Load Lock for fast sample transfer
- Navigation: correlative navigation, Thermo Scientific Maps™ Software tiling and stitching
- Gas injection: up to 2 units (other accessories may limit number of GIS available) for beam-induced deposition of:
  - Platinum
  - Tungsten
  - Carbon
- Manipulators
- Cryo-stage
- Electrical probing / multi-probing stations
- Electrostatic beam blanker

Software options
- Maps Software for automatic large area acquisition using tiling and stitching; correlative work
- Thermo Scientific AutoScript™ 4 Software—Python-based application programming interface
- TopoMaps for image colorization, image analysis, and 3D surface reconstruction
- Advanced image analysis software
- Remote control software

Documentation
- Online user guidance
- Operating instructions handbook
- Online help
- Prepared for RAPID (remote diagnostic support)
- Free access to online resources for owners

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

Installation requirements
(Refer to preinstall guide for detailed data)
- Power:
  - Voltage 100–240 V AC (-6%, +10%)
  - Frequency 50 or 60 Hz (±1%)
  - Consumption: <3.0 kVA for basic microscope
- Earth resistance <0.1 Ω
- Environment:
  - Temperature (20 ± 3)°C
  - Relative humidity below 80%
  - Stray AC magnetic fields <40 nT asynchronous, <100 nT synchronous for line times, 20 ms (50 Hz mains) or 17 ms (60 Hz mains)
- Minimum door size: 0.9 m wide × 1.9 m high
- Weight: column console 980 kg
- Dry nitrogen recommended for venting
- Compressed air 4–6 bar, clean, dry and oil-free
- System chiller
- Acoustics: site survey required, as acoustic spectrum relevant
- Floor vibrations: site survey required, as floor spectrum relevant
- Optional active vibration isolation table

Consumables (partial list)
- Replacement Schottky electron source module

*** Optional**

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

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