

Apreo 2 SEM

Unmatched versatility powered by ChemiSEM 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 Apreo 2 SEM improves its impressive resolution specifications and introduces live quantitative elemental mapping. A number of other new features are designed to make its advanced capabilities accessible for all users.

Multi-purpose labs see a wide spectrum of users looking to image a 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 Smart Align Technology to optimize image acquisition settings and remove 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. Thanks to Smart Align Technology and automated fine tuning processes (FLASH), new users can easily access the high-end performance of the Apreo 2 SEM.

The Apreo 2 SEM's feature set also expands to analytical capability by integrating Thermo Scientific™ ChemiSEM™ Technology into the main microscope UI. ChemiSEM Technology revolutionizes and simplifies EDS analysis by fully integrating SEM and EDS functions into a single, cohesive user interface. Based on live quantification and building on decades of expertise in EDS analysis, the technology provides elemental information quickly and easily, guaranteeing reliable results. And because ChemiSEM Technology is always on, it can dramatically shorten time to results, highlight features that would have previously gone unnoticed, and provide more complete information.

Key features

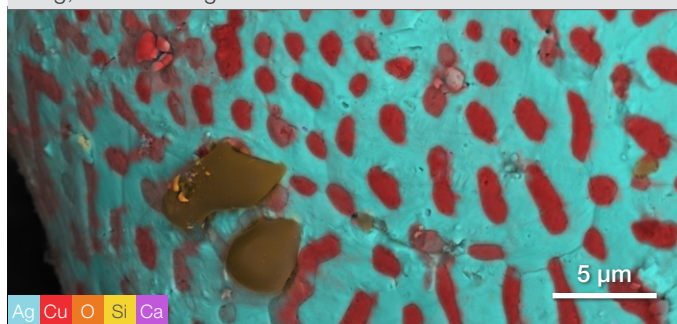
All-round nanometer or sub-nanometer resolution performance on materials ranging from nanoparticles, powders, catalysts, and nanodevices to bulk magnetic samples, even at long (10 mm) working distances

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 ChemiSEM 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 ChemiSEM technology. Silicate contamination is immediately recognized when inspecting samples with live compositional imaging via ChemiSEM.



ChemiPhase image showing different phases present in a complex inclusion in steel.

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 (available on Apreo 2 C and Apreo 2 S SEMs) 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.

For the most challenging applications, the Apreo 2 SEM's 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.

All these capabilities are complemented by easy sample handling and an easy-to-use microscope user interface, saving time for novice and expert users alike. A customizable user interface provides many options for user guidance, automation, and remote operation. With unique technologies like SmartAlign, FLASH, and ChemiSEM 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 (optional)
 - 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 (optional) 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 (optional)		
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 highvacuum 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 (optional):

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

ChemiSEM Technology (optional)

- EDS detector size: 10, 30, or 60 mm²
- Light element sensitivity down to beryllium
- 127 eV or 129 eV spectral resolution
- Optional motorized slide available

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 (optional) (38° and 90°). Tools are not required to mount a sample.
- Each optional row-bar accommodates 6 STEM grids
- Wafer and custom holders (optional)

Stage and sample

Type	Eucentric goniometer stage, 5 axes motorized
XY	110x110 mm
Repeatability	<math><3.0 \mu\text{m}</math> (@ 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
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)

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
- CleanConnect Sample Transfer Device

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 requirement

(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

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