ThermoFisher SCIENTIFIC

Quattro ESEM

Ultra-versatile high-resolution SEM with environmental capability

The Thermo Scientific™ Quattro™ ESEM combines all-around imaging performance with an environmental mode (ESEM) that allows you to study samples in their natural state. The Quattro ESEM features Thermo Scientific™ ChemiSEM™ Technology, which provides live, fully integrated, and quantitative chemical analysis.

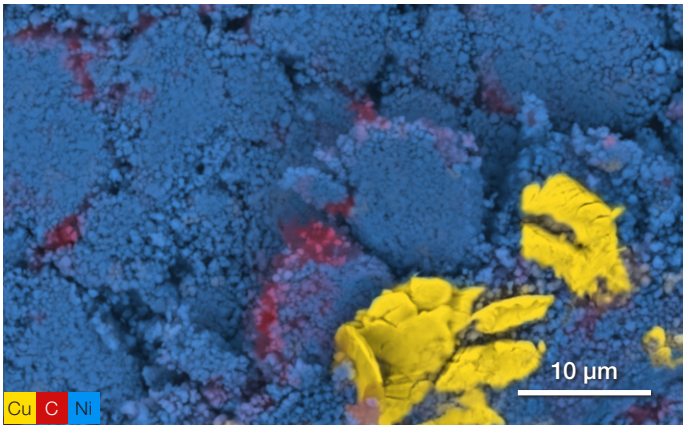
Today's research laboratories expect a modern SEM to accommodate a wide variety of samples, offer excellent image quality, and minimize sample preparation. The Quattro ESEM's field emission gun (FEG) delivers excellent resolution in a wide range of conditions as well as tunable contrast through a wide selection of detectors. In high vacuum, these include the Everhart-Thornley detector (ETD), a retractable under-the-lens directional backscatter detector (DBS), and STEM and cathodoluminescence detectors.

The Quattro ESEM simultaneously acquires and displays images from multiple detectors and detector segments with a single scan, which reduces beam exposure for sensitive samples, makes it easy to see different sample information at once, and enables true dynamic experimentation. It offers three vacuum modes (high vacuum, low vacuum, and ESEM) for enhanced flexibility to accommodate a wide range of samples, especially beam-sensitive samples, out-gassing materials, and specimens that would not otherwise be vacuum compatible. The ESEM mode is the most versatile solution as it allows for a maximum pressure of 4,000 Pa, so you can match the environment inside the SEM to the needs of the sample rather than adapting the sample to meet the needs of the SEM.

The Quattro ESEM's analytical chamber was designed to accommodate a wide range of analyses, with 12 ports, including EDS ports separated by 180 degrees, and up to three simultaneous EDS detectors. Thanks to the Quattro ESEM's through-the-lens pumping, quantitative EDS results are extremely accurate even for non-conductive samples, wet samples, low vacuum or ESEM conditions, or at high temperature.

Key features

- **High-resolution FEG-SEM** with environmental mode (ESEM) allows you to study materials *in situ*
- **Live composition-based image coloring** offers intuitive elemental analysis with optional ChemiSEM Technology
- **Always-on EDS analysis** speeds up your work and collects complete sample information
- **Low-vacuum and ESEM capability** minimize sample preparation time and enable charge-free imaging and analysis of non-conductive and hydrated specimens with simultaneous SE and BSE imaging in every mode of operation
- **Cryo, Peltier, and heating stages** enable *in situ* analysis at temperatures ranging from –165°C to +1,400°C
- **Flexible and precise** eucentric sample stage with a tilt range of 105° allows you to observe samples from all perspectives
- **Easy-to-use**, intuitive software with user guidance and undo function help you work faster with fewer mouse clicks



Battery cathode with copper contamination.

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As research facilities and universities move away from having a single expert microscopist in favor of multi-user laboratories, they expect modern SEMs to accommodate a wide variety of samples and offer excellent image quality with the least amount of sample preparation. The Quattro ESEM's built-in User Guidance not only instructs users but also directly interacts with the microscope. And the 'undo' functionality encourages novice users to experiment while helping expert users easily shorten their time to results. The Quattro ESEM supports scanning presets, column presets, easy camera-based navigation, and SmartSCAN and drift-compensated frame integration (DCFI) to boost productivity, data quality, and ease of use even further.

ChemiSEM Technology revolutionizes EDS analysis to provide a streamlined user experience. Fully integrated within the user interface, ChemiSEM Technology simultaneously displays SEM and elemental information and puts all the tools needed to interpret the data in one place. ChemiSEM Technology is always on and provides real-time quantitative compositional information and reliable live quantification (Noran quantification) with a short time to data.

Thermo Scientific Maps Software can be added to the Quattro ESEM to enable large-area mapping and correlation to other techniques. Similarly, AutoScript Software adds a Python-based application programing interface (API) to help you customize experimentation and automation.

This combination of an accessible, high-performance SEM with advanced automation and environmental capability makes the Quattro ESEM a central player for today's research laboratories.

Nanocharacterization applications

- Metals and alloys, fractures, welds, polished sections, magnetic and superconducting materials
- Ceramics, composites, plastics
- Films and coatings
- Geological sections and minerals
- Soft materials: Polymers, pharmaceuticals, filters, gels, tissues, and plant material
- Particles, porous materials, and fibers

In situ applications

- Crystallization and phase transformation
- Oxidation and catalysis
- Material growth
- Hydration, dehydration, wetting, and contact angle analysis
- Tensile (with heat or cooling)

Electron optics

- High-resolution field emission SEM column with a high-stability Schottky field emission gun to provide stable high-resolution analytical currents
- 45° objective lens geometry with heated objective apertures
- Through-the-lens differential pumping reduces beam skirting for accurate analysis and high resolution
- Guaranteed minimum source lifetime: 12 months

Electron beam resolution

- High-vacuum imaging
  - 0.8 nm @ 30 kV (STEM)
  - 0.9 nm @ 15 kV (SE)
  - 1.0 nm @ 30 kV (SE)
  - 2.5 nm @ 30 kV (BSE)
  - 3.0 nm @ 1 kV (SE)
- High-vacuum imaging with beam deceleration
  - 2.1 nm @ 1 kV (BD mode + ICD)
  - 3.0 nm @ 1 kV (BD mode + BSED
  - 3.1 nm @ 200 V (BD mode + ICD)
- Low-vacuum imaging
  - 1.3 nm @ 30 kV (SE)
  - 2.5 nm @ 30 kV (BSE)
  - 3.0 nm @ 3 kV (SE)
- ESEM
  - 1.3 nm @ 30 kV (SE)

Electron beam parameter space

- Beam current range: 1 pA to 200 nA
- Accelerating voltage range: 200 V to 30 kV
- Landing energy range: 20 eV to 30 keV with optional beam deceleration (Quattro S ESEM only)
- Magnification: 6 to 2,500,000×

Optimized detection for every vacuum mode

Vacuum range	SE	BSE	Other
High vacuum: < $6x10^{-4}$ Pa	ETD, ICD	DBS, GAD	IR camera, Nav-Cam Camera, STEM3+, CL, current measurement, 2 external signal inputs
Low vacuum: Up to 200 Pa	LVD	GAD, DBS	
ESEM: Up to 4,000 Pa	GSED, ESEM-GAD	ESEM-GAD, GAD	

Chamber

- Inside 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 and EBSD orthogonal to the tilt axis of the stage
- General purpose 9-pin electrical feedthrough

Detectors

The Quattro ESEM is equipped with a wide array of detectors to offer flexibility for various applications. It supports simultaneous acquisition and display of signals from multiple detectors or detector segments in a single scan, significantly improving the time to results.

- Everhart-Thornley SE detector (ETD)
- Low-vacuum SE detector (LVD)
- Gaseous SED (GSED) (used in ESEM mode)
- IR camera for viewing sample in chamber
- Thermo Scientific™ Nav-Cam™ Sample Navigation Camera (in-chamber color optical camera)
- Directional backscatter detector (DBS) (retractable or mounted under the lens)
- Lens-mounted gaseous analytical detector (DBS-GAD)
- STEM 3+ retractable segmented detector (BF, 4 DF, 6 HADF)
- Scanning transmission detector (Quattro S ESEM only)
- WetSTEM Peltier stage for observing thin, wet samples (Quattro S ESEM only)
- Real color CL detector (RGB-CLD)
- In-column detector (ICD) for beam deceleration mode (Quattro S ESEM only)
- Electron beam current measurement

ChemiSEM Technology

ChemiSEM Technology is an optional analytical mode that combines SEM and EDS functionality within a single interface. It supports point ID, linescan, and real-time quantitative X-ray mapping modes and has a minimum dwell time of 100 ns.

- EDS detector size: 30 or 60 mm^2 active area
- Detection range: Be to Am
- Resolution: 129 eV @ Mn kα
- Optional motorized insertion and retraction
- ChemiView Software for full offline EDS data processing, including phase analysis and quantification of compounds

Vacuum system

- 1 × 250 liter TMP
- 1 × PVP
- 2 × IGP
- Integrated IGP battery backup (system protection from unplanned power outage)
- Patented through-the-lens differential pumping
- Beam gas path length: 10 or 2 mm
- Evacuation time: ≤ 3.5 minutes to high vacuum and ≤ 4.5 minutes to ESEM
- Optional CryoCleaner cold trap
- Optional upgrade to oil-free scroll/dry PVPs

Sample holders

- Multi-sample SEM holder mounts directly onto the stage, hosts up to 18 standard stubs (ø 12 mm), and does not require tools to mount a sample (standard on Quattro S ESEM, not available on Quattro C ESEM)
- Multi-purpose holder for 18 stubs, three pre-tilted stubs, cross-section samples, and STEM samples (optional) (Quattro S ESEM only)
- Row bar holder for 6 STEM grids (optional) Quattro S ESEM only)
- Wafer and custom holders

Stage and sample

Model	Quattro C ESEM	Quattro S ESEM
Type	Eucentric goniometer stage, 5-axes motorized	
XY	55 × 55 mm	110 × 110 mm
Repeatability	< 3.0 µm (@ 0° tilt)	
Motorized Z	65 mm	
Rotation	n x 360°	
Tilt	–15° / +90°	
Max. sample height	Clearance: 85 mm to eucentric point (10 mm)	
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 LTSC, keyboard, optical mouse
- 24-inch LCD display, WUXGA 1920 × 1200 (second monitor optional)
- Customizable graphical user interface with up to four simultaneously active images
- Image registration to easily import images from other systems for navigation
- Navigation montage for large-area imaging
- Undo and redo functionality
- User guidance to help new or infrequent users obtain excellent results
- Joystick (optional)
- Manual user interface (knob board) (optional)

Image processor

- Dwell time range from 25 ns to 25 ms/pixel
- Up to 6,144 × 4,096 pixels
- File type: TIFF (8-, 16-, 24-bit), JPEG, or BMP
- Single-frame or four-view image display
- SmartSCAN (256-frame average or integration, line integration and averaging, interlaced scanning)
- DCFI (drift-compensated frame integration)

In situ accessories (optional)

- Software-controlled –20°C to +55°C Peltier cold stage
- Software-controlled 1,000°C low-vacuum/ESEM heating stage
- Software-controlled 1,100°C high-vacuum heating stage
- Software-controlled 1,400°C low-vacuum/ESEM heating stage
- Integrated gas injection: Up to two units (other accessories may limit the number of GIS available) for beam-induced deposition of platinum, tungsten, and carbon
- Manipulators
- Cryo-stage
- Electrical probing and multi-probing stations

System options

- Beam deceleration with stage bias from –4,000 V to +50 V (Quattro S ESEM only)
- Electrostatic beam blanker
- Sample and chamber cleaning: CryoCleaner, integrated plasma cleaner
- Thermo Scientific™ QuickLoader™ Vacuum Technology: Load lock for fast sample transfer
- Support PC
- Manual user interface
- Joystick
- Analysis: EDS, EBSD, parallel beam WDS, CL, Raman
- Integrated 16-bit patterning engine, electron beam lithography modules
- Specimen current meter
- Specimen holder kit
- Acoustic enclosure for vacuum pump
- Oil-free pre-vacuum option (scroll pump)

Software options

- Maps Software for automated large-area imaging, spectroscopy, and image correlation with other modalities
- AutoScript Python-based application programming interface for customizing automated workflows by controlling the stage, beam, detectors, and ChemiSEM EDS
- Pattern generation software
- TopoMaps for image colorization, image analysis, and 3D surface reconstruction
- Web-enabled data archive software
- Advanced image analysis software
- Remote control software

Documentation

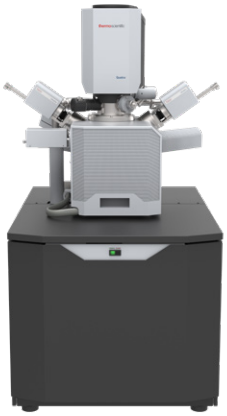
- Online user guidance
- Operating instructions handbook
- Online help
- Prepared for RAPID (remote diagnostic support)

Warranty and Training

- One-year warranty
- Choice of service maintenance contracts
- Choice of operation and application training contracts

Installation requirements

(Refer to preinstall guide for full details)



- Power
  - Voltage: 100 to 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: 980 kg (column console)
- Dry nitrogen recommended for venting
- Compressed air: 4 to 6 bar, clean, dry, and oil-free
- System chiller
- Acoustics: Site survey required, as acoustic spectrum is relevant
- Floor vibrations: Site survey required, as floor spectrum is relevant
- Optional active vibration isolation table

Consumables (partial list)

- Replacement Schottky electron source module

Learn more at **thermofisher.com/quattro**