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DATASHEET

Quattro SEM

Ultra versatile high resolution SEM with unique environmental capability

The Thermo Scientific Quattro SEM combines all-round performance in imaging and analytics with a unique environmental mode (ESEM) that allows samples to be studied in their natural state.

Today's research laboratories expect a modern SEM to accommodate a wide variety of samples with excellent image quality and with the least amount of sample preparation. The field emission gun (FEG) inside the Thermo Scientific™ Quattro SEM ensures excellent resolution, while tunable contrast is provided by a choice of detectors that include directional backscatter information, STEM and cathodoluminescence. Simultaneous acquisition and display of images from multiple detectors and detector segments allows images with the different sample information to be available with a single scan reducing beam exposure for sensitive samples and enabling true dynamic experimentation. Quattro SEM's three vacuum modes (high vacuum, low vacuum and ESEM™) provide flexibility by accommodating the widest range of samples of any SEM available, including samples that are outgassing or otherwise not vacuum compatible. Moreover, ESEM™ enables the *in situ* study of samples in real-world conditions, such as wet/humid, hot or reactive environments.

The increasing need for elemental and crystallographic sample data is accommodated by Quattro SEM's analytical chamber, simultaneously supporting dual opposing Energy Dispersive X-ray Spectroscopy (EDS) detectors, coplanar EDS/Electron Back Scatter Diffraction (EBSD) and parallel beam Wavelength Dispersive X-ray Spectroscopy (WDS). No matter what type of sample, in high vacuum or when combined with the unique experimental conditions supported by Quattro SEM, reliable analytical results are obtained even on samples that are conductive, insulating, wet or at high temperature.

Key Benefits

***In situ* study of materials in their natural state:** Unique high resolution FEG-SEM with environmental mode (ESEM).

Minimize sample preparation time: low vacuum and ESEM capability enable charge-free imaging and analysis of non-conductive and/or hydrated specimens.

Observe all information from all samples with simultaneous SE and BSE imaging in every mode of operation.

***In situ* analysis** at temperatures ranging from -165°C to 1400°C with a range of cryo, Peltier and heating stages.

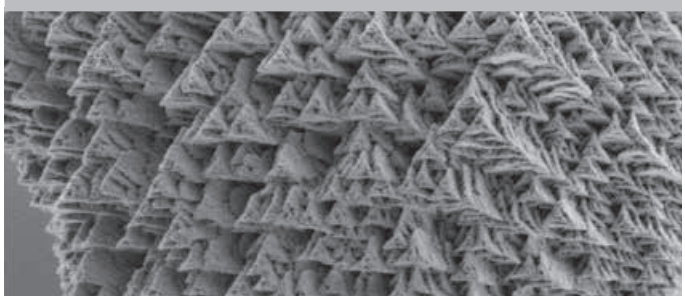
Excellent analytical capabilities with a chamber that allows up to 3 simultaneous EDS detectors, EDS ports that are separated 180°, WDS, and coplanar EDS/EBSD.

Excellent analysis of non-conductive samples: accurate EDS and EBSD are enabled in low vacuum with Quattro SEM's through-the-lens pumping.

Flexible and precise eucentric sample stage with a tilt range of 105° for sample observation from all perspectives.

Easy to use, intuitive software with user guidance and undo function. Work faster with fewer mouse clicks.

New innovative options, including a retractable RGB cathodoluminescence (CL) detector, a 1100°C high vacuum heating stage and AutoScript, a Python-based scripting tool (API).



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As multi-user facilities require all this data to be acquired by a large group of users while minimizing the required training time, ease of use is paramount. Quattro SEM's unique hardware is supported by a help function (User Guidance) that not only instructs, but also directly interacts with the microscope. And with the 'undo' functionality, novice users are encouraged to experiment while expert users easily shorten their time to results. Quattro SEM supports scanning presets, column presets, easy camera-based navigation, SmartSCAN™ and drift compensated frame integration (DCFI) to boost productivity, data quality and ease of use even further.

Additional software extensions can be added to Quattro SEM to enable large area mapping and correlation to other techniques with the MAPS™ Software package, while users can bring their experimentation and automation to the next level with AutoScript – a Python based Application Programming Interface (API).

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

Typical applications include:

Nanocharacterization

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

Characterization *in situ*

- Crystallization / phase transformation
- Oxidation, catalysis
- Material growth
- Hydration/dehydration/wetting/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 the most accurate analysis and highest resolution
- Guaranteed minimal source lifetime: 12 months

Electron beam resolution

- High-vacuum imaging
  - 0.8 nm @ 30 kV (STEM)
  - 1.0 nm @ 30 kV (SE)
  - 2.5 nm @ 30 kV (BSE)
  - 3.0 nm @ 1 kV (SE)
- High-vacuum imaging with beam deceleration
  - 3.0 nm @ 1 kV (BD mode* + BSED*)
  - 2.1 nm @ 1 kV (BD mode* + ICD*)
  - 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 – 30 kV
- Landing energy range: 20 eV – 30 keV with optional beam deceleration (Quattro S SEMonly)
- Magnification: 6 to 2500000×

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

Detectors

Quattro detects up to four signals simultaneously from any combination of the available detectors or detector segments:

- ETD – Everhart-Thornley SE detector
- Low-vacuum SE detector (LVD)
- Gaseous SED (GSED) (used in ESEM mode)
- IR camera for viewing sample in chamber
- Nav-Cam™: In-chamber color optical camera for sample navigation*
- DBS – Retractable or lens-mounted segmented under-the-lens Directional BackScatter detector*
- DBS-GAD – Lens-mounted gaseous analytical detector*
- STEM 3+ – Retractable segmented (BF, 4 DF, 6 HADF) Scanning Transmission detector* (Quattro S SEM only)
- WetSTEM™ – Peltier stage integrated STEM for observation of thin wet samples (Quattro S only)
- RGB-CLD – real color CL detector*
- In-column detector (ICD) for Beam Deceleration mode* (Quattro S SEM only)
- Electron beam current measurement*

Optimized detection for every vacuum mode			
Vacuum range	**SE**	**BSE**	**Other**
High vacuum: < $6 \cdot 10^{-4}$ Pa	ETD, ICD*	DBS*, GAD*	IR camera, Nav-Cam*, STEM3+*, CL*, Current measurement, 2 external signal inputs
Low vacuum: up to 200 Pa	LVD	GAD*, DBS*	
ESEM: up to 4000 Pa	GSED, ESEM-GAD*	ESEM-GAD*, GAD*	

Vacuum system

- 1 × 250 liter/s 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 mm or 2 mm
- Evacuation time: ≤ 3.5 minute to high vacuum and ≤ 4.5 minute to ESEM
- Optional CryoCleaner cold trap
- Optional upgrade to oil free scroll/dry PVPs

Sample holders

- Multi-sample SEM holder, uniquely mounts directly onto the stage, hosts up to 18 standard stubs (⌀ 12 mm), does not require tools to mount a sample (standard on Quattro S SEM, not available on Quattro C SEM)
- Multi-purpose holder for 18 stubs, three pre-tilted stubs, cross-section samples and STEM samples as an option (Quattro S SEM only)
- Optional row bar holder for 6 S/TEM grids (Quattro S SEM only)
- Wafer and custom holders*

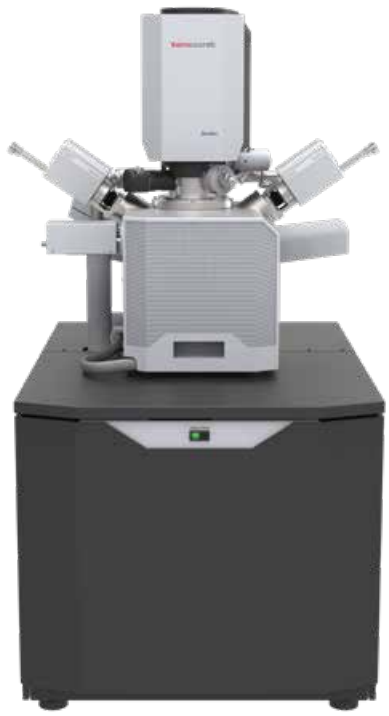
System Control

- 64-bit GUI with Windows, keyboard, optical mouse
- 24-inch LCD display, WUXGA 1920 × 1200 (second monitor optional)
- Customizable graphical user interface, with up to 4 simultaneously active images
- Image registration to easily import images from other systems for navigation
- Navigation montage
- Undo / Redo functionality
- User guidance enabling new or infrequent users to obtain excellent results
- Optional joystick
- Optional manual user interface (knob board)

Image processor

- Dwell time range from 25 ns – 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

Stage and sample		
Model	**Quattro C**	**Quattro S**
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 × 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 2 kg at 0° tilt)	
Max. sample size	122 mm diameter with full X,Y, rotation (larger samples possible with limited stage travel or rotation)	



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- 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 1000° C low vacuum/ESEM heating stage
- Software controlled 1100° C high vacuum heating stage
- Software controlled 1400° C low vacuum/ESEM heating stage
- Integrated gas injection: up to 2 units (other accessories may limit number of GIS available) for beam-induced deposition of the following materials:
  - Platinum
  - Tungsten
  - Carbon
- Manipulators
- Cryo-stage
- Electrical probing / multi-probing stations

System options
- Beam deceleration with stage bias from -4000 V to +50 V (Quattro S only)
- Electrostatic beam blanker
- Sample / 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 automatic large area acquisition using tiling and stitching; correlative work
- AutoScript 4; a Python-based application programming interface
- 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
- 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

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

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