

A scanning electron microscope (SEM) image showing a porous, interconnected network of material. The structure is composed of numerous small, rounded, interconnected particles or fibers, creating a highly porous, sponge-like appearance. The color scheme is a false-color representation, with the majority of the structure appearing in shades of red and orange, while some larger, more irregularly shaped regions are highlighted in green and yellow. The overall texture is highly detailed and porous.

thermoscientific

# Scanning Electron Microscopes

The widest range of SEM solutions for all  
your surface characterization needs

**ThermoFisher**  
SCIENTIFIC

# Introduction

Since the introduction of electron microscopes in the 1930s, scanning electron microscopy (SEM) has developed into a critical tool within numerous different research fields. As soon as microscopic information about the surface or near-surface region of a specimen is needed, SEM becomes a necessary tool. For that reason, the method finds applications in nearly every branch of science, technology and industry.

That is why Thermo Fisher Scientific is dedicated to producing analytical SEMs that are ideally suited for your specific needs. We offer a range of versatile tools, everything from our easy-to-use Thermo Scientific™ Phenom™ desktop SEMs to powerhouse instruments capable of unparalleled resolution and contrast, like the Thermo Scientific Verios™ 5 SEM. Whether you are looking for a workhorse data reporting machine or just maximum multi-user versatility, we have the right SEM for you.

# Products



Phenom Pharos Desktop SEM.



Phenom XL G2 Desktop SEM.



Phenom P-Series G6 Desktop SEM.



Phenom ParticleX-Series Desktop SEM.

## Desktop SEMs

The Phenom product line redefines speed, ease-of-use and performance thanks to its innovative, user-friendly design and software, which allow even a novice user to obtain an SEM image in minutes. Not only that, but the cutting-edge Thermo Scientific Phenom Pharos™ Desktop SEM even features a field emission gun (FEG) source, enabling resolutions below 2.5 nm.

### Phenom Pharos Desktop SEM

- Enhanced FEG source enables resolution below 2.5 nm
- Magnification range up to 1,000,000x
- Enabled for low kV performance to image beam sensitive specimen

### Phenom XL G2 Desktop SEM

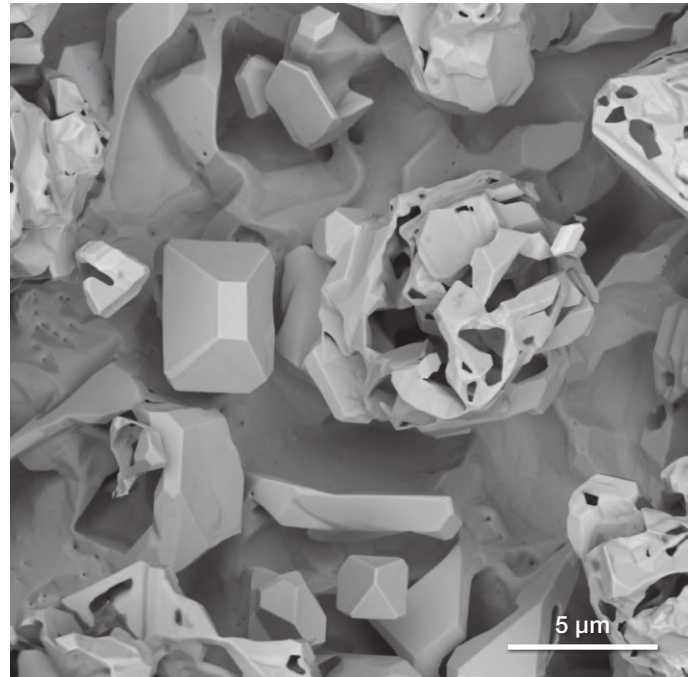
- Large sample chamber for large samples and automation
- Motorized scan of samples up to 100 x 100 mm in size
- Automate with custom scripting

### Phenom P-Series G6 Desktop SEM

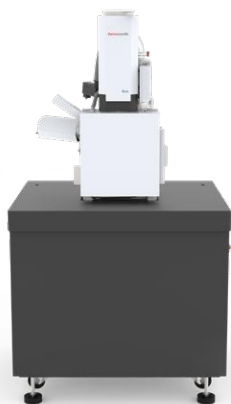
- Powerful SEM with a large variety of sample holders for your imaging needs
- Effortless and fast elemental analysis to do more research
- Ideal for multi-user environments
- Resolution up to 6 nm (SE) or 8 nm (BSE)
- Fully integrated SED and EDS as option

### Phenom ParticleX Desktop SEM

- Automate your quality control system
- Analyze materials up to ten times faster than outsourcing with in-house quality control
- Achieve:
  - Purity at the microscale (ParticleX AM)
  - Cleanliness at the microscale (ParticleX TC)
  - High-quality steel manufacturing (ParticleX Steel)



Metallic filter mesh sample showing the enhanced high-resolution imaging capabilities of the Phenom Pharos Desktop SEM.



Axia ChemiSEM.



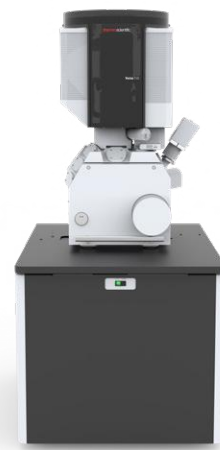
Prisma E SEM.



Quattro SEM.



Apreo 2 SEM.

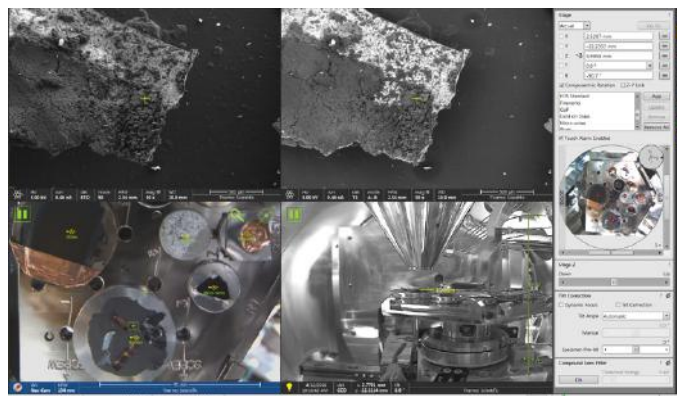


Verios 5 SEM.

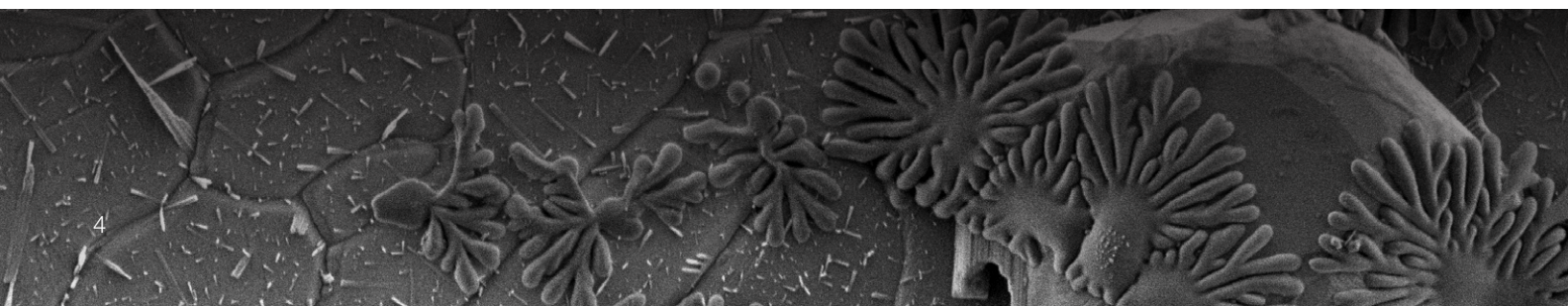
### Entry-level and floor-model environmental SEMs

Our versatile Thermo Scientific Axia™ ChemiSEM, Thermo Scientific Prisma E and Thermo Scientific Quattro SEMs are the ideal choice if sample flexibility is a priority. The Axia ChemiSEM blends extreme sample size flexibility with the most intuitive and efficient EDS characterization workflow available. Available in traditional High Vacuum or as optional Low Vacuum configuration, the Axia ChemiSEM is the ideal platform for routine analysis and failure analysis.

The Thermo Scientific Prisma E and Quattro instruments are capable of remarkable all-around performance under a range of conditions due to the environmental SEM (ESEM™) modes, enabling the analysis of charging, outgassing, wet, hot, dirty or otherwise difficult samples. High stability and ease of use (as well as a selection of optional accessories and a highly modular analytical chamber) make these instruments the tools of choice for multi-user labs. Both instruments feature the optional Thermo Scientific ColorSEM Technology, which colorizes the greyscale SEM image in real time according to elemental composition using combined SEM and EDS imaging.



The navigation function, integrated in the SEM user interface, saves time with the capability to load more than 18 samples at a time and navigate directly to the region of interest thanks to the integrated navigation camera.



#### Axia ChemiSEM

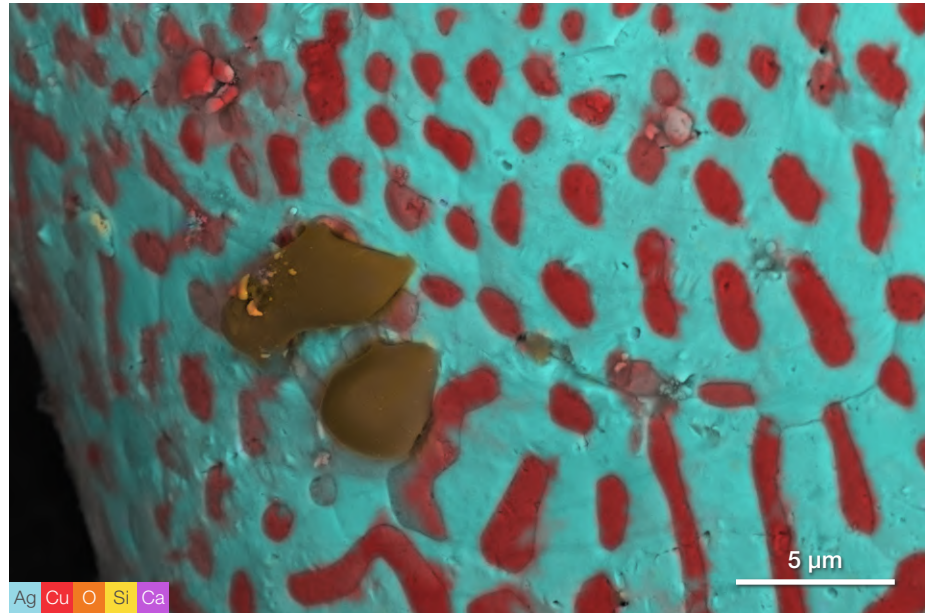
- Live compositional information
- Flexible stage with a capacity of 10 kg
- Low-vacuum mode and charge mitigation

#### Prisma E SEM

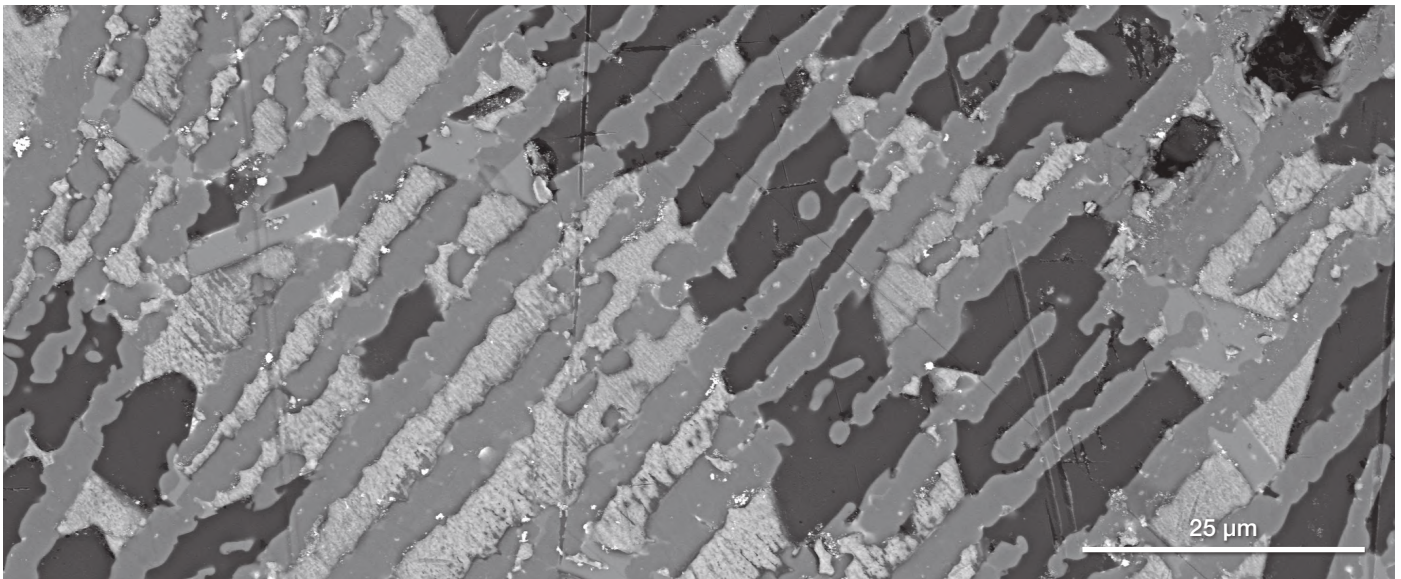
- Tetrode-boosted tungsten source for excellent low kV performance
- Resolution: 3 nm @ 30 kV
- Best in class for low kV, low vacuum performance
- 110 x 100 mm 5 axis motorized eucentric stage supporting 90° tilt and 5 kg maximum sample weight

#### Quattro SEM

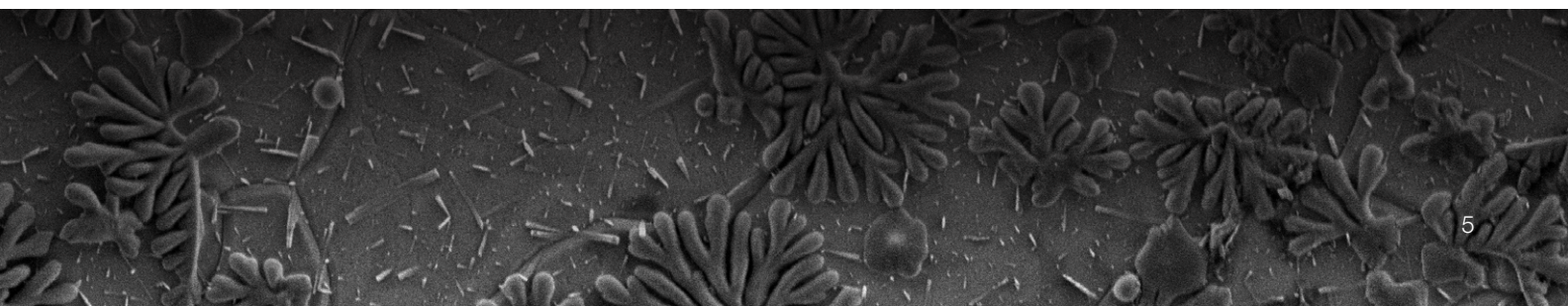
- FEG source for enhanced resolution and detail
- The only ESEM FEG on the market



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



The Quattro SEM is capable of imaging insulating samples without sample coating. On this glass specimen, a high-quality artifact-free image is obtained thanks to the instrument's low vacuum mode. *Sample courtesy of Stazione Sperimentale del Vetro, Murano, Venezia.*



### High-resolution systems

If you would like to maximize resolution and contrast, look no further than our revolutionary Verios 5 and Apreo 2 SEMs. These instruments are committed to obtaining the most detailed information possible, with the excellent contrast and resolution of the Apreo 2 SEM matched only by the world-leading performance of the Verios 5 SEM.

#### Apreo 2 SEM

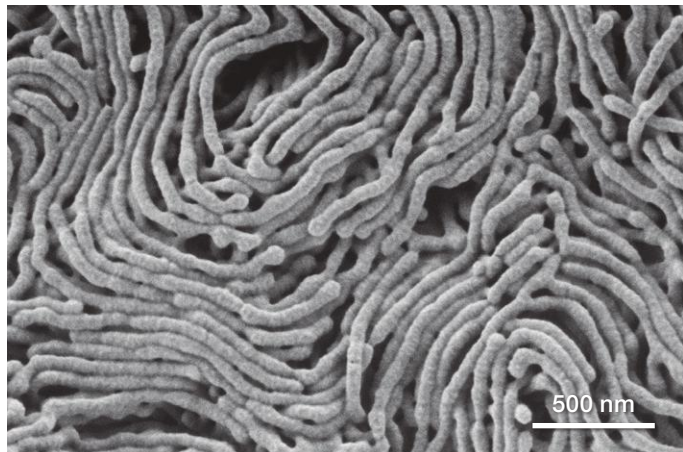
- All-round nanometer or sub-nanometer resolution performance on materials ranging from nanoparticles, powders, catalysts and nanodevices to bulk magnetic samples, even at long (10 mm) working distance.
- Extreme flexibility for handling a wide range of sample types including insulators, sensitive materials, or magnetic samples, and for collecting the data that matters most to your applications.
- Less time spent on maintenance with an optics system that aligns itself (Thermo Scientific SmartAlign Technology)
- Elemental information at your fingertips with ColorSEM Technology for live quantitative elemental mapping for unprecedented time to result and ease of use.
- Advanced automation including Thermo Scientific FLASH Technology for automatic image finetuning, Undo, User Guidance, and tiling and stitching with Thermo Scientific Maps™ Software.

#### Thermo Scientific VolumeScope SEM

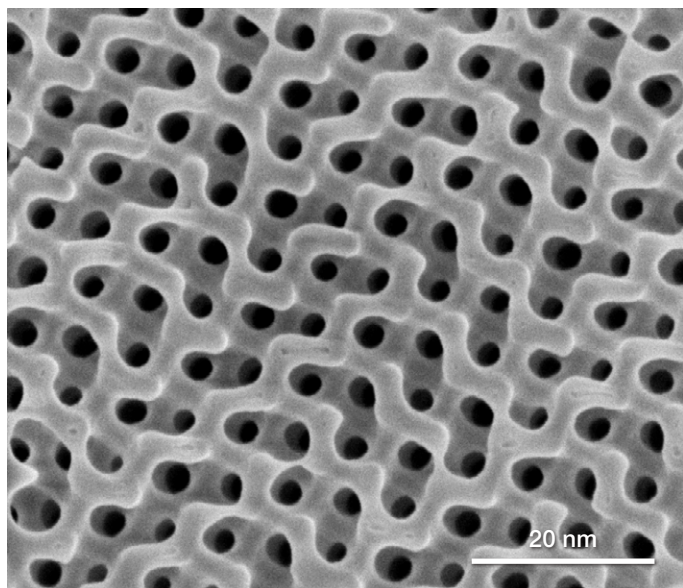
- A serial block-face imaging solution designed for large-volume, high-resolution 3D imaging, based on Apreo 2 SEM technology
- Ideal for imaging the phase distribution in blended polymers
- Reveals representative volumes of polymer filter membranes
- Combine with Thermo Scientific Avizo™ Software for quantitative analysis and transport property calculations

#### Thermo Scientific Verios 5 SEM

- Unique monochromated FEG source for ultimate resolution
- Piezo stage ensures highest stability and accurate sample manipulation
- Three in-column detectors capture a range of sample information including surface topography and pure material contrast
- Suited for optional STEM (scanning transmission electron microscopy) detector



Blend of polystyrene and polyacrylic acid polymers imaged on Apreo 2 SEM.



The Verios XHR SEM reveals the finest details even on the most beam sensitive samples. This example shows mesoporous SiO<sub>2</sub> imaged at 1 kV.



## Industry-specific tools

The Phenom ParticleX Desktop SEM is a multi-purpose solution designed for quality control and cleanliness at the microscale. It gives you the ability to carry out speedy analysis, verification and classification of materials, supporting your production with fast, accurate and trusted data. The system is automated and offers multiple sample analysis, making testing and classification up to 10 times faster.

### Phenom ParticleX AM Desktop SEM

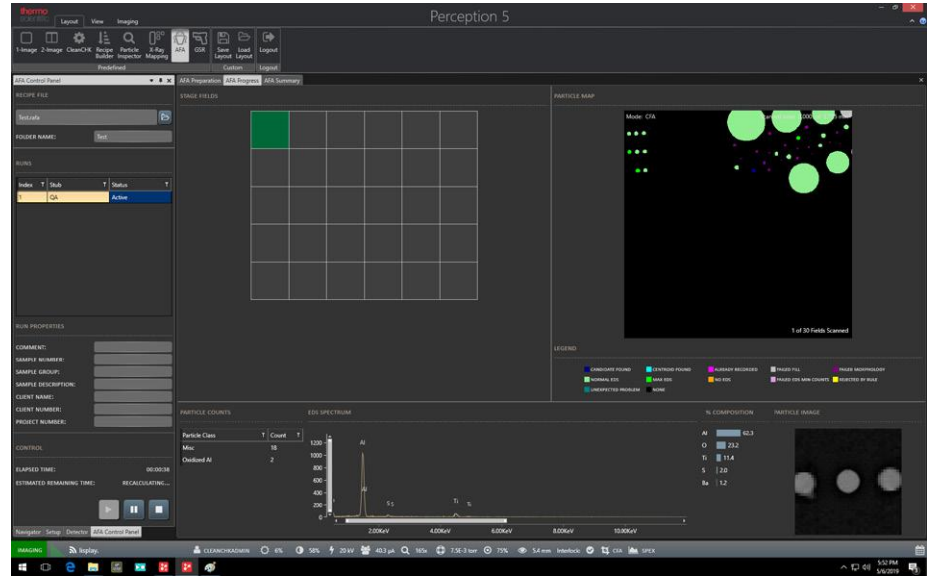
- Monitor critical characteristics of metal powders
- Suited for powder-bed and powder-fed additive manufacturing processes
- Identify particle size distributions, individual particle morphology, and foreign particles

### Phenom ParticleX TC Desktop SEM

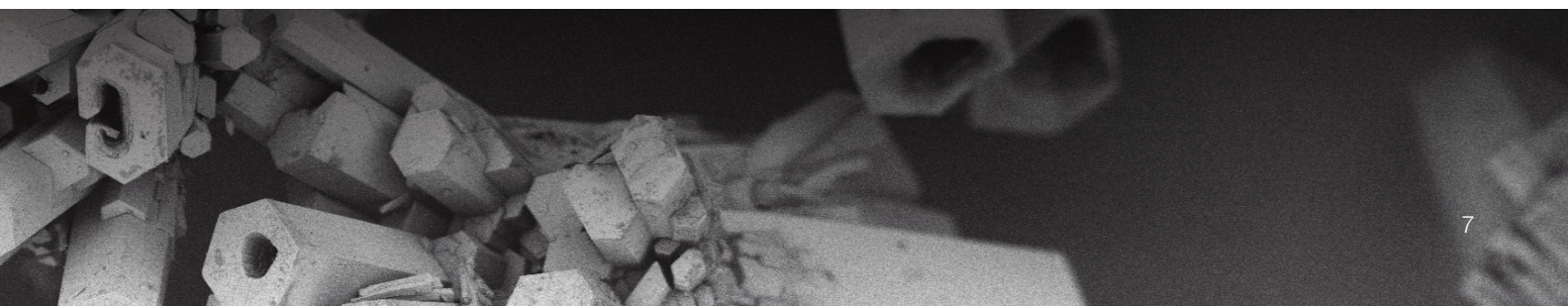
- Designed to gauge automotive parts cleanliness
- Automatically monitor size, shape, chemistry and classification of particulate extracted from fluid systems
- Standard reports compliant with VDA 19 / ISO 16232

### Phenom ParticleX Steel Desktop SEM

- Gain insight in your steel making processes with timely and accurate data on non-metallic inclusions in steel
- Identify root cause of failed components
- Ternary diagrams provide metallurgists the tools to understand re-oxidation phenomena



User interface of the Phenom ParticleX Desktop SEM's software. Industry standard 47 mm filters can be automatically analyzed by starting an Automated Feature Analysis run. Standard recipes can be applied while specific parameters like particle size range, chemical classification rules, area of interest and stop criteria can be set for your application.



# Key benefits

## Advanced analytical capabilities

All Thermo Scientific SEM models support optional energy-dispersive x-ray spectroscopy (EDS) detection. EDS complements the visual information of SEM imaging with elemental analysis, providing critical compositional information on, for example, inclusions, contaminants and trace materials. With ChemiSEM Technology, EDS analysis can even be performed in tandem to SEM data collection, immediately providing elemental context to the observed topography.

Electron backscattered diffraction (EBSD) and wavelength-dispersive X-ray spectroscopy (WDS) detectors are additional add-ons for crystallography and enhanced chemical X-ray analysis respectively.

## Flexible detection

The Directional Backscatter Detector offers a unique way to simultaneously capture information from a range of angles. With its concentric ring design, backscatter signal can easily be separated by emittance angle. Simultaneous detection of the signals from all four rings is possible.

An added benefit of the detector is that it is capable of filtering charge while imaging non-conductive specimens. Charge-related signal is trapped and forced into the final lens of the SEM using beam deceleration (stage bias), resulting in a high-quality charge-free image.

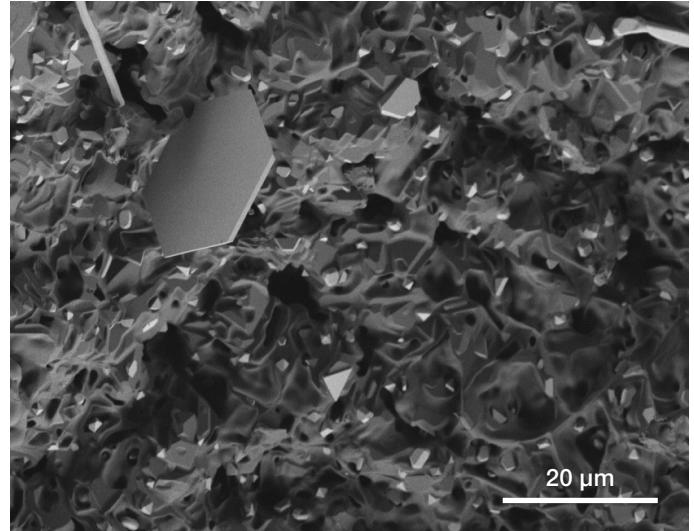
## Environmental SEM (ESEM)

ESEM-equipped SEM instruments feature differential pumping of the column, which enables the study of a variety of traditionally “difficult” samples. With ESEM, samples can be imaged with minimal preparation and, variables such as hydration, thermal cycling and gas-induced dynamic changes can all be controlled.

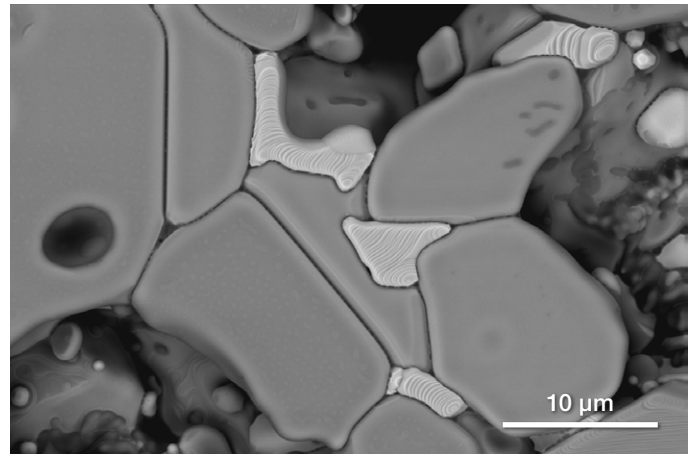
## User guidance and undo functionality

User guidance is a help function that directly interacts with the microscope for impactful, approachable assistance and troubleshooting.

Additionally, when changing settings manually, there is always undo/redo, which allows novice users to experiment without worry and experienced users to accelerate their time to results.



Ceramic sample with Pt particles (part of a failed heating stage) showing the unique detection capabilities of the Apreo SEM. Image courtesy of Adrian Sandu.



$\text{CaCu}_3\text{Ti}_4\text{O}_{12}$  (CCTO) – a compound with an extraordinarily high dielectric constant. Sample courtesy: Ensi Caen, CRISMAT laboratory – Guillaume Riquet, Sylvain Marinel, Yohann Breard.



# Software and accessories

## ChemiSEM Technology

ChemiSEM Technology seamlessly combines SEM imaging with EDS elemental analysis for contextually colorized images. While false-color SEM colorization is a standard procedure for many analytical labs, the process is time consuming and requires manual image manipulation. With ChemiSEM Technology, this process is automatically performed live during SEM image acquisition for vibrant, information-rich images that are available instantly. This allows users of any experience level to directly observe the elemental composition of the sample.

## AutoScript Software

A Python-based application programming interface (API) that offers control of Thermo Scientific SEM systems, Thermo Scientific AutoScript™ Software opens up the microscope to a world of advanced functions that can be employed for powerful automation.

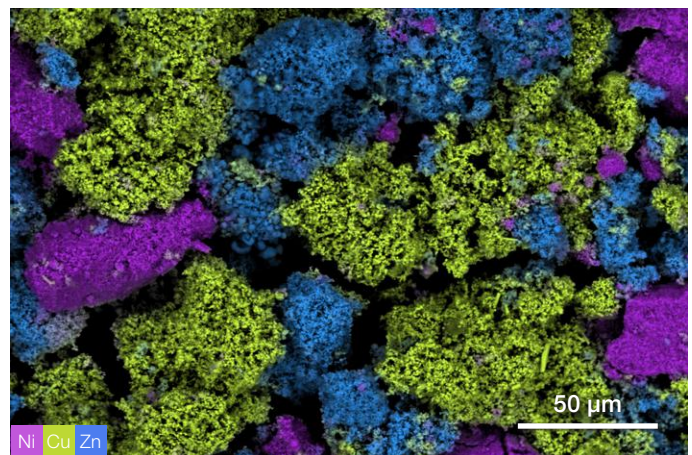
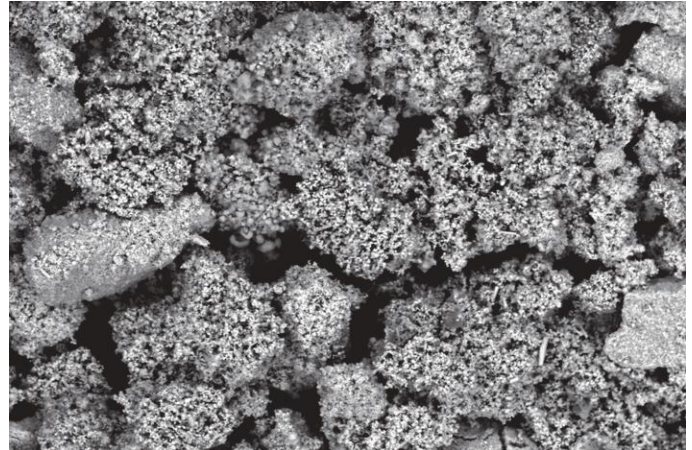
- Scripting control of stage, beam, imaging, detectors and more
- Integrated development environment for syntax highlighting, code completion, error checking and project navigation
- Improved reproducibility and accuracy of repetitive or tedious tasks
- Unattended, high-throughput imaging
- Supported by the Python 3.5-based scripting environment

## Advanced *in situ* stages

*In situ* stages enable testing of materials in real-world conditions, which are recreated by carefully controlling the sample temperature and environment while maintaining the stability required for high quality imaging.

Sample hydration is enabled by the cooling stage, which, together with the chamber pressure, controls the local humidity. This ESEM application allows for the study of wetting, drying and freezing processes while they happen on microscopic length scales.

- Controls small bulk sample temperature *in situ* between -20 and +50°C
- Temperature and pressure can be varied independently to control hydration
- Perform *in situ* dynamic freezing experiments



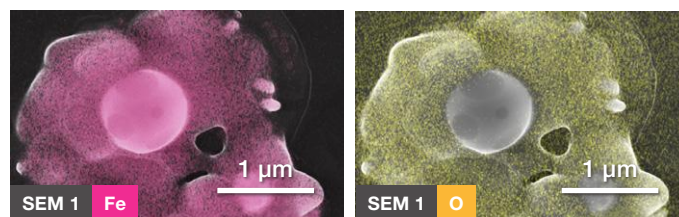
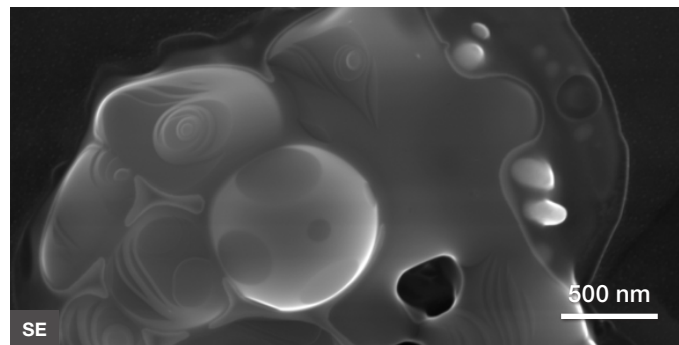
ChemiSEM Technology allows differentiation between materials that are otherwise difficult to tell apart. Here we can clearly see how the nickel, copper and zinc are distributed – this information cannot be derived from a conventional greyscale BSE image.

The High Vacuum Heating Stage is ideal for high-temperature experiments where cleanliness or speed are important. It enables heating up to 1,100°C while preserving excellent image quality with conventional high-vacuum detection.

- Stage control is fully integrated into the SEM user interface
- Multiple set-points, ramp and soak times can be programmed
- Manual control of heater power is available

For high-temperature experiments that involve interaction with a gas in the chamber, two ESEM heating stages are available. (Ideal for studying oxidation.) Heating is available from ambient/room temperature up to 1,400°C within the low vacuum and ESEM pressure ranges.

- A 1,000°C and a 1,400°C version of the ESEM stage is available
- Capable of continuous imaging throughout sample heating
- Easily drive and visualize oxidation reactions

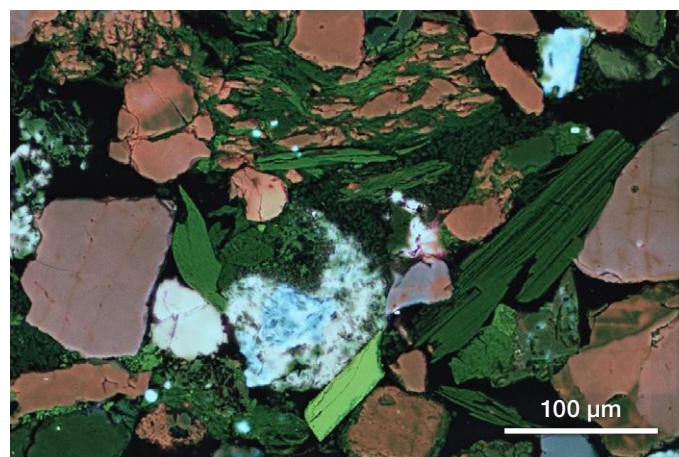


The Thermo Scientific µHeater Holder enables EDS at elevated temperature. SE image of magnetite-hematite sample and corresponding EDS maps show elemental separation during melting.

### RGB Cathodoluminescence detector

The light emitted from an electron beam irradiated sample (called cathodoluminescence or CL) provides information about the sample composition, photonic structure, defects and other properties. Conventional CL relies on careful optical alignment, typically limited field of view and has no freedom in working distance. The new RGB cathodoluminescence detector resolves these issues with a novel, flat design that provides real color CL data without compromising usability.

- Easy to use: automatic insertion, no optical alignment necessary
- Large field of view
- Works across a wide range of working distances
- Provides real-time RGB color imaging
- Allows for simultaneous SE, BSE and EDS detection

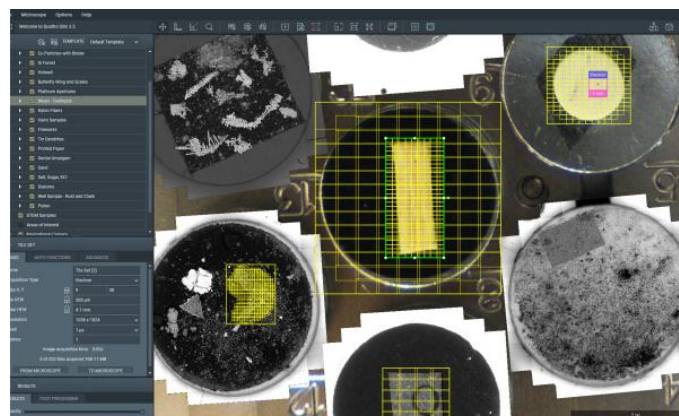


CL contrast on this sandstone sample can be used to differentiate between minerals that cannot always be identified with BSE or EDS, such as muscovite (mica) and illite which have similar composition.

### Maps Software

An automation and correlative workflow software suite which can link observations from multiple sources including microCT, SEM, DualBeam™ and TEM instruments. With Maps Software, multi-scale context can be obtained, allowing you to inspect your complete sample in more detail. Additionally, Maps Software enables you to automatically acquire and stitch together large 2D tile sets.

- Easily set up multi-resolution acquisition on single or multiple samples
- Import imagery from any source to generate a correlative dataset
- Explore and interpret all your data efficiently and with context



Maps Software makes it easy to set up automated acquisition on single or multiple samples during a single session. Image shows setup of multiple samples on Quattro SEM multi-sample holder.



Notes

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