CIQTEK

FESEM

SEM5000Pro

Field Emission
Scanning Electron Microscope

2016

CIQTEK was officially established.

2019

CIQTEK launched commercial **Scanning Electron Microscope,** which was recognized very well by the market.

2021

R&D overcame obstacles, and the 1st **Schottky Field Emission Scanning Electron Microscope** was launched.

2022

More models SEM2000, SEM3200 and SEM3300 were released, in which SEM3300 broke through the long standing resolution limit of **Tungsten Filament Scanning Electron Microscope**. In the same year, more than 100 units of Scanning Electron Microscopes were delivered.

2023

The **High-speed SEM** model HEM6000, the **Focused Ion Beam Scanning Electron Microscope** (FIB-SEM) model DB500 and **Ultra-high Resolution FESEM** model SEM5000X were released, the delivery of Electron Microscopes exceeded 200 units in a single year.

Field Emission Scanning Electron Microscope
SEM5000Pro

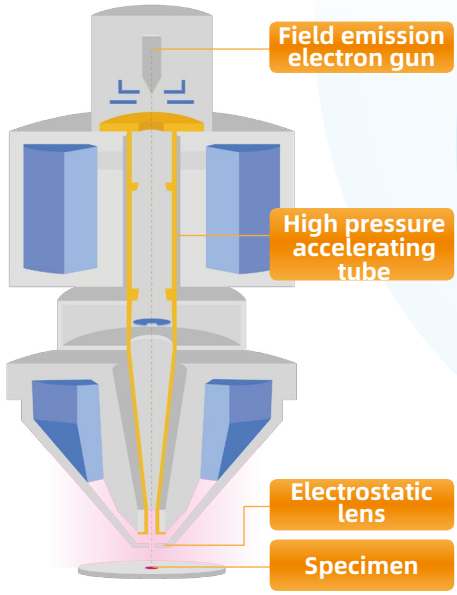
High Resolution under Low Excitation

SEM5000Pro is a Schottky field emission scanning electron microscope (FE-SEM) specialized at high resolution even under low excitation voltage, with employment of an advanced "Super-Tunnel" electron optics technology, facilitates crossover free beam path together with an electrostatic-electromagnetic compound lens design. These advancements reduce spatial charging effect, minimize lens aberrations, enhance imaging resolution at low voltage, achieve a resolution of 1.2 nm at 1 kV, which allows for direct observation of non-conductive or semi-conductive samples, effectively reducing sample irradiation damage.

- **Low Voltage High Resolution** (1.2 nm @ 1 kV)
- **High Stability**
- **In-lens Electron Detector**
- ***Specimen Exchange Loadlock** (8 inches compatible)
- **Electromagnetic Beam Deflection with multi-hole Aperture**
- **Excellent expandability**

Electron Optics

SEM5000Pro



01

"Super Tunnel" electron optics column technology/in-lens beam deceleration

Decrease spatial charging effect, ensuring low voltage resolution

02

Crossover free in the electron beam path

Effectively reduce lens aberrations and improve resolution

03

Electromagnetic & electrostatic compound objective lens

Reduce aberrations and significantly improve resolution at low voltages, and enable observation of magnetic samples

04

Water-cooled constant-temperature objective lens

Ensure the stability, reliability, and repeatability of the objective lens operation

05

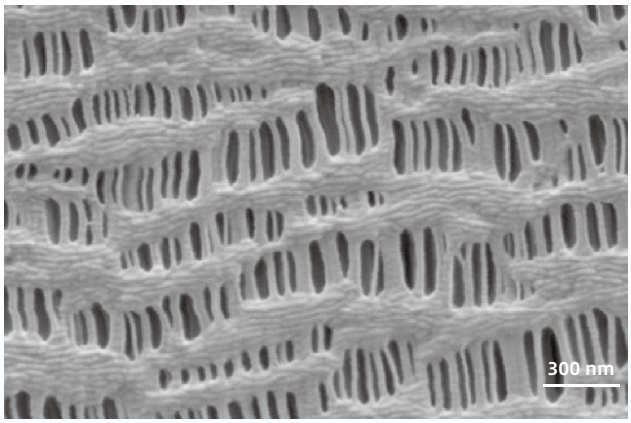
Variable multi-hole aperture with electromagnetic beam deflection system

Automatic switching between apertures without mechanical motion, allowing fast switching between imaging modes

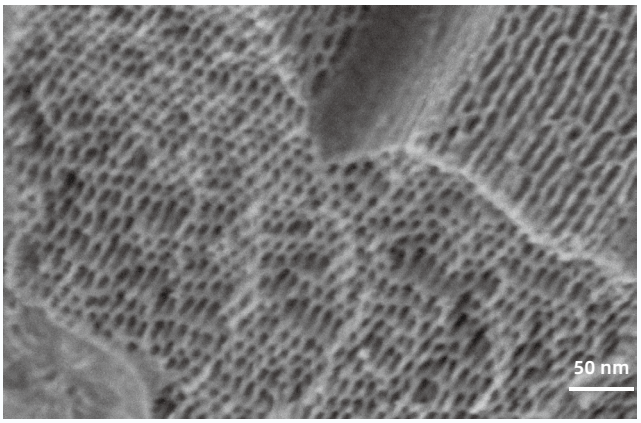
01

Low-voltage high-resolution images

SEM5000&SEM5000X

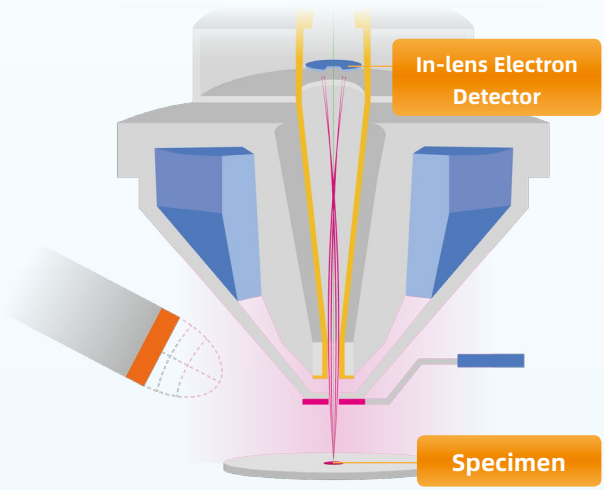


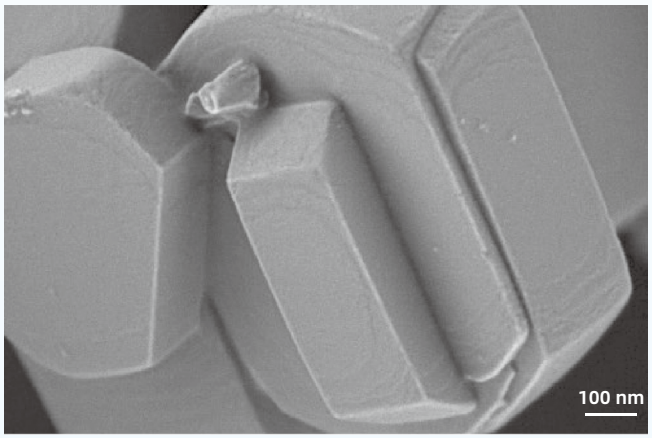
In-lens Electron Detector image at 200 V low excitation voltage, achieves non-destructive morphological characterization of lithium-ion polymer membrane fiber structures.



Pore structure of SBA-15 silica-based mesoporous material characterization, In-lens Electron Detector image at 500 V low voltage without conductive coating (under dual deceleration mode with In-lens beam deceleration + Specimen stage tandem beam deceleration).

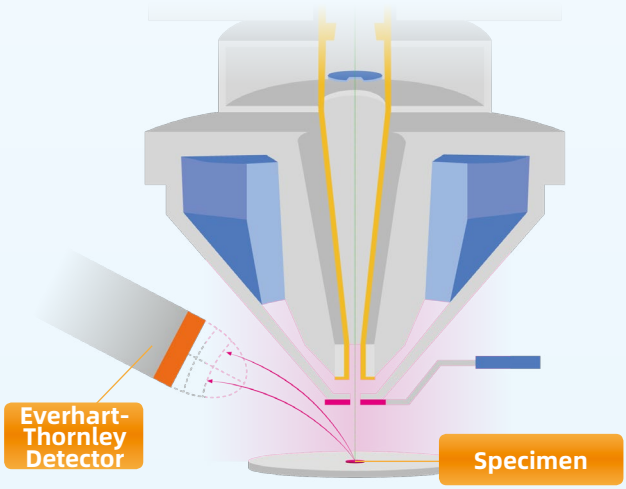
In-lens Electron Detector /specimen

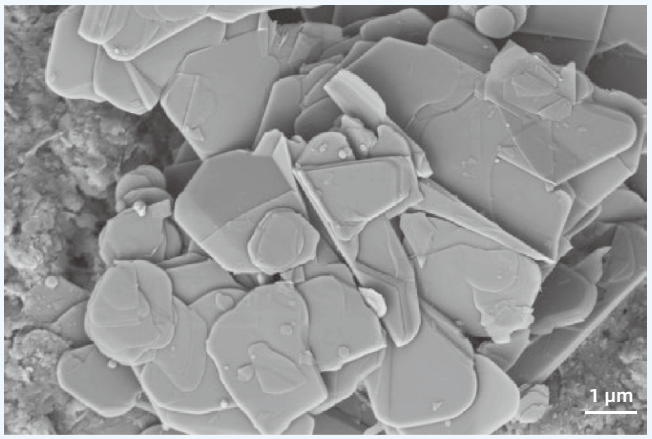




ZSM-8 molecular sieve, a typical catalyst across multiple frontier research field. Low-voltage imaging without conductive coating provides direct characterization of the surface details of the molecular sieve particles.

Everhart-Thornley Detector (ETD)

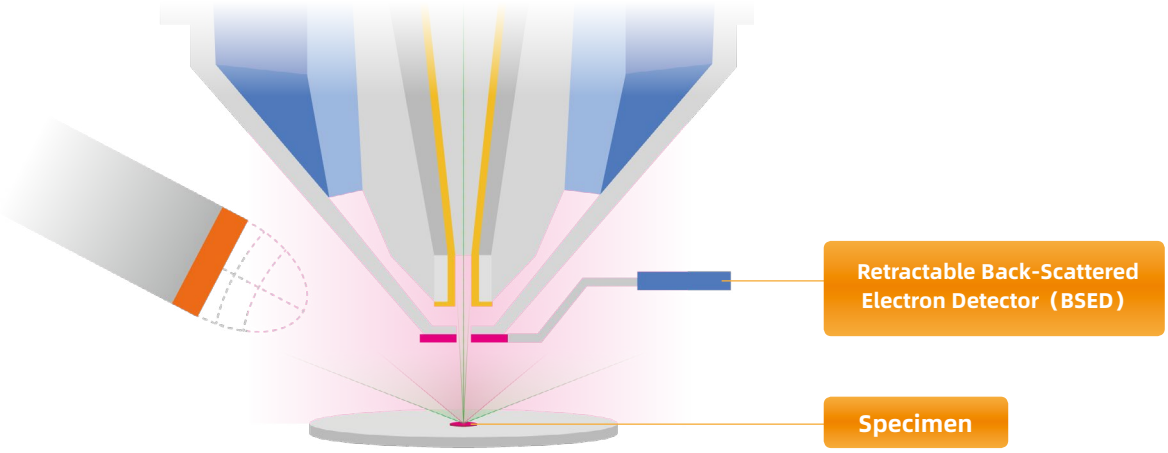


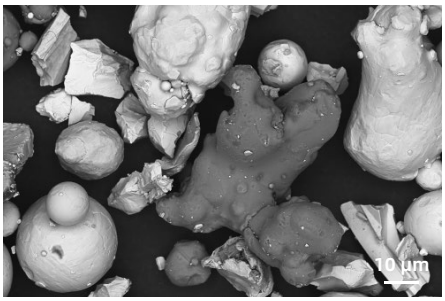


BN ceramic nano-sheets, expose layer structure under low-voltage ETD image.

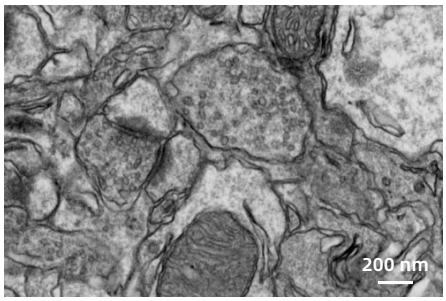
Retractable Back-Scattered Electron Detector（BSED）

* Optional

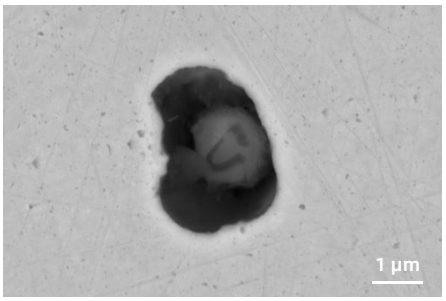




High-entropy alloy powder/10 kV



Mouse brain tissue cells/10 kV

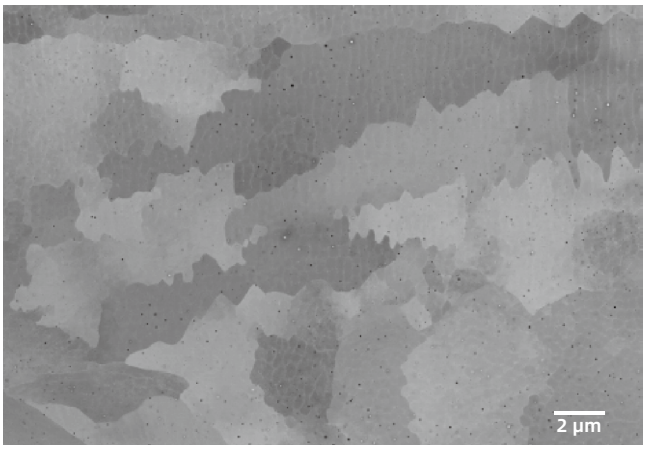


Steel inclusions/15 V

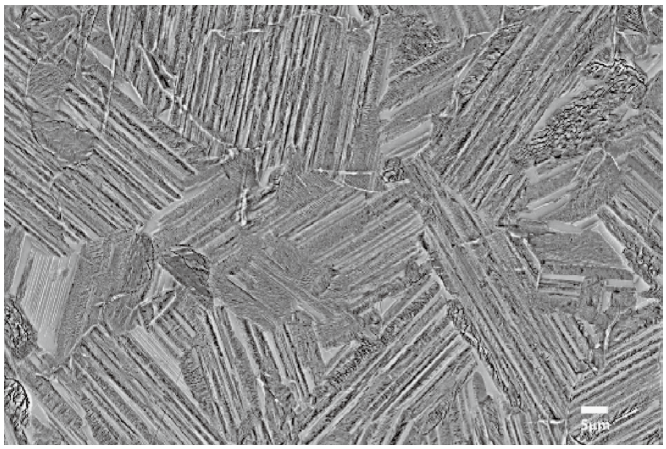
BSED-based ECCI mode (Electron Channeling Contrast Imaging)

The "Electron Channeling effect" refers to a significant reduction in electron scattering by crystal lattices, when the incident electron beam satisfies the Bragg diffraction condition, allowing a large number of electrons passing through the lattice, thus exhibit a "channeling" effect.

For polycrystalline materials with uniformed composition and polished flat surfaces, the intensity of backscattered electrons relies on the relative orientation between the incident electron beam and crystal planes. Grains with larger orientation variation exhibit stronger signals therefore brighter images, qualitative characterization with such grain orientation map is achieved.



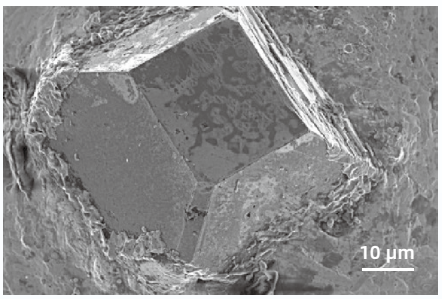
3D-printed alloys (prepared with ion beam polishing)



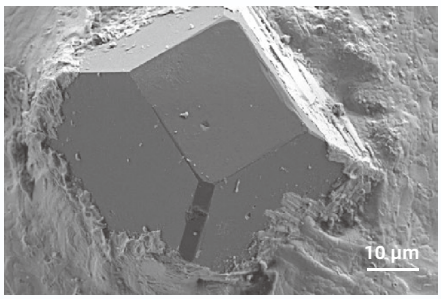
Stainless steel (prepared with ion beam polishing)

01

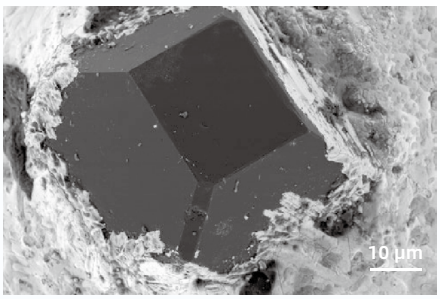
Simultaneously multi-channel imaging via various detectors



Great resolution achieved on surface topographic features with in-lens electron detector imaging

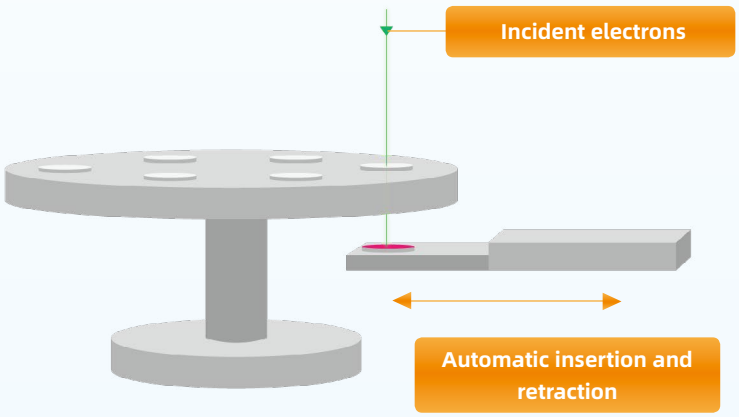


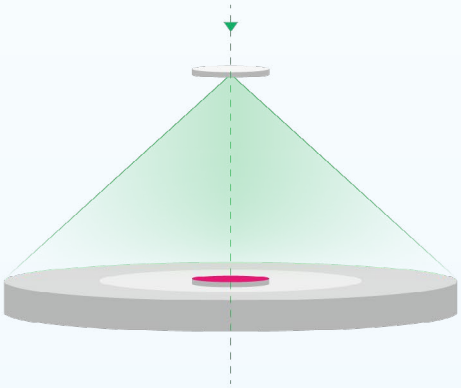
Good stereoscopic images of morphological features with Everhart-Thornley Detector imaging



Atomic number contrast (Z-contrast) image with retractable Back-Scattered Electron Detector imaging

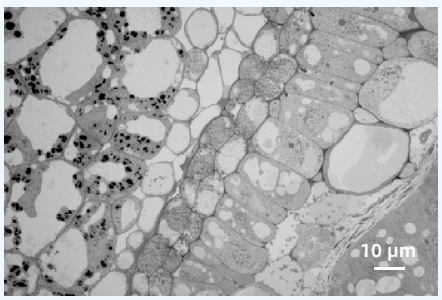
Retractable Scanning Transmission Electron Microscopy (STEM) Detector





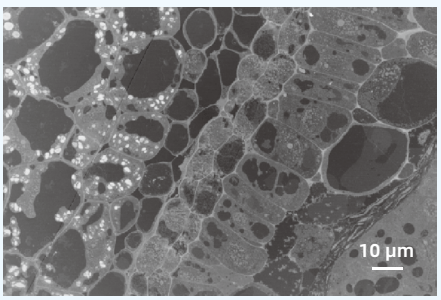
Multiple operating modes

Bright-field (BF) imaging



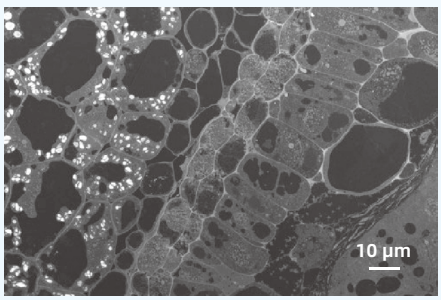
Plant section bright-field imaging (STEM-BF)

Dark-field (DF) imaging



Plant section dark-field imaging (STEM-DF)

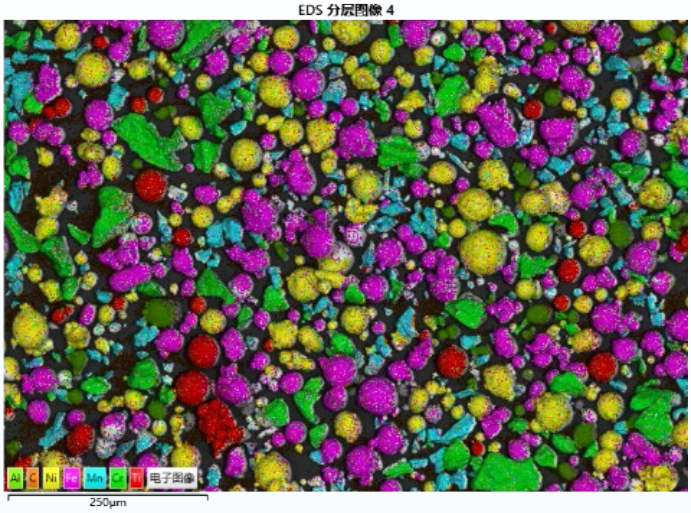
High-angle annular dark-field (HAADF) imaging

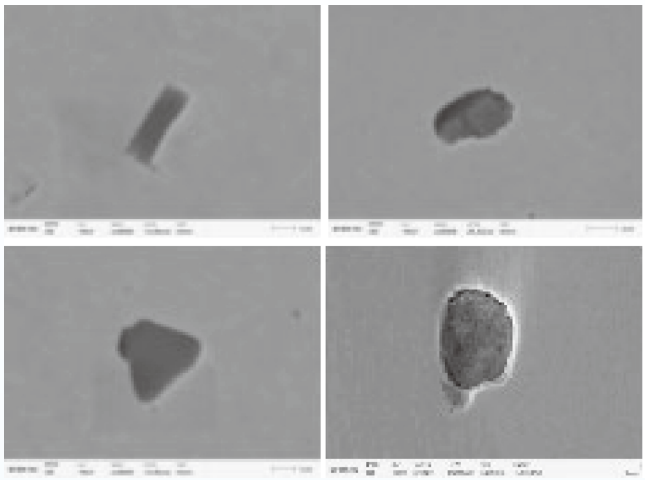


Atomic number contrast (Z-contrast) image with Retractable Back-Scattered Electron Detector

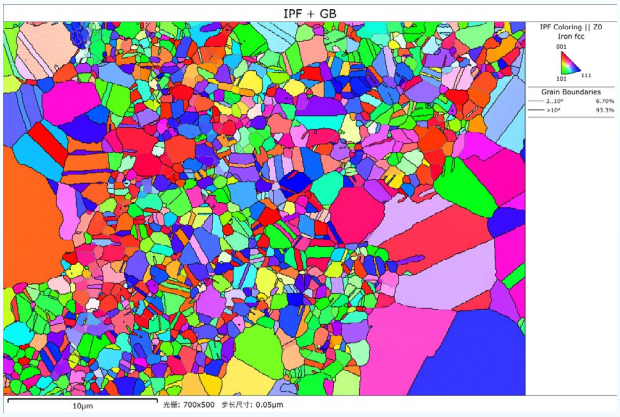
Advances in CIQTEK electron microscopy technology - more options

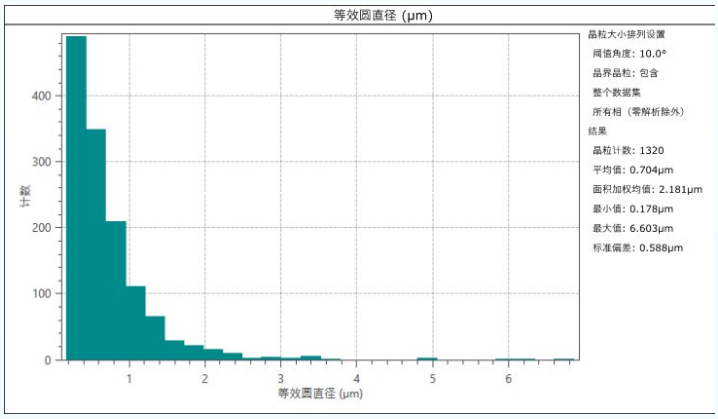
Energy Dispersive spectrometry



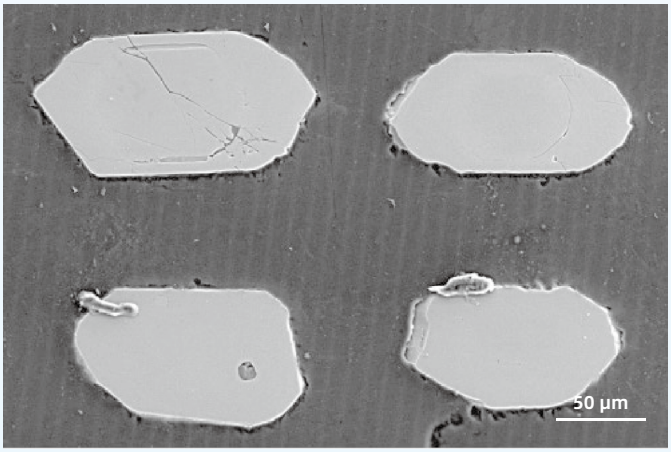


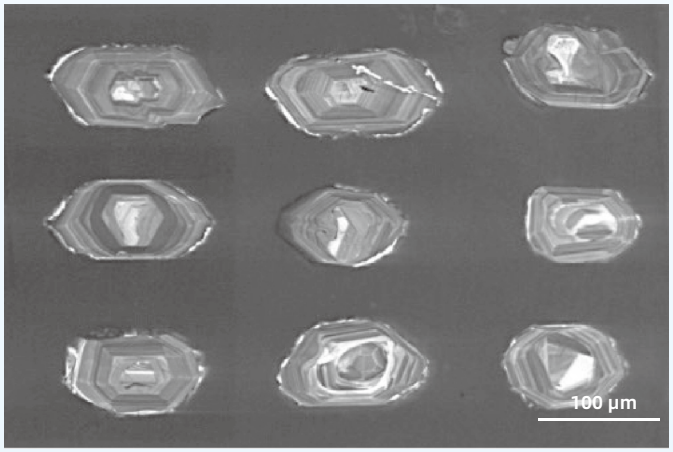
EBSD





Catholuminescence（CL）





02

Specimen Exchange Loadlock

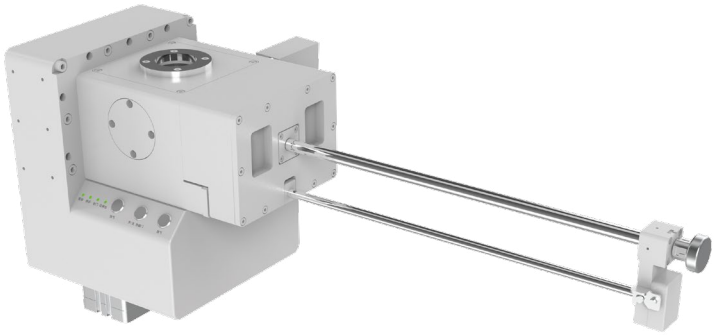
* Optional

Features:

Effectively reduce chamber contamination
Linear guiding rail design, drawer-style opening and closing

4-inches（110mmx40mm）

8-inches（208mmx40mm）

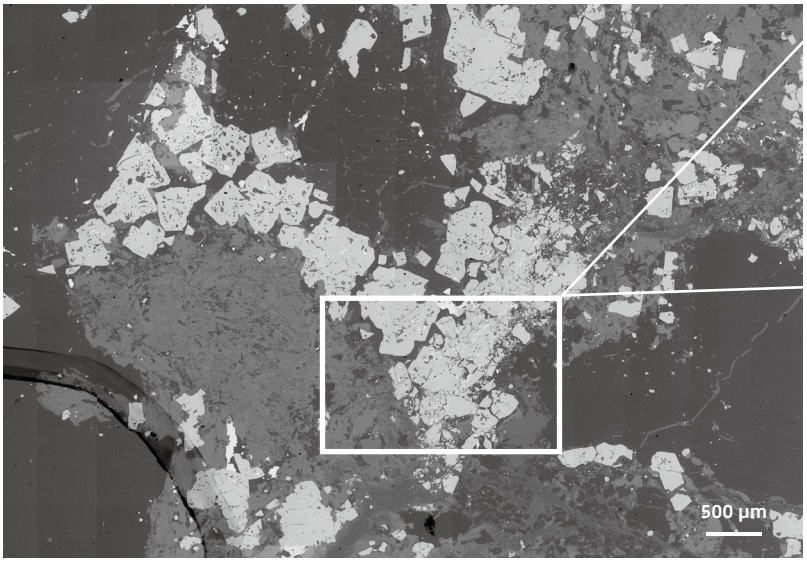


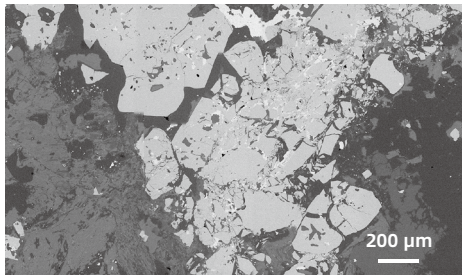
Trackball & Knob Control Panel

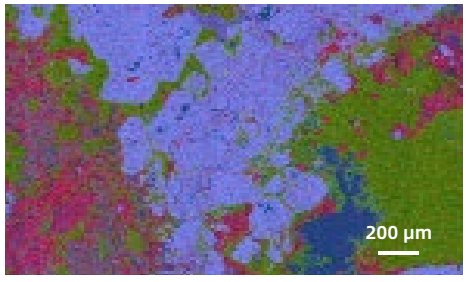
* Optional

AutoMap

* Optional



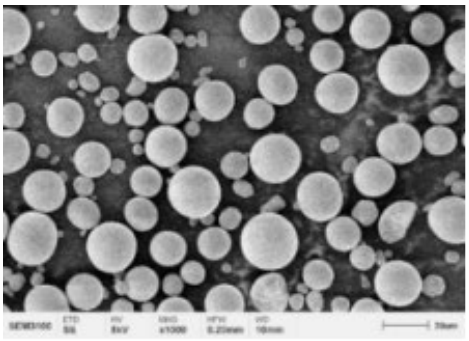


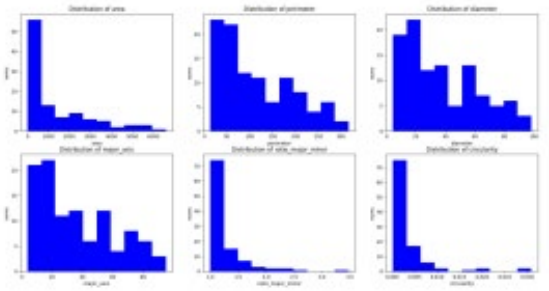


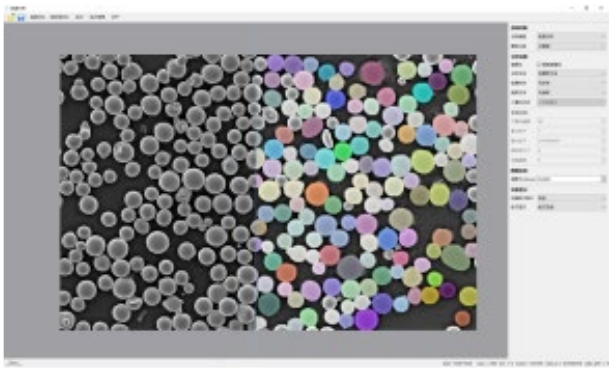
- **Maximum Field of View greater than 100 mm^2**
- **Support single frame resolution up to 48k pixels, and stitched image up to 800 billion pixels**
- **Patented algorithms for local and global optimization, achieving optimal stitching effects (*Patent number: 202210372676.8)**
- **Preset imaging condition for unattended continuous image acquisition and real-time stitching**
- **Automatic focusing, automatic astigmatism deduction, and automatic brightness & contrast functions during image acquisition**
- **Offline data browsing, stitched images can be imported into 3rd party image post-processing software**
- **Built-in various measurement tools**

Particle and Pore Analysis Software

* Optional







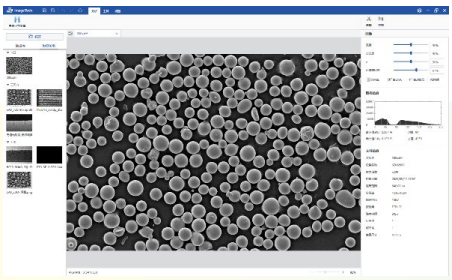
The software employs various target detection and segmentation algorithms, suitable for various types of particle and pore samples. It enables quantitative analysis of particle and pore statistics and can be applied in fields such as materials science, geology, and environmental science.

- Uses Mask-RCNN, an object detection and instance segmentation algorithm that accurately identifies particles in an image without the need for parameter tuning.
- Utilizes classical watershed algorithm and ensemble contour non-convex cutting method for precise segmentation of adhesive and overlapping particles.
- Offers two modes: particle statistics and pore analysis.
- Provides multiple morphological information statistics and exportation, such as particle counting, average area calculating, particle size, pore volume, etc.
- Mask-RCNN: Mask Region-based Convolutional Neural Network is a deep learning model used for object detection and instance segmentation.

Image post-processing software

* Optional

- Operates offline, allowing for data processing anytime, anywhere.
- Gamma correction.
- Automatic brightness & contrast adjustment.
- Automatic AI noise reduction.
- Histogram analysis.
- Resolution calculation.
- Image measurement and annotation.
- Compatible with various image formats, such as TIFF/PNG/JPG/BMP.

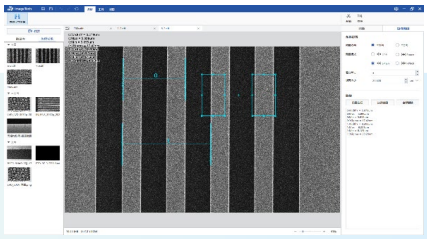


Performs online or offline image post-processing on images captured by electron microscopes and integrates commonly used EM image processing functions, convenient measurement and annotation tools

AutoMeasure

* Optional

- Gradient calculation for all pixels within the selected frame, enabling more precise edge detection.
- Multiple edge detection modes, such as line, space, and pitch.
- Compatibility with various image formats, including TIFF, PNG, JPG, and BMP.
- Built-in image post-processing functions.

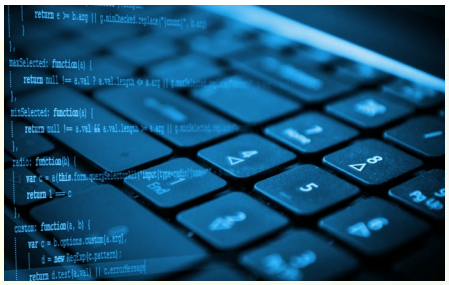


Automatic recognition of line width edges, resulting in more accurate measurements and higher consistency. Supports multiple edge detection modes, such as Line, Space, Pitch, etc. Compatible with multiple image formats and equipped with various commonly used image post-processing functions. The software is easy to use, efficient, and accurate.

Software Development Kit（SDK）

* Optional

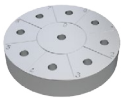
- Support for popular programming languages, such as C++, Python, C#, etc.
- Well-defined interface specifications and documentation.
- Provided C++ and Python code examples for integration and usage.
- Full control over the functions of the scanning electron microscope.



Provides a set of interfaces for controlling the scanning electron microscope, including image acquisition, operating condition settings, power on/off, stage control, etc. Concise interface definitions allow for rapid development of specific electron microscope operation scripts and software, enabling automated tracking of regions of interest, industrial automation data acquisition, image drift correction, and other functions. Can be used for software development in specialized areas such as diatom analysis, steel impurity inspection, cleanliness analysis, raw material control, etc.

Multiple sample holders available (customizable)

Standard configuration

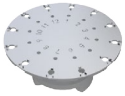


Standard 9-position holder.

Specifications: 9 position, diameter of 50 mm.

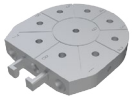
Quick-exchange deceleration mode compatible sample holder.

Specifications: 8 position, diameter of 50 mm.



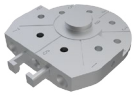
6-inches wafer sample holder.

Specifications: 6 inches.



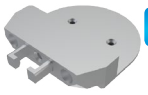
Quick-exchange 9-position sample holder.

Specifications: 9 position, diameter of 50 mm, supports sample height of 5 mm.



Quick-exchange 9-position holder.

Specifications: 9 position, diameter of 50 mm, supports sample height of 14 mm.



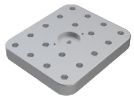
Quick-exchange flat sample holder.

Specifications: diameter of 50 mm, supports sample height of 20 mm.

Custom configuration

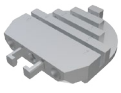
Custom configuration.

Custom quick-exchange EBSD 70° sample holder.



Custom 19-position sample holder.

Specifications: size of 81x70x11 mm³.



Custom quick-exchange cross-section sample holder.

Specifications: diameter of 50 mm, supports sample height of 14 mm.

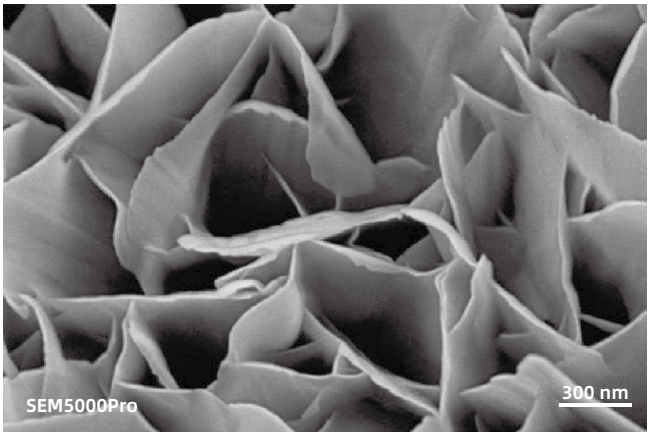
Custom 9-position mold sample holder.

Specifications: custom diameter 25 molds, 9 to them with dimensions of 86x86x10 mm³.

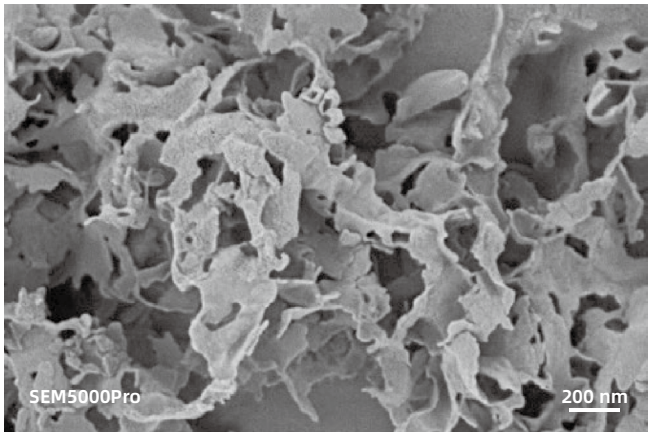
Customized sample holders available according to various application scenarios.

Materials Science

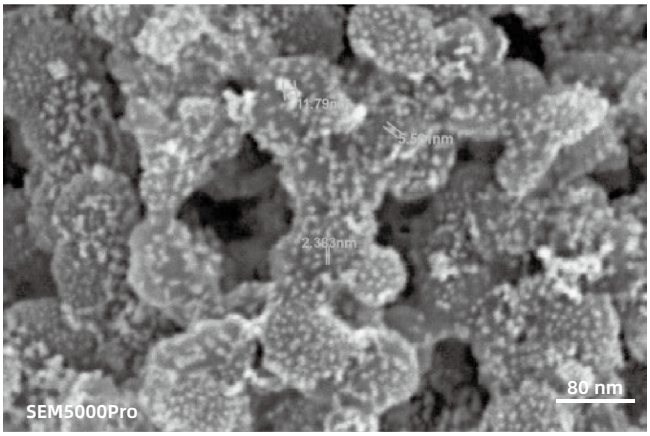
Nanomaterials



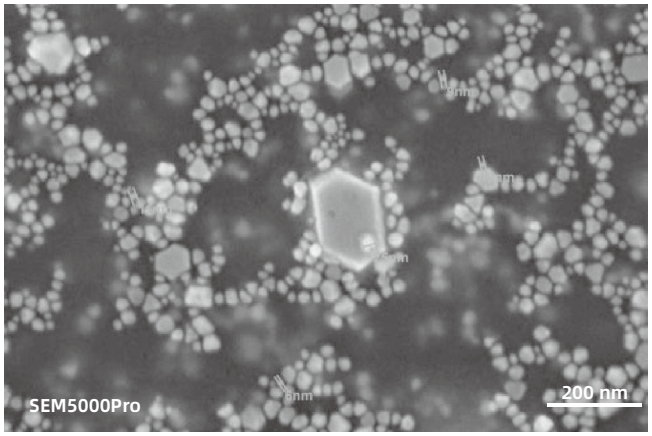
Imaging of nickel foam with strong three-dimensional effect using a 2 kV excitation voltage with Everhart-Thornley Detector (ETD).



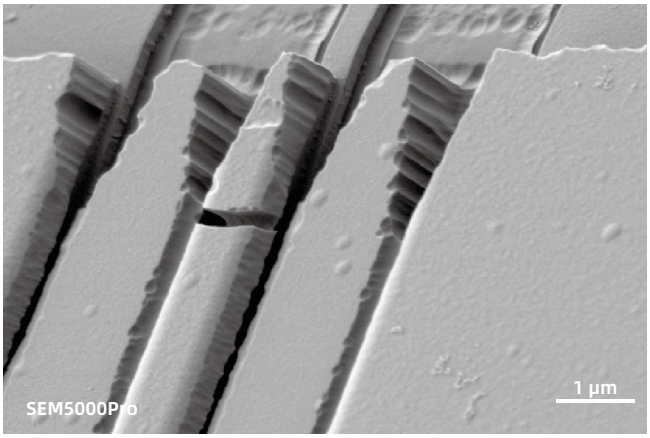
Non-conductive two-dimensional material C3N4, non-destructive characterization of its fine layer structure under low-voltage conditions at 500 V.



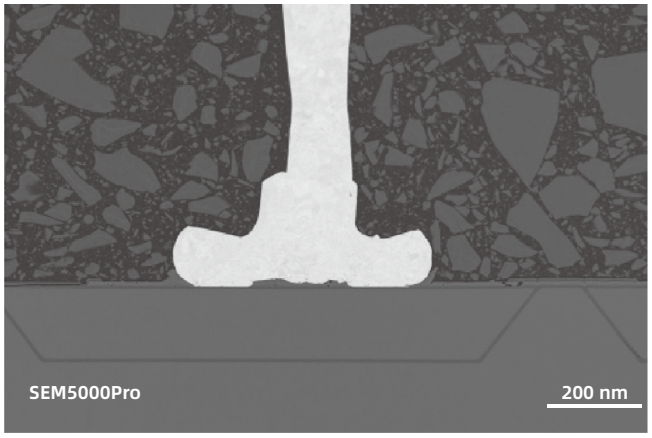
Imaging of the distribution of platinum particles on carbon material for a common Pt-C catalyst at 2 kV voltage.



Imaging of sub-nanometer silver powder using an in-lens electron detector at 3 kV under high-vacuum conditions.



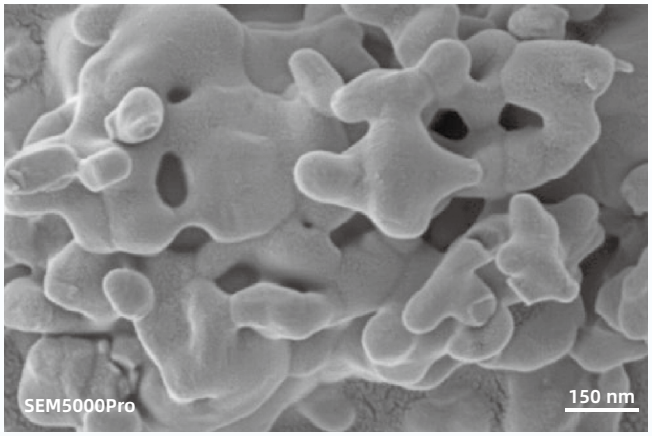
Characterization of the surface features and structures of a waveguide using a low voltage (1 kV) with Everhart-Thornley Detector (ETD).



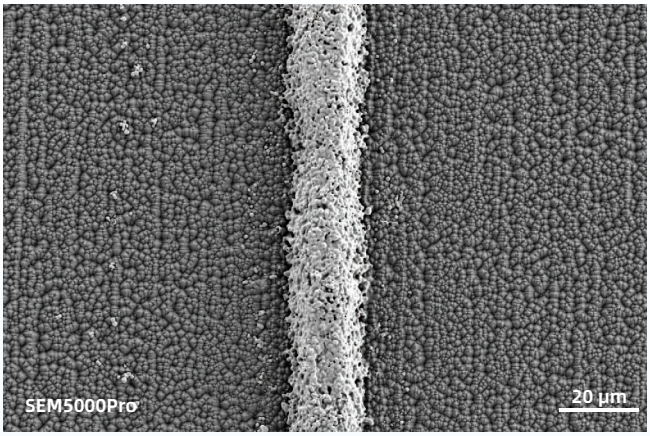
Imaging of the solder joints of gold wires on a chip using a Retractable Back-Scattered Electron Detector(BSED). Sample prepared with ion beam polishing.

Materials Science

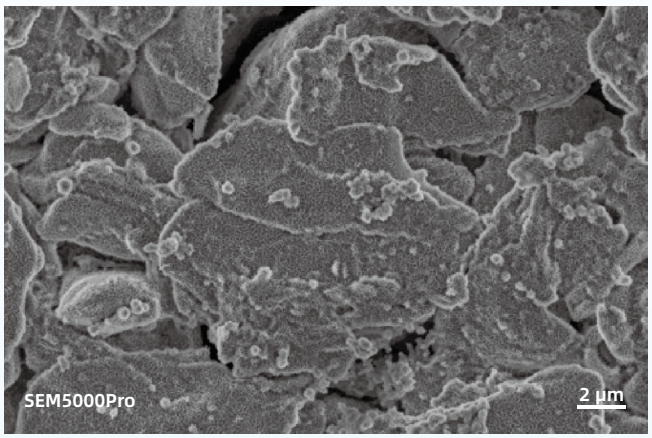
Energy Materials



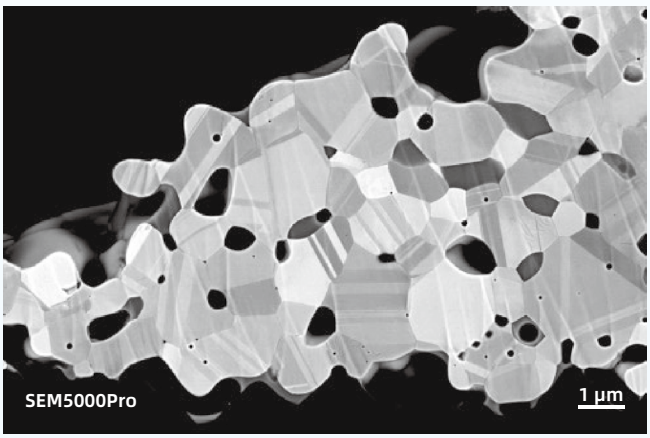
Lithium-ion Battery Cathode Precursor - Iron Phosphate with poor conductivity, imaged using an In-lens Electron Detector (In-lens) under low voltage (1 kV) conditions.



Surface metallization quality of photovoltaic silicon wafers detected using a Chamber-mounted Everhart-Thornley Detector (ETD) at 2 kV.

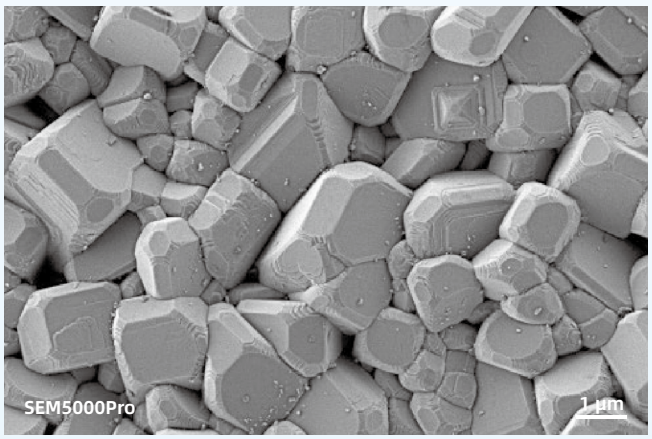


Surface SEI (Solid Electrolyte Interphase) film on the failed negative electrode imaged under high vacuum conditions using an In-lens Electron Detector (In-lens) at 3 kV.

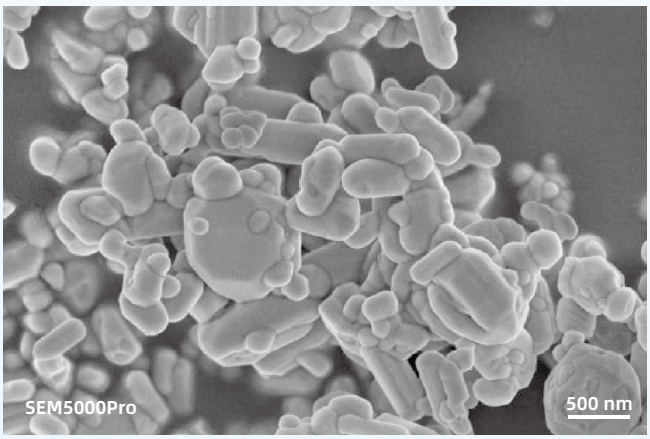


Channel lining and morphological details of a silver metal electrode cross-section distinguished using a Retractable Back-Scattered Electron Detector(BSED) at 5 kV. Specimen prepared with Ion beam polishing.

Ceramic Materials



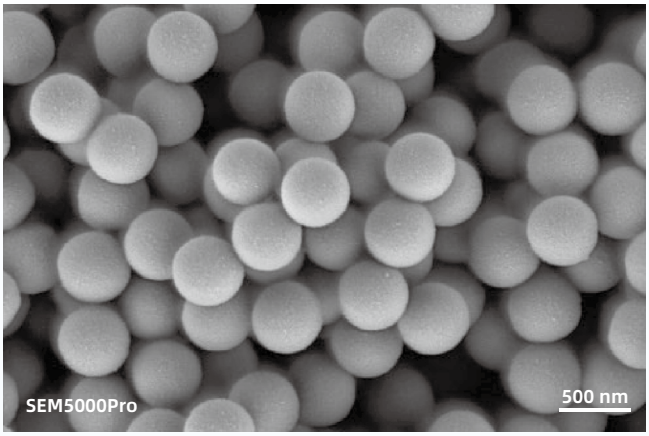
Particle morphology and growth steps on ceramic surfaces imaged using a Chamber-mounted Everhart-Thornley Detector (ETD) at 2 kV.



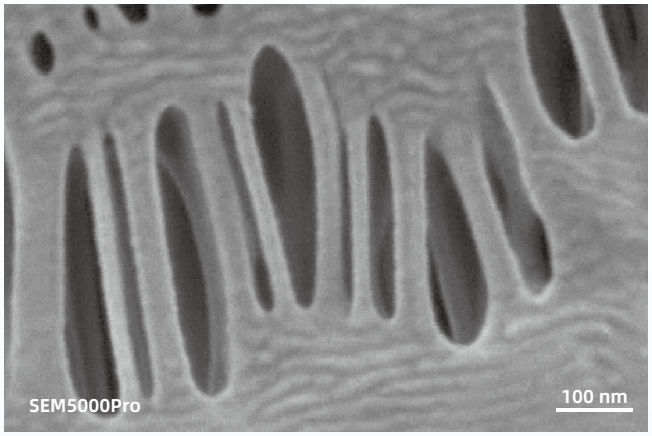
Barium Titanate ceramics imaged using an In-lens Electron Detector (In-lens) at 3 kV.

Material Science

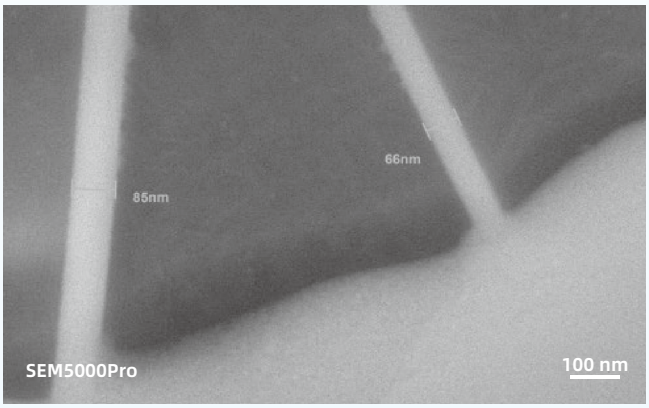
Polymer Materials and Metal Materials



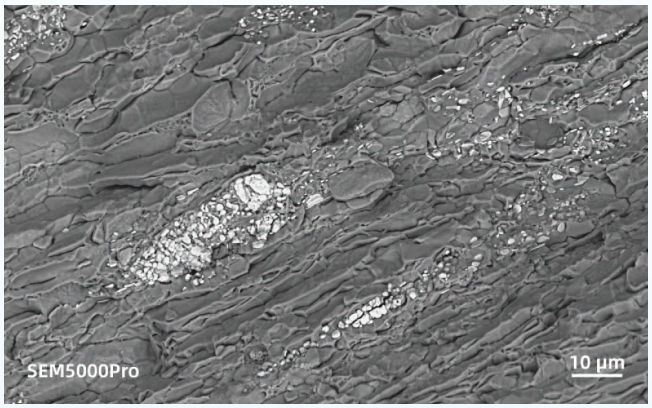
Using Everhart-Thornley Detector (ETD) under high vacuum and low voltage conditions (1 kV) for imaging the morphology of polystyrene microspheres. No charging phenomenon observed, resulting in a strong three-dimensional perception.



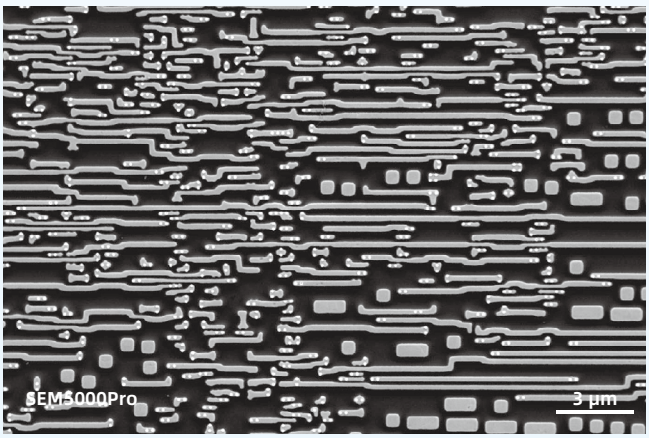
Non-destructive 500 V imaging of lithium-ion battery polymer membrane fibers under the surface-sensitive condition.



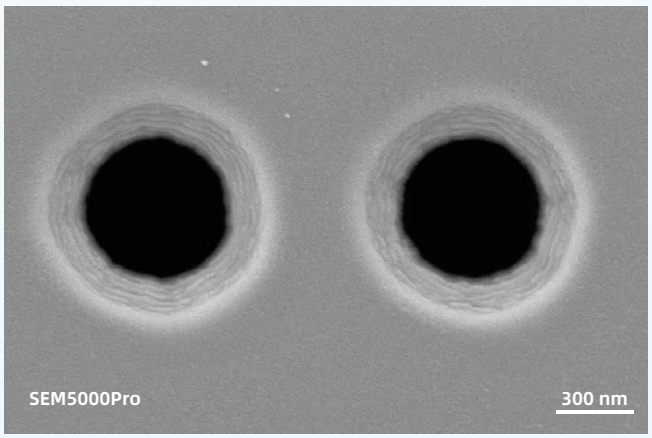
High-resolution imaging of nano-sized precipitates in fracture surfaces using the Retractable Back-Scattered Electron Detector(BSED).



Characterization of pore distribution on the surface of hydrogel polymers under high vacuum conditions (2 kV), following critical point drying as a sample preparation.



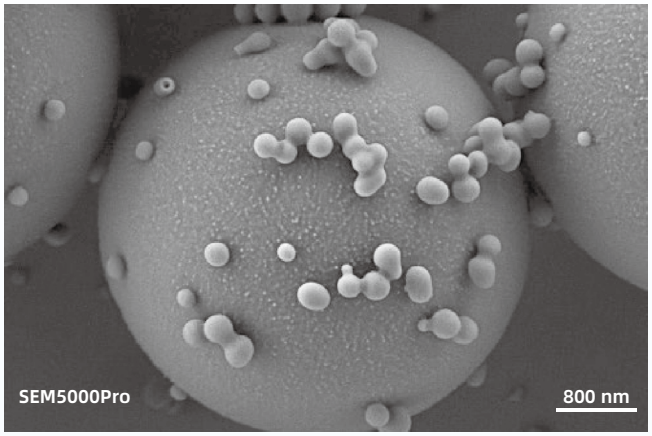
Imaging of the surface patterns and circuits on a chip using a Retractable Back-Scattered Electron Detector(BSED).



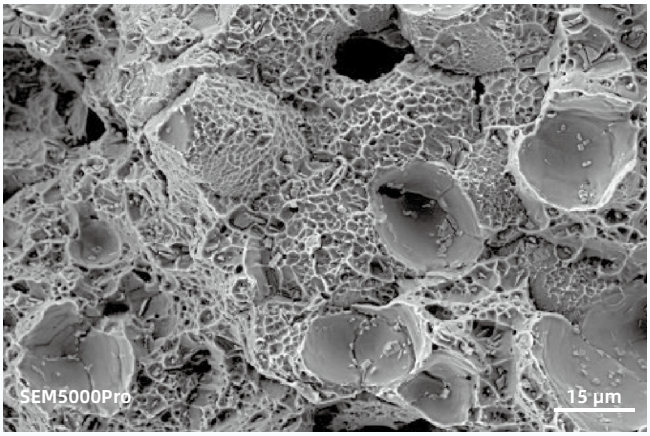
Low voltage (2 kV) Everhart-Thornley Detector (ETD) characterization of the surface and hole edge textures of a photoresist.

Magnetic Materials

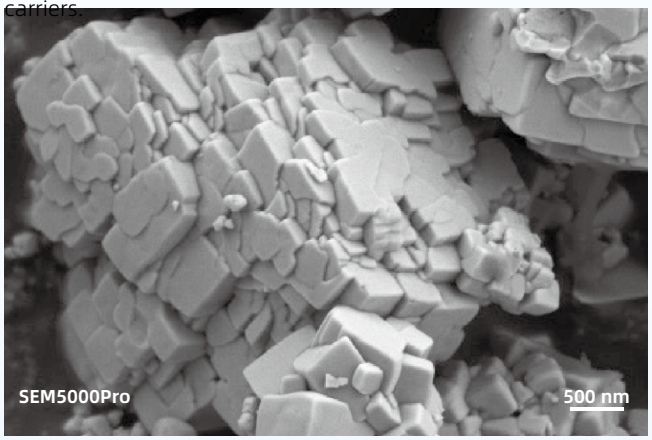
Polymer materials and metal materials



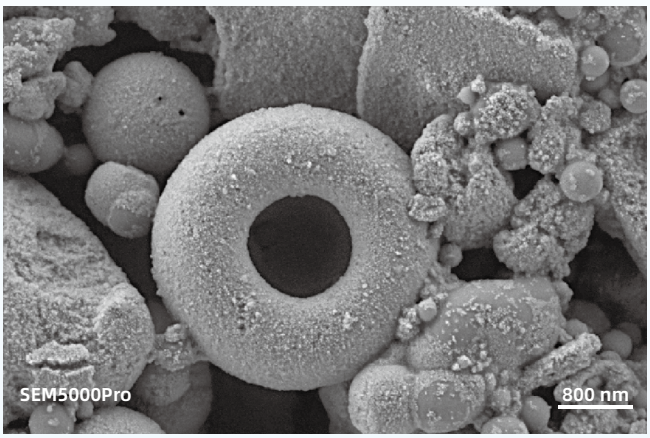
Polymer magnetic beads, with poor conductivity, characterized using a low-voltage at 2 kV with Everhart-Thornley Detector (ETD) for the characterization of biologically targeted drug delivery carriers.



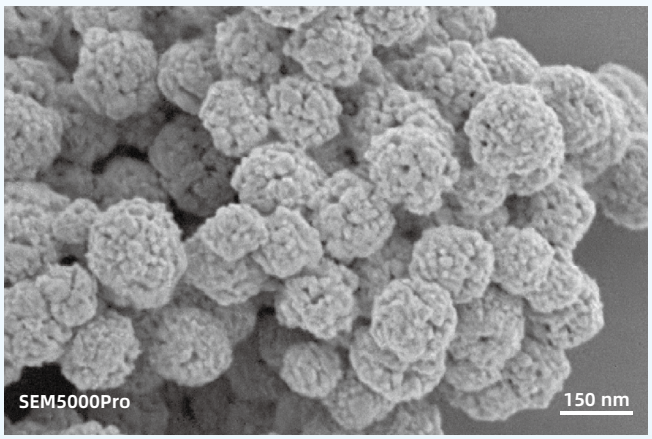
10 kV imaging with Everhart-Thornley Detector (ETD) used to characterize the fracture surface of iron-nickel alloy metal.



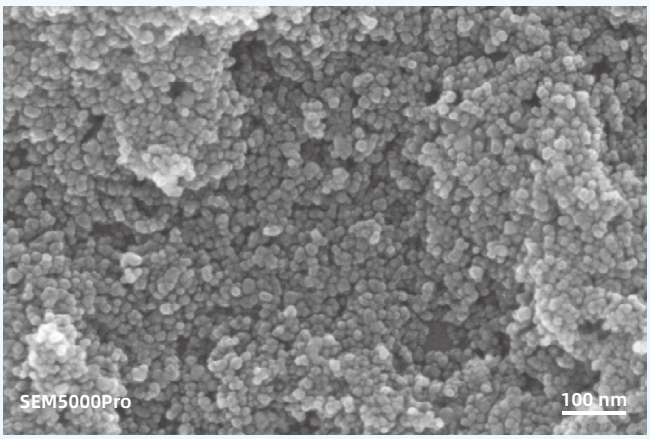
Magnetic field free design of non-emersion objective lens facilitates the microstructural characterization of $Ba_2Fe_{0.8}Nb_{1.2}O_6$ powder specimen, which has strong magnetic field.



Polymer magnetic beads, characterized using a low-voltage 2 kV with Everhart-Thornley Detector (ETD), exhibit a strong sense of three-dimensionality.



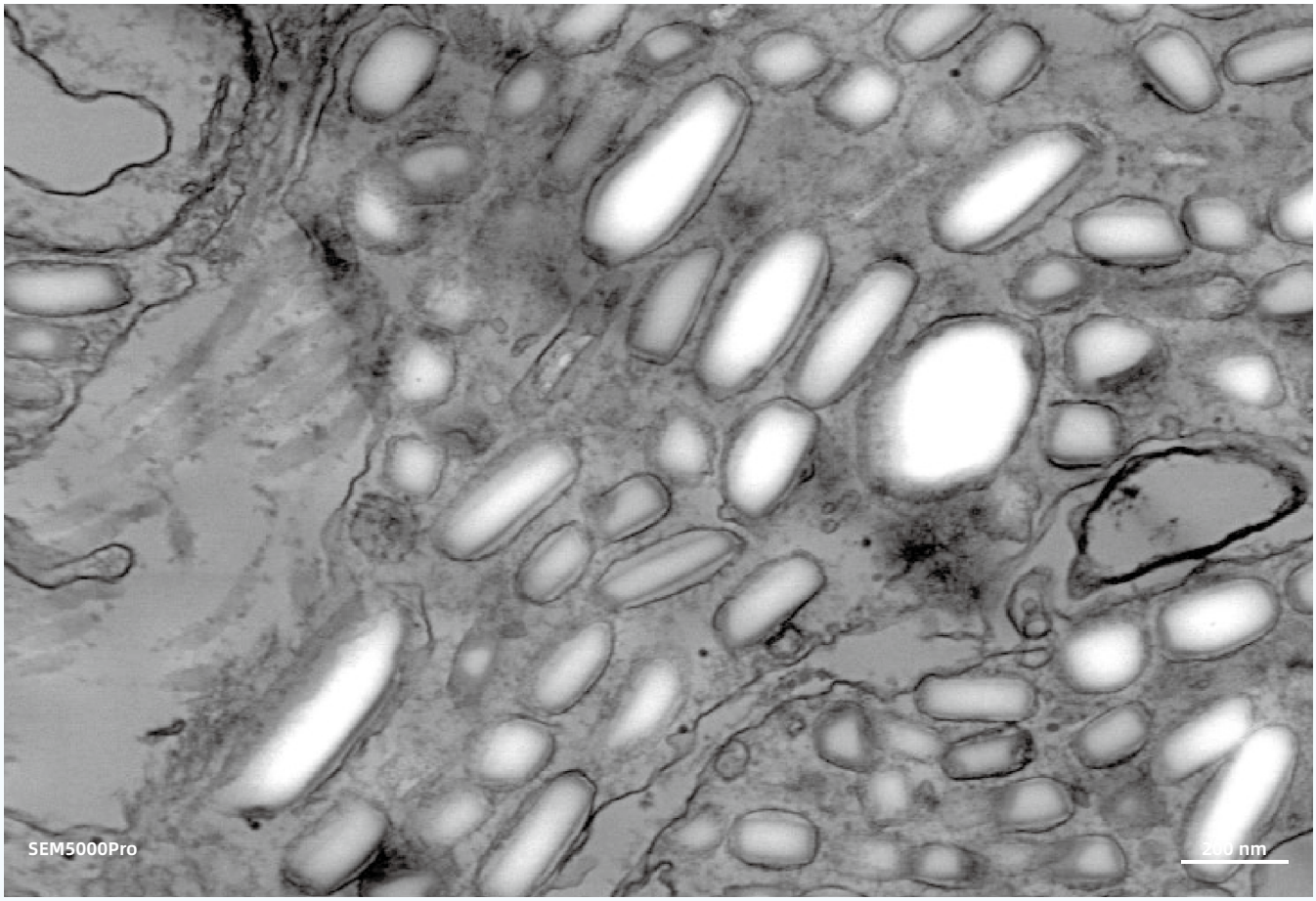
Used for cell sorting and immunity detection in related fields, characterized under low-voltage conditions of 1 kV.

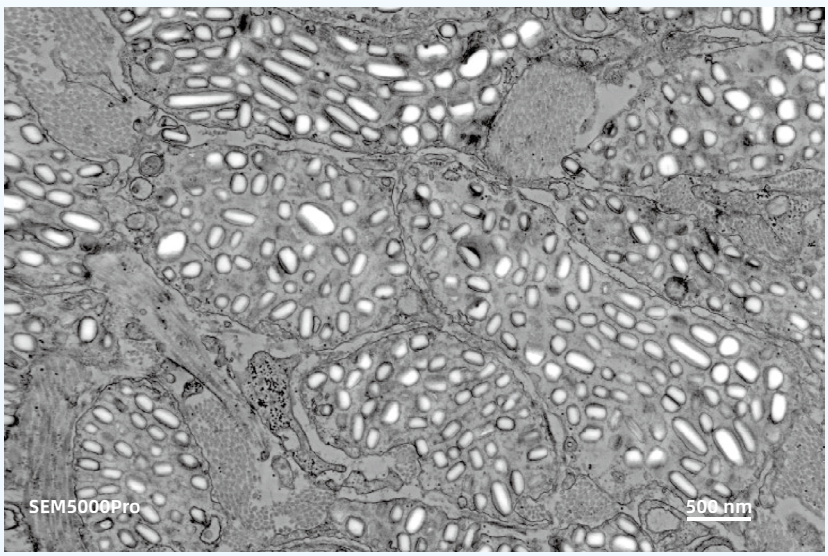


Common metal powders containing Fe and Mn which exhibit magnetic properties, with particle sizes below 20 nm

Life Science

Lizard skin cells





Characterization of iridophores in lizard skin cells, using -STEM detector in a SEM5000 FE-SEM.

Animal colors in nature can be classified into two categories based on their formation mechanisms: pigment colors and structural colors. Pigment colors are achieved through variations in pigment composition and the overlapping of colors, similar to the principles of "primary colors." Structural colors, on the other hand, are generated through the reflection of light of different wavelengths by intricate physiological structures, based primarily on principles of optics.

Iridophores, found in lizard skin cells, possess structures similar to diffraction gratings. We refer to these structures as "crystalline plates." Crystalline plates can reflect and scatter light of different wavelengths. Studies have shown that by varying the size, spacing, and angle of the crystalline plates in lizard iridophores, the wavelengths of light scattered and reflected by their skin can be altered. This finding is significant for understanding the mechanisms behind color change in lizard skin

Specifications

	Specifications	SEM5000Pro
Electron Optics	Resolution	0.8 nm @ 15 kV, SE 1.2 nm @ 1.0 kV, SE
	Accelerating voltage	20 V ~30 kV
	Magnification（Polaroid）	1 ~2,500,000 ×
	Electron gun	Schottky Field Emission Electron Gun
Specimen Chamber	Low Vacuum	/
	Camera	Optical navigation + chamber monitoring
	XY Range	110 mm
	Z Range	50 mm
	T Range	-10° ~+70°
	R Range	360°
Detector	In-lens Electron Detector	Inlens
	Everhart-Thornley Detector	ETD
	Retractable Back-Scattered Electron Detector（BSED）	○
	Retractable Scanning Transmission Electron Microscopy detector（STEM）	○
	Low Vacuum Detector（LVD）	○
	Energy Dispersive Spectrometer（EDS）	○
	Electron Backscattered Diffraction Pattern （EBSD	○
Optional	Specimen exchange loadlock（4 inch /8 inch）	○
	Trackball & Knob Control Panel	○
	Duo-Dec mode（Duo-Dec）	/
	Ultra beam deceleration mode technology	/
User Interface	Operation System	Windows
	Navigation	Optical navigation, gesture quick navigation, trackball(optional)
	Automatic Functions	Auto brightness & contrast, auto focus, auto stigmator

● Standard configuration. ○ Optional / None

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Email: info@ciqtek.com Website: www.ciqtekglobal.com
Address: Building E2, No. 2800. Innovation Ave, Hi-tech Zone, Hefei, Anhui 230088, China