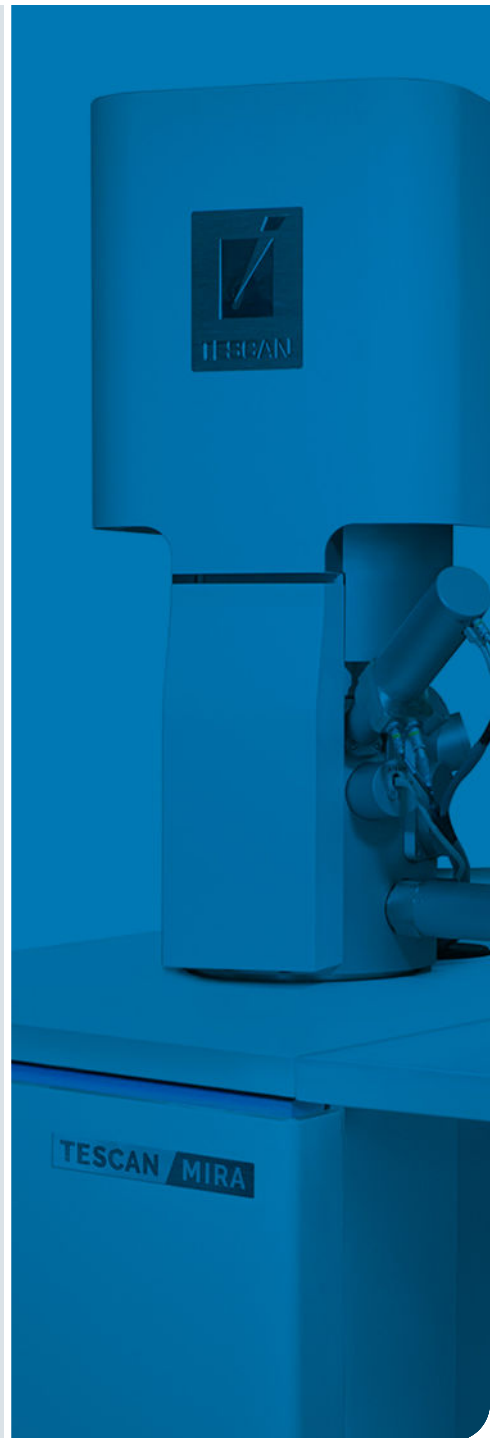
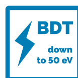


TESCAN MIRA

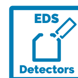
High-resolution analytical SEM for routine materials characterization, research and quality control applications at the sub-micron scale.

Single Beam (SEM)

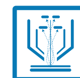
Field Emission Electron Source



Beam Deceleration Technology



Fully integrated EDS (Essence™ EDS)



In-Colum Detectors

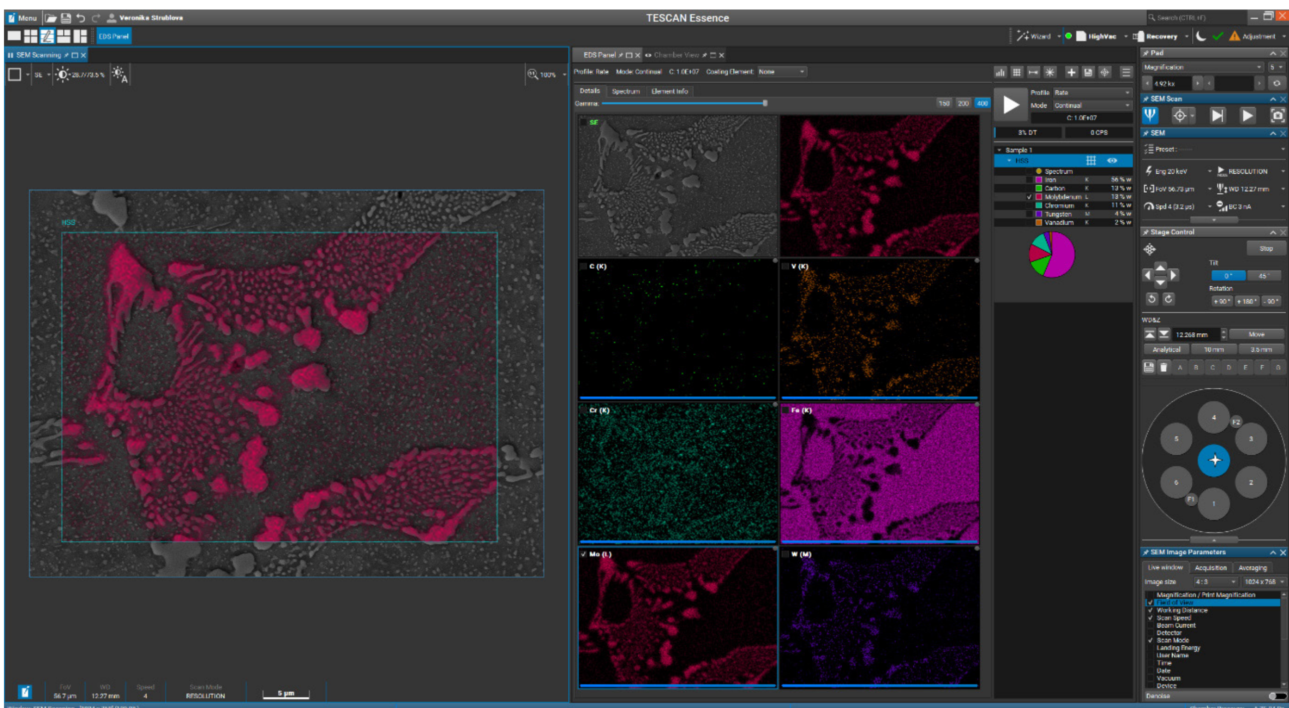
Variable Pressure (MultiVac)

Key features

TESCAN MIRA's 4th generation Scanning Electron Microscope (SEM) with FEG Schottky electron emission source combines SEM imaging and live elemental composition analysis in a single window of TESCAN's Essence™ software. This combination significantly simplifies acquisition of both morphological and elemental data from the sample, making MIRA SEM an efficient analytical solution for routine materials inspection in quality control, failure analysis and research labs.

Fully integrated Essence™ EDS efficiently combines SEM imaging with elemental composition analysis in the SEM's live scanning window.

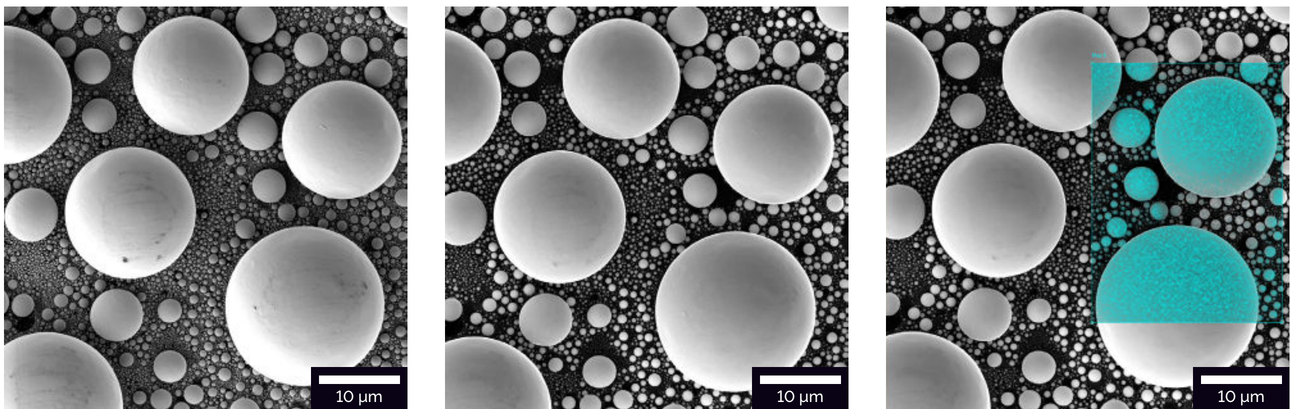
TESCAN MIRA features optional Essence™ EDS, which operates within the SEM live scanning window of the Essence™ microscope control software to make analytical operation fast and easy. With a single mouse click, all set-up parameters are changed so that element-based inspection can begin instantly. Essence™ EDS provides immediate access to the elemental spectrum, map or line EDS profile from any region or point on the sample. The data are stored automatically within a structured data tree so users can recall results at any time. Data are linked with stage position as well, so even after proceeding with further analysis, operators can return to previous areas of interest and continue investigations using other analytical techniques.



▲ Layout of the Essence™ EDS in the Essence software GUI. Analysis can be made directly in the live SEM window. Mo precipitates in HSS steel

Optimum imaging and analytical conditions immediately available thanks to TESCAN´s unique apertureless design.

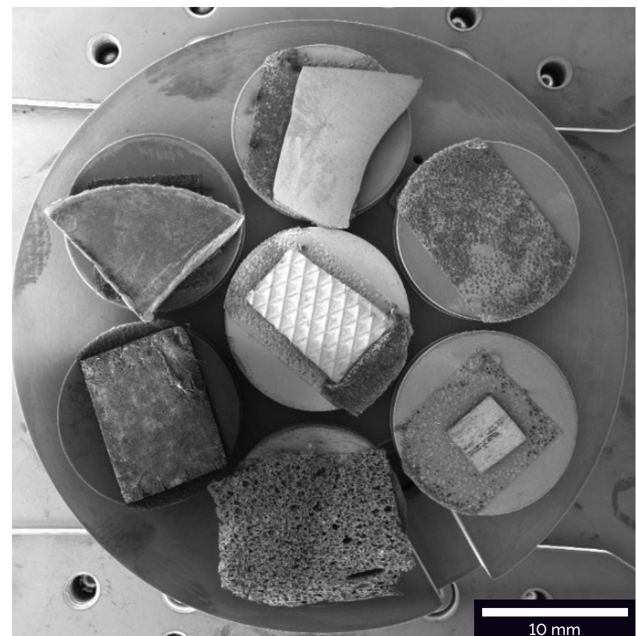
TESCAN MIRA features an innovative optics design which guarantees immediate and seamless selection of imaging or analytical conditions whenever required, without the need for any in-column mechanical re-alignment. TESCAN MIRA is equipped with a unique additional lens – the Intermediate Lens™ – which is powered by In-Flight Beam Tracing™. This combination allows users to continuously increase the current to the value where the signal-to-noise ratio is optimum for imaging at the desired magnifications and accelerating voltages. More importantly, to switch between imaging (low beam current) and analytical (high beam current) conditions, is a matter of a single click in the software.



▲ Tin balls imaged at 3 keV (left), 20 keV (middle) and at 20 keV 5 nA (analytical conditions) with Essence™ EDS map of Tin (right). It is evident that sufficient resolution for imaging and EDS analysis is maintained even at analytical beam currents.

Effortless and precise SEM navigation on the sample at magnification as low as 2×

Precise navigation to the desired area of interest is guaranteed by Wide Field Optics™, which provides the operator with a live SEM overview of the sample. Wide Field Optics™ provides unprecedented depth of focus along with a view of the sample's actual topography for a more intuitive navigation process. Begin observation in the live SEM window at 2× magnification for a detailed overview, then continuously magnify directly over areas of interest—without the need for an optical navigation camera. Live SEM overview can also be used with pre-tilted holders, such as those for EBSD, and supports scanning tilt correction for accurate navigation on tilted analytical samples.

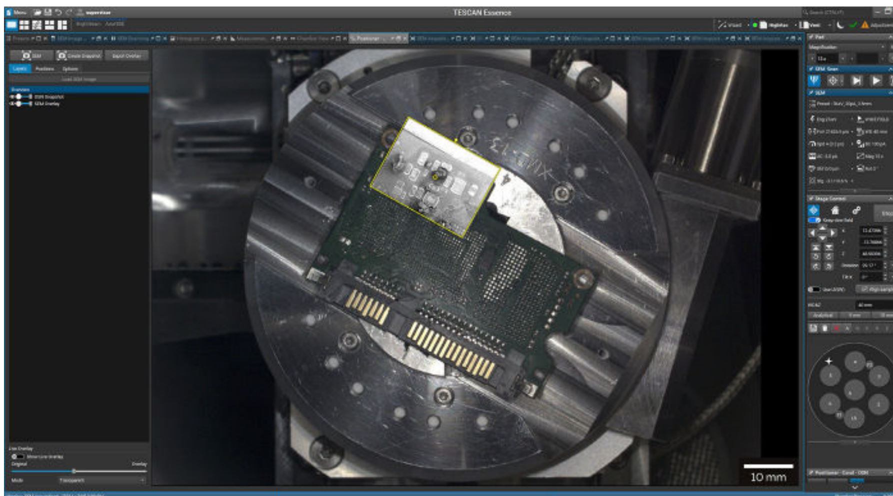


▶ Overview image captured by Wide Field Optics™ mode showing the three samples placed on the SEM stage in the GM chamber.

Optical Navigation and Correlation camera (ONCam) for navigation on large samples and to features of interest according to their true color, appearance or marks that cannot be seen with SEM contrast methods alone.

TESCAN's Optical Navigation and Correlation Camera (ONCam) is an option that provides intuitive, image-based sample navigation from within TESCAN's Essence™ software environment. ONCam is equipped with four independent LED segments that use ONCam's advanced minimum intensity stacking algorithm to eliminate reflections in the optical navigation image. That makes navigation on polished samples, such as metal cross-sections, more precise and efficient.

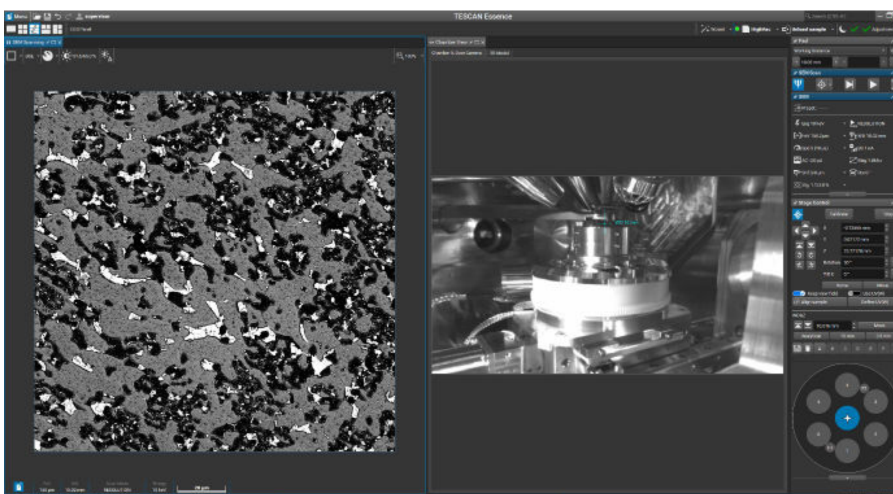
Extended field of view covering 120 × 120 mm² can capture navigation photos even for large samples such as cut-outs from metal or large materials test. ONCam's interface provides correlative functionality via direct overlay of the SEM image on the ONCam capture, with adjustable transparency. Using both the OnCam capture and electron contrast images simultaneously assures navigation to the correct area of interest.



▲ Photo-realistic image of a semiconductor chip captured with the Optical Navigation and Correlation camera (ONCam)

Intuitive and modular Essence™ software designed for effortless operation regardless of a user's experience level.

TESCAN MIRA is operated from TESCAN Essence™ multiuser software, which features many tools to speed analytical work, like quick search function, undo commands and presets. TESCAN Essence™ is built to allow users to define specific workflows that match their level of experience and/or specific application need.



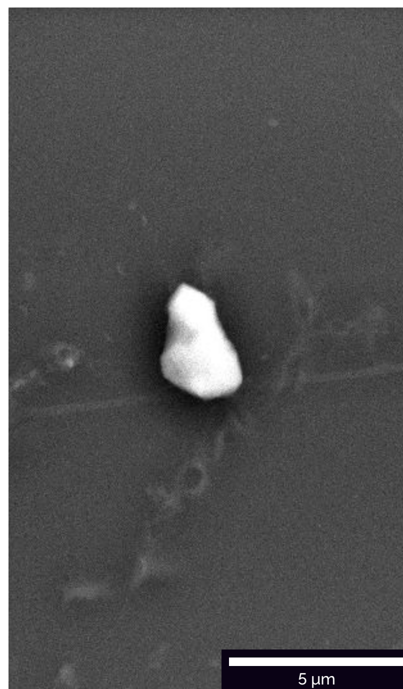
▲ Essence™ software layout

Ultimate safety of the chamber mounted detectors when the stage and sample are in motion is guaranteed with Essence™ 3D Collision model.

Additionally, Essence™ 3D Collision model virtually replicates the chamber interior for a live visualization of hardware geometry, size and position of stage, samples and chamber mounted equipment. Essence™ Collision model predicts the intended movements and interactions for a particular imaging or analytical routine to make it nearly impossible for samples to collide with any chamber mounted detector or 3rd party devices*, like tensile or heating stages.

SingleVac mode as a standard feature for observing charging and beam-sensitive samples.

TESCAN MIRA is delivered with SingleVac mode as standard. SingleVac uses a factory preset pressure value to make observation of charging samples possible, without a conductive surface coating. SingleVac can be accompanied by optional MultiVac mode to allow continual adjustments of the chamber pressure, up to 700 Pa for SE and BSE imaging of extreme charging, outgassing and beam sensitive materials.

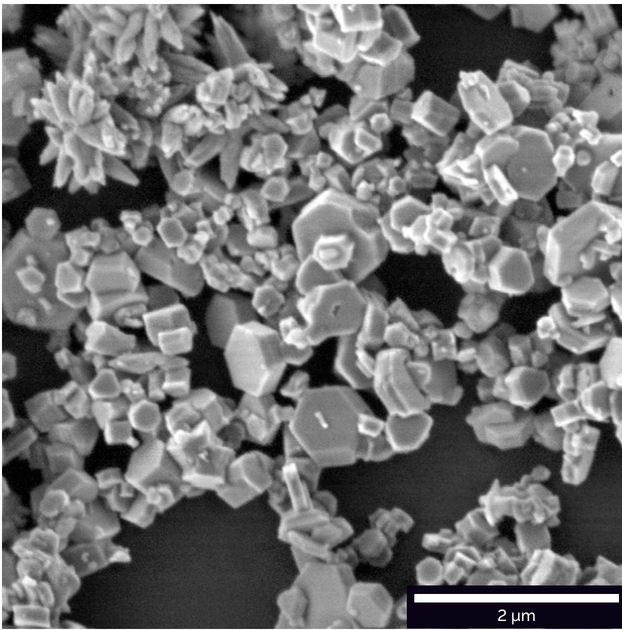


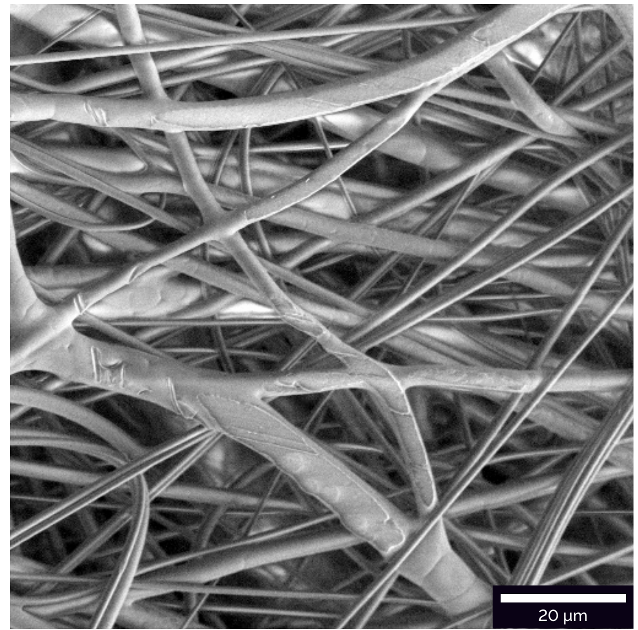
▲ Contamination on the cleaved edge of a display LED (left), contamination and structure of the glass surface (middle) and detail of the tree leaf surface (right). All images acquired in SingleVac mode with chamber BSE detector.

MultiVac mode for achieving the finest topographic characterization of insulating, beam sensitive and outgassing samples, in low vacuum.

TESCAN MultiVac is an optional mode which supports imaging of insulating samples without surface metal coating by enabling low vacuum and extended variable pressure up to 700 Pa. MultiVac includes a gaseous secondary electron detector (GSD) for the most efficient topographical characterization of raw materials. Additionally, the GSD provides an H_2O atmosphere which maximizes signal collection efficiency of MIRA at low keV in low vacuum. This is especially important for the capturing sub-micron details on charging samples that often are also electron beam transparent.

*Compatibility only applies to 3rd party options already integrated in the collision model.

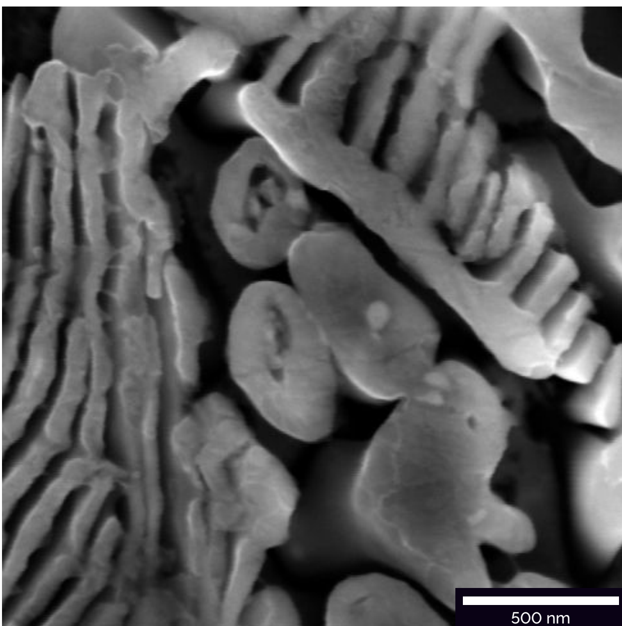


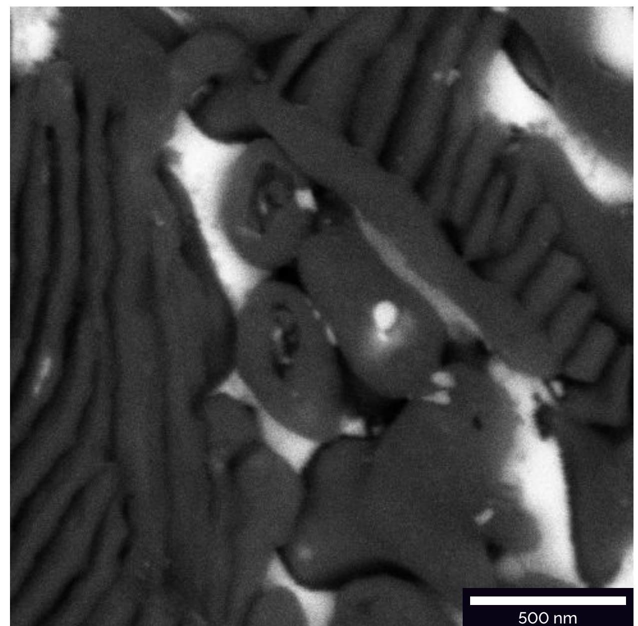


▲ $MgOH_2$ nanoparticles captured at 2 keV in MultiVac mode using GSD detector (left). Moth PP fibers captured at 3 keV in MultiVac mode using GSD detector (right).

Optional in-column SE and BSE detectors, including Beam Deceleration Technology, to enhance imaging performance at low accelerating voltages.

Optional in-column SE and BSE detectors and Beam Deceleration Technology further extend the capabilities of MIRA to meet both current and future characterization challenges in the sub-micron space. Additional In-column SE and BSE detectors allow simultaneous acquisition of up to 4 signals differentiated by contrast, for example, chamber mounted SE, chamber mounted BSE, in-column SE and in-column BSE. Beam Deceleration Technology enhances imaging performance to deliver high resolution, particularly at low acceleration voltages.





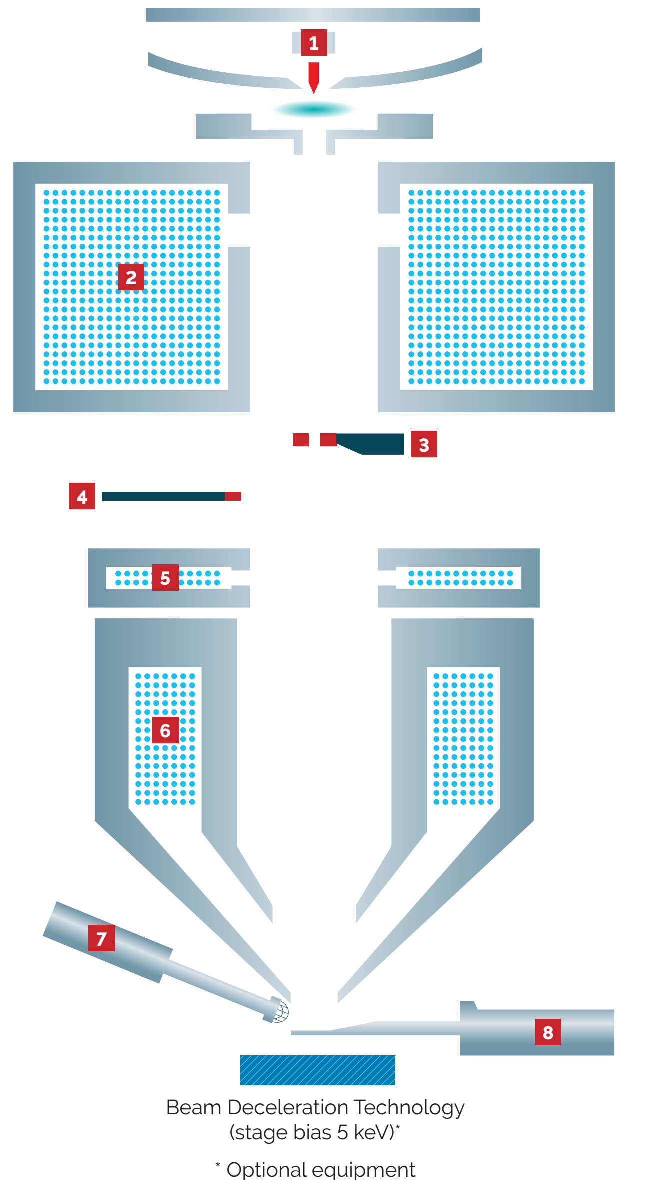
▲ (left) High resolution image of solder alloy captured with In-Beam SE detector and (right) In-Beam LE BSE detector simultaneously at 5 keV.

Technology behind TESCAN MIRA

TESCAN MIRA is a High-Resolution (HR) Analytical SEM with a high brightness field emission electron source (FEG). The SEM column is equipped with an additional condenser lens – TESCANs unique Intermediate Lens™ – which optimizes the spot size for higher beam currents while also providing access to the unique DEPTH and Wide-Field™ observation modes. Wide-Field Optics™ provides users with a clear overview of the sample at any time to facilitate precise and fast navigation to the correct region of interest. Depth mode extends the depth of focus, so that samples with extreme topography are imaged with all features in focus.

TESCAN MIRA is equipped with two chamber mounted detectors: a secondary electron detector (SE) for topographical contrast and a backscattered electron detector (BSE) for material contrast. TESCAN offers several options of the BSE detectors. The single crystal YAG BSE detector delivers high material contrast, even at the fastest scanning rate, and as such is appreciated for its robustness and delivering the fastest signal collection, with unlimited lifetime. The YAG BSE detector offers unlimited lifetime. Another popular option is a four quadrant BSE detector (4Q BSE). This detector is appreciated by those whose investigations require take off angle-dependent signals. Each quadrant can be switched on or off according to the characterization requirements. This detector also provides access to predefined 4Q BSE observation modes such as COMPO for compositional observation and TOPO for topographical observation.

TESCAN MIRA provides the option to equip two in-column detectors. These optional in-column SE and BSE detectors are ideal for high resolution imaging of materials at short working distances. The in-column BSE detector, thanks to its position, is not significantly affected by the topographical shadowing from the surface of the sample so it provides enhanced contrast and may reveal otherwise hidden features. Furthermore, Beam Deceleration Technology can enhance the resolution capabilities of MIRA at low accelerating voltages.

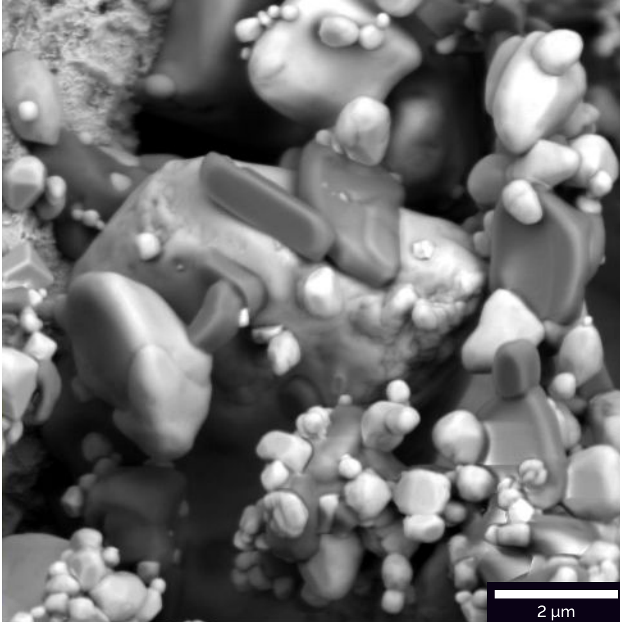


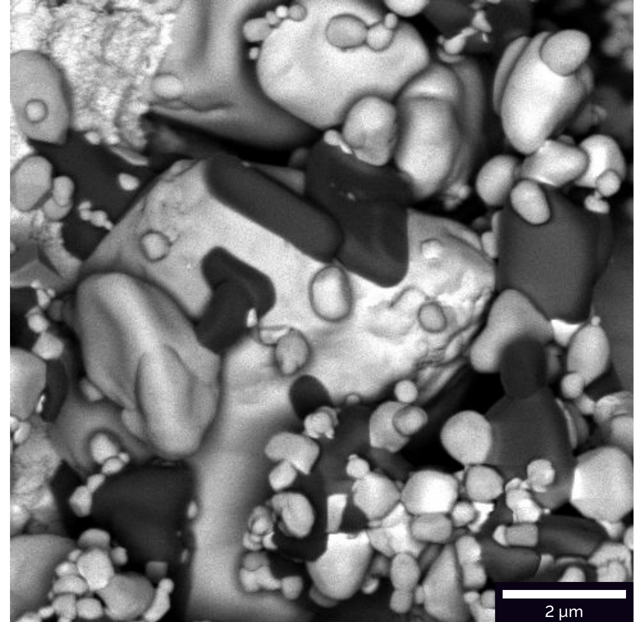
1 Field Emission electron source
2 Condenser lens
3 In-Beam LE BSE Detector*
4 In-Beam SE Detector*
5 Intermediate Lens™
6 Objective lens
7 SE Detector
8 BSE Detector

Engineered for maximum ease of use and reduced time to data

All SEM operation is accomplished from a single, intuitive user interface. Navigation and imaging are entirely software-driven, allowing users to obtain crisp images with minimal effort. TESCAN Wide Field Optics™, In-Flight Beam Tracing™ and the optional fully integrated Essence™ EDS all work together in a single, live view window of the SEM software to improve imaging results, speed analytical work and reduce time to data. Use Wide Field Optics™ to navigate to the desired region of interest with a single click, then zoom in to individual features of interest while maintaining a clear and accurate image of the sample. Any features that appear transparent at high beam voltage can be resolved by simply reducing the beam voltage - without requiring mechanical aperture changes. TESCAN's unique optics design includes a unique Intermediate Lens™ that supports both wide field imaging and optimized imaging conditions based on TESCAN's In-Flight Beam Tracing™. Finally, with the optional fully integrated Essence™ EDS, users are a click away from their elemental analysis results.

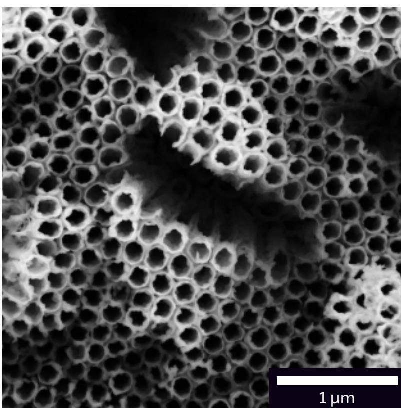
Get maximum contrast information from the sample by acquiring two angle-discriminated BSE signals simultaneously using chamber-mounted and low-energy-sensitive, high resolution in-column BSE detectors.

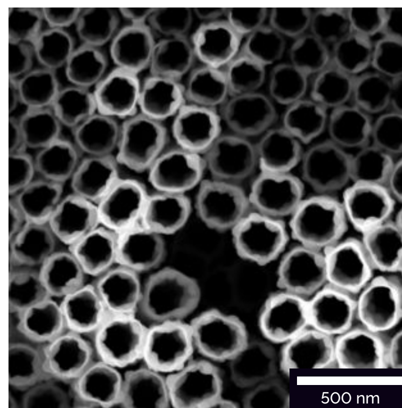


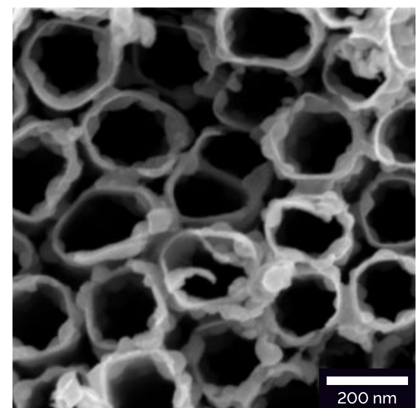


▲ BSE image of the Si Anode surface captured with chamber BSE detector (left) and In-Beam BSE detector (right). In-Beam BSE detector further enhances material contrast. BSE contrast outcome is not affected by the shadowing effect, which is more pronounced with a chamber BSE detector. Captured simultaneously at WD 10 mm at 5 keV.

Complete topographical characterization of the sample using chamber mounted SE, In-Beam SE and In-Beam SE (BDM) detectors.

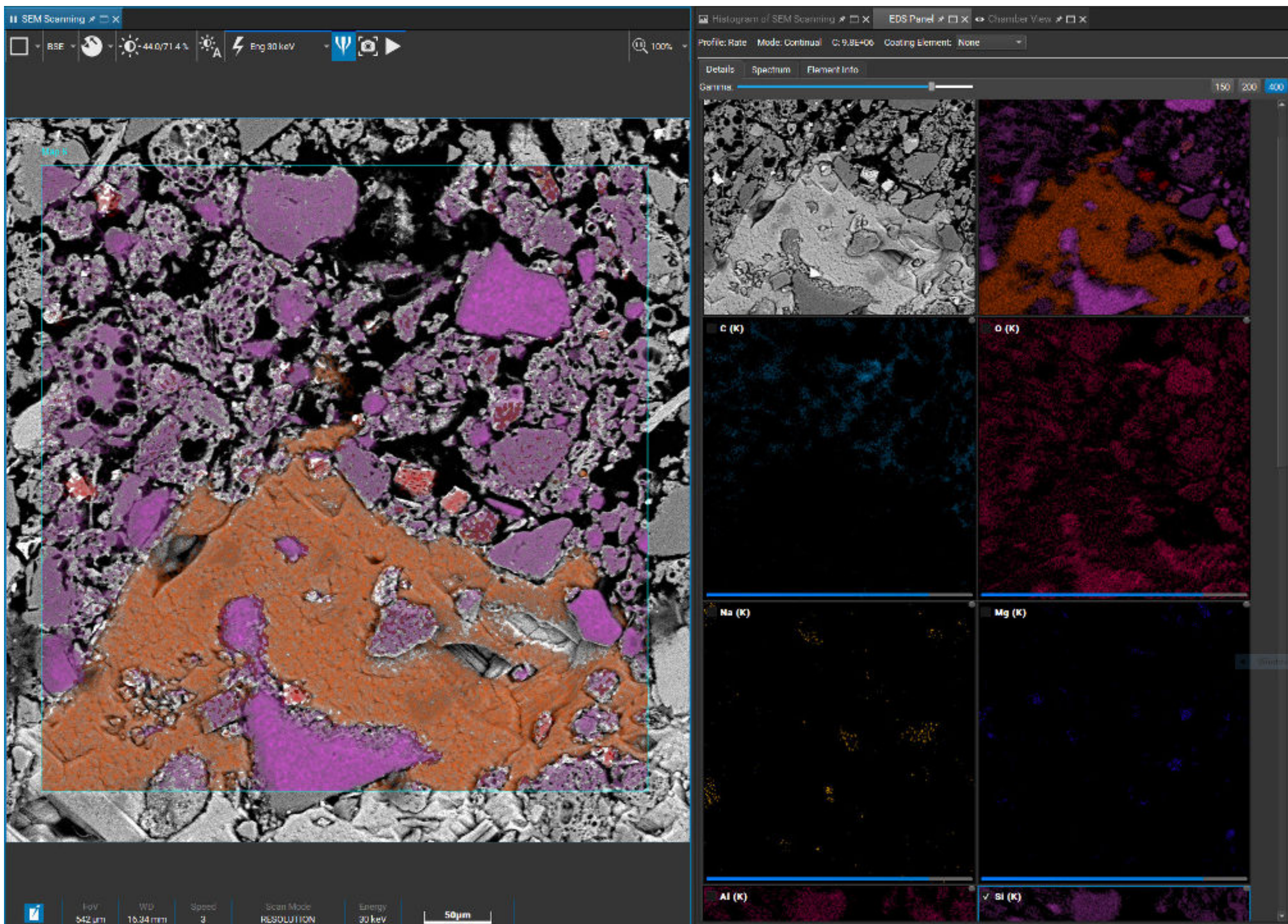






▲ TiO_2 nanotubes imaged with SE (left) and In-Beam SE (middle) at 5 keV; and, imaged with SE(BDM) at 3 keV (right)

Speed your time to analytical data thanks to integrated Essence™ EDS, which delivers the advantage of combining SEM imaging and elemental composition acquisition in a single live view window of Essence™ microscope control software.



▲ EDS elemental map of Ca (orange) and Si (purple) from a polished cross section of plaster, captured with Essence™ EDS defined in a live window of the SEM.

Applications – Ideal for:

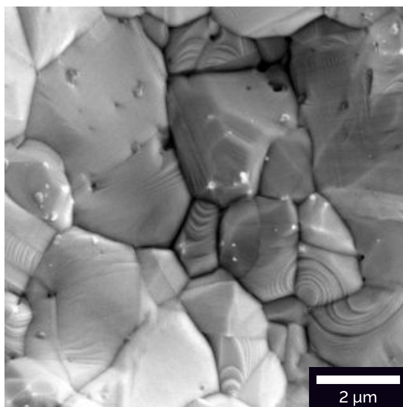
High resolution study of metal samples at the sub-micron scale

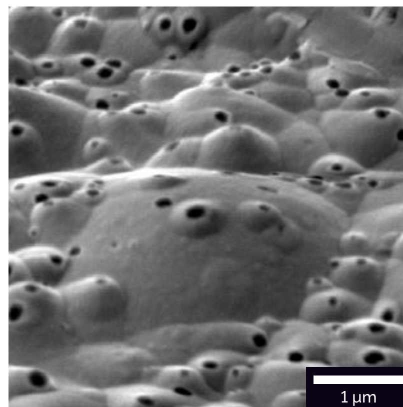
In quality assurance labs, SEM is often part of the routine inspection process for quality analysis of metal samples. TESCAN MIRA, with its high brightness field emission electron emitter, assures high resolution capabilities even at reduced accelerating beam energies that topographical metal samples require. This makes MIRA ideal for SEM quality analysis laboratories in a variety of metal processing industries.

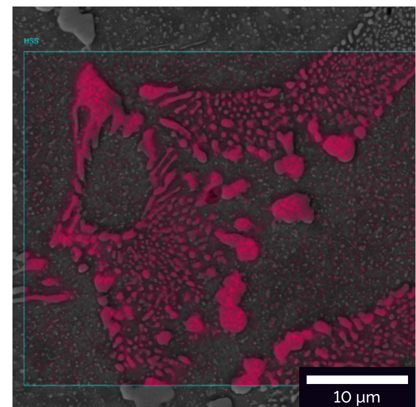
MIRA's high brightness Field Emission source provides high contrast-to-noise ratio that operators will appreciate when observing samples at the sub-micron scale. Materials for additive manufacturing, hard coatings, metal composites, micro-inclusions, and other samples may require imaging for high topographical contrast, which can be reached only when the accelerating energy of the beam is reduced. Thanks to TESCAN MIRA FE technology, images with high signal-to-noise ratio are captured even at reduced accelerating energies. Samples can be analyzed for their topography with chamber SE and in-column SE detectors, and for their elemental contrast using chamber BSE, and low energy, high sensitivity in-column BSE detectors. In-column detectors are preferred for those applications in which high resolution imaging for topography and material contrast are critical to process evaluation and decision-making.

Furthermore, TESCAN MIRA features an optional fully integrated Essence™ EDS. This expands the capabilities of MIRA beyond imaging alone and gives also insights to the compositional properties of the materials. Essence™ EDS eliminates the need for additional third-party software and hardware. Composite metals, sample homogeneity or even material failures can be inspected easily when performing EDS analysis through the familiar Essence™ GUI.

TESCAN MIRA SEM provides a fast, consistent and intuitive path to the right data, all of which are important characteristics for inspection and analytical tools in quality control, failure analysis and research labs for metal processing industries.





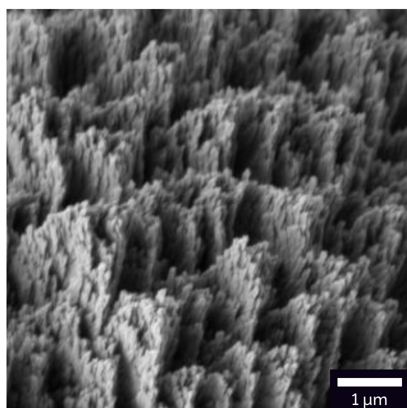


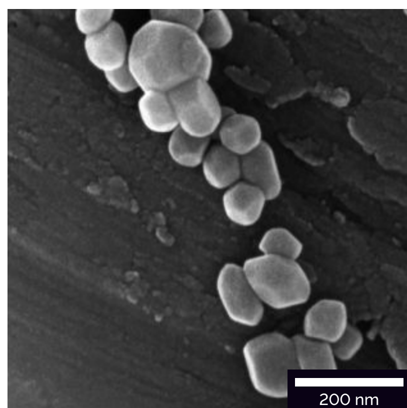
▲ (left) micro-grains of the 3D printed metal foam, (middle) Surface of a corroded NiP coating imaged in tilt with SE detector at 5 keV, (right) EDS map of Mo precipitates in HSS steel captured in live SEM window extracted from Essence™ EDS GUI

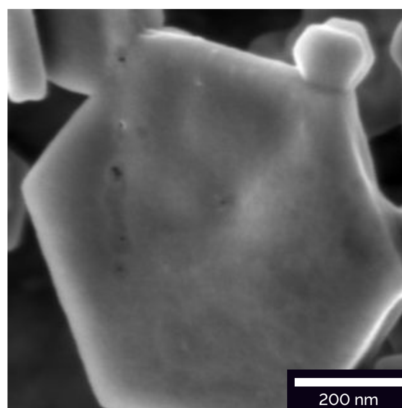
High resolution imaging of particles, agglomerates and other materials at the sub-micron scale

TESCAN MIRA is a versatile instrument that can characterize a variety of materials in detail. In order to specify the size and topography of powders, micro-contaminants, nanoparticles and other micro- or nanoscale materials, the accelerating energy of the beam must be decreased. Decreased accelerating voltage results in less electron penetration into the sample's surface. TESCAN MIRA, equipped with high brightness FE electron source, delivers detailed topographical imaging with the chamber mounted SE detector even below 5 keV. Thanks to In-Flight Beam Tracing™ and Intermediate Lens, conditions of the beam are changed quickly and without need of any mechanical adjustment to the in-column apertures. In-Flight Beam Tracing™ also assures the ideal spot size with respect to the beam current. Optional

In-Beam SE detector is used at shorter working distances to give the TESCAN MIRA its high-resolution capability at decreased landing energies. In-Beam SE detector is commonly used to more efficiently characterize size for nano powders, nanoparticles and other features at the sub-micron scale level. Furthermore, Beam Deceleration Technology (BDT) further enhances resolution at the lowest accelerating energies to explore surface features in great detail.



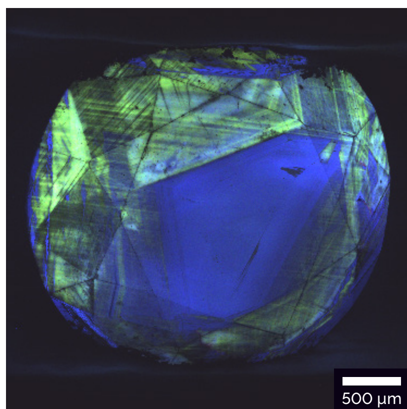


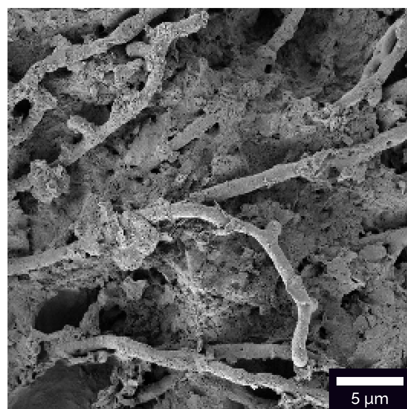


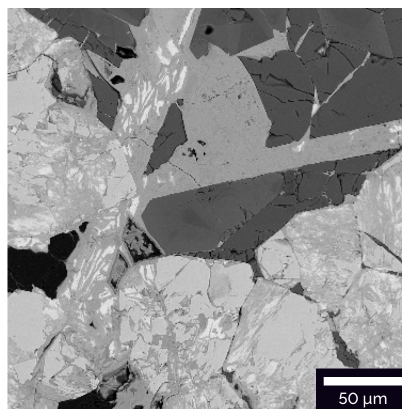
▲ (left) Contamination on glass imaged with SE detector at 1.5 keV; (middle) TiO_2 nanoparticles imaged at 10 keV; (right) $Ca(OH)_2$ nanoparticles imaged at 2 keV with SE(BDM) detector.

Morphological and elemental characterization of geological samples at the sub-micron scale

TESCAN MIRA is an ideal tool for daily work on geological samples due to its FEG technology, which assures maximum signal-to-noise ratio through the entire range of accelerating energies. At the same time, the beam current remains stable and In-Flight Beam Tracing™ immediately sets up and controls not only landing energy but also beam current - with high precision. This assures that analytical and imaging results from polished petrographic samples, crystal aggregates and microfossils are captured effortlessly and with maximum efficiency. This complements the analytical capability brought by the optional integrated Essence™ EDS, which provides instant access to elemental analyses in the live SEM window, thereby eliminating the need to switch to third party software to obtain spectra, elemental maps or profiles. At the same time, backscattered electron acquisition using TESCAN's YAG-based BSE detector speeds inspection. This detector has a high signal-to-noise ratio, even at very fast scanning speed, which significantly reduces the time required to locate and analyze areas of specific phase contrast. Furthermore, TESCAN's optional color and panchromatic cathodoluminescence detectors are used to reveal compositional and structural variations in minerals, often as a step preceding geochronological dating or other high-resolution analytical techniques.





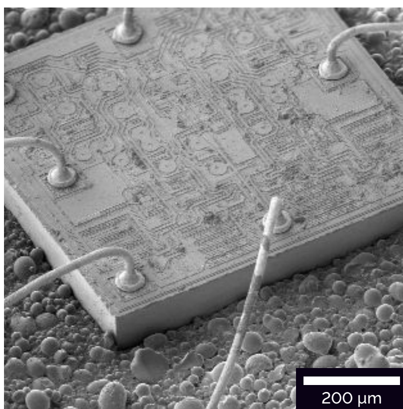


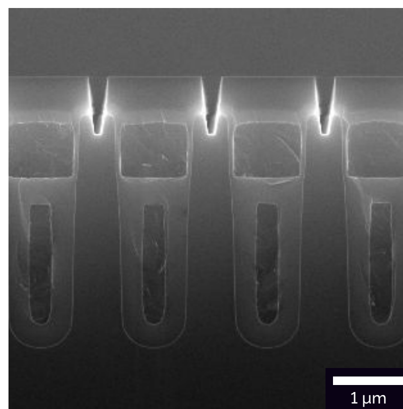
▲ (left) Low vacuum cathodoluminescence image of diamond growth zonation as a proof of its genuineness; (middle) detailed image of chitinozoan fossil surface imaged at 2kV; (right) complex association of scandian minerals imaged by backscattered electron detector.

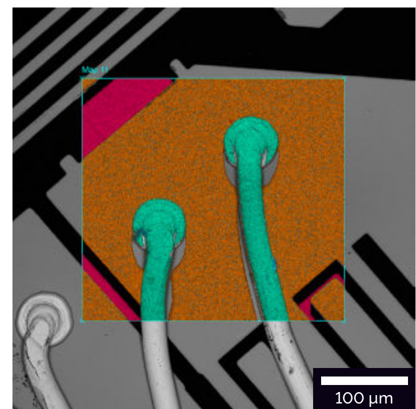
Quality analysis of semiconductor devices at the sub-micron scale

For electronics and semiconductor microchip production support, TESCAN MIRA is the ideal tool to perform routine inspection of microelectronic devices or whole wafers (up to 12"). MIRA's high brightness FE electron emitter assures high resolution capabilities even at reduced accelerating beam energies. This helps to speed routine sample inspections for semiconductor chip laboratories performing failure analysis, wafer inspection and observation of cracked or polished samples, which may contain layered structures at sub-micron scales. Applications for characterizing wafer defects, contaminants and particle defects, will benefit from MIRA's in-column SE and BSE detection capabilities which deliver enhanced topographic and materials contrast. Simultaneously, TESCAN MIRA's Wide-Field Optics™ mode provides a seamless and precise tool for navigating to the correct area of interest and targeting specific failures or regions which are to be analyzed. Not only surface features, but also cleaved cross sections can be investigated with ease to identify interconnect problems during development and production, or for electromigration failures after aging as well. Also, device size can be verified with respect to their dimensional criteria.

TESCAN MIRA provides topographical SE and elemental BSE contrast information to deliver compositional inspection using the optional integrated Essence™ EDS. This is ideal for attaining comprehensive results in minimum time to streamline the workflows for sub-micron scale failure analysis investigations that are common in semiconductor analysis laboratories.







▲ Overview of wire bonding (left), cleaved edge of a semiconductor device (middle), EDS map of wire bonding captured in live SEM window extracted from Essence™ EDS GUI.

Technical Specifications / Electron Optics:

Electron Gun:	High Brightness Schottky Emitter	
Electron Optics:	Wide Field Optics™ Technology with Intermediate Lens™ and In-Flight Beam Tracing™	
Resolution:	**High Vacuum Mode:**	**Low Vacuum Mode:**
	1.2 nm at 30 keV	2.0 nm at 30 keV with BSE detector*
	3.5 nm at 1 keV	1.5 nm at 30 keV with LVSTD detector*
	1.8 nm at 1 keV with BDT	* optional detectors
Maximum Field of View:	>50 mm at max WD	

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