MIRA3

FEG

1.0 nm at 30 keV

BDT 50 eV to 30 keV

TESCAN
PERFORMANCE IN NANOSPACE

MIRA3

High performance field emission scanning electron microscope

MIRA3 is a high-performance SEM system which features a high-brightness Schottky emitter for high-resolution and low-noise imaging. MIRA3 offers all the advantages that come with the latest technologies and developments in SEM. MIRA3 delivers faster image acquisition, an ultra-fast scanning system, dynamic and static compensation and built-in scripting for user-defined applications. Its excellent resolution at high beam-currents has proven to be especially advantageous for EDX, WDX and EBSD compositional analyses. The capabilities for imaging at low and ultra-low electron landing energies can be further enhanced using the optional beam deceleration technology (BDT). BDT enhances the performance of the electron column by reducing optical aberration - thus allowing small spot sizes and high-resolution imaging at low energies. A variety of BSE detectors can be optionally installed according to specific analytical needs. This includes the LE-BSE detector – a scintillator-based BSE detector optimised to increase detection sensitivity at low energies. The MIRA3 configurations include LM, XM, and GM chamber sizes with ideal geometry for EDX and EBSD analyses and are capable of both low- and high-vacuum operations. The extended low-vacuum mode (chamber pressures up to 500 Pa) allows imaging of non-conductive samples including biological specimens. MIRA3 can be also configured with uniquely large AMU chamber allowing SEM analysis of extraordinary large samples.

Modern Electron Optics

- High brightness Schottky emitter for high-resolution/high current/low-noise imaging
- Unique Wide Field Optics™ design with a proprietary Intermediate Lens (IML) offering a variety of working and displaying modes, for enhanced field of view or depth of focus, etc.
- Real-time In-Flight Beam Tracing™ for performance and beam optimization, which also allows direct and continuous control of the beam and beam current
- Beam Deceleration Technology (BDT) for excellent resolution at low electron-beam energies
- Excellent imaging at short working distances with the powerful In-Beam detector (optional)
- Fully automated electron optics set-up and alignment
- Fast imaging rate up to 20 ns
- Unique live stereoscopic imaging by using the advanced 3D Beam Technology which opens up the micro and nanoworld for an amazing 3D experience and 3D navigation

Analytical Potential

- All MIRA3 chambers (LM, XM, and GM) provide superior specimen handling using a 5-axis fully motorized compucentric stage and have ideal geometry for EDX and EBSD
- Optional extra-large chambers (XM, GM) with robust stages able to accommodate large samples including large wafers (6", 8", 12") are also available
- Numerous interface ports with optimized analytical geometry for attaching EDX, WDX and EBSD detectors and many others
- First-class scintillation crystal-based detectors
- Selection of optional detectors and other accessories
- Full operating vacuum can be quickly and easily obtained with powerful turbomolecular and dry fore vacuum pumps; electron gun pumping with an ion pump
- Investigation of non-conductive samples in variable pressure modes
- Several options for chamber suspension type ensure effective reduction of ambient vibrations in the laboratory
- Unique integrated active vibration isolation for analytical GM chamber delivered as standard
- Excellent quality imaging of magnetic samples
- Non-distorted EBSD pattern

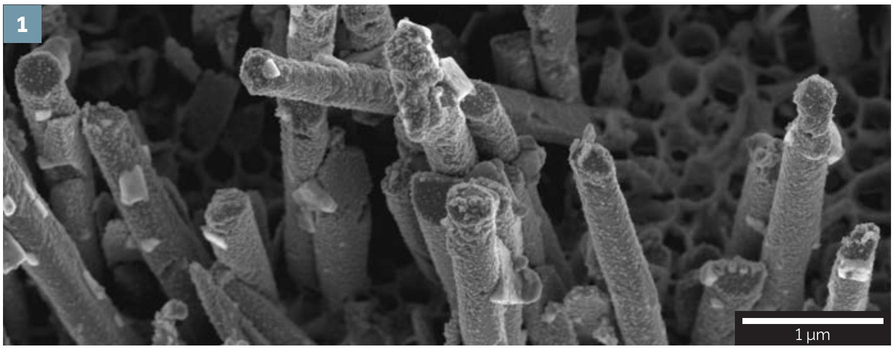


Fig.1: Silver nanowires prepared by electrolysis on an alumina membrane

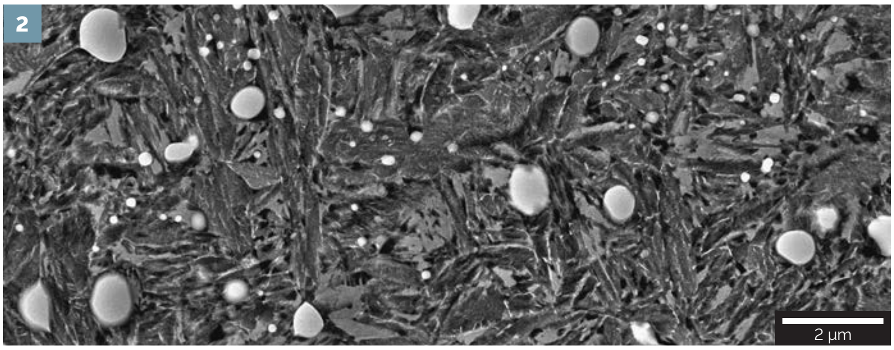


Fig. 2: Hi speed steel with Cr carbides

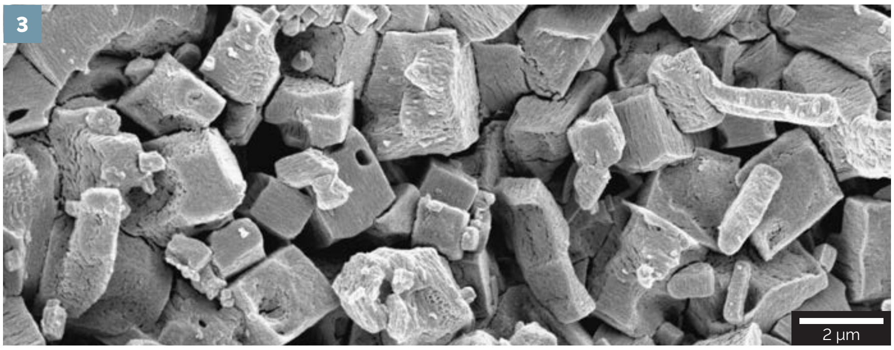


Fig. 3: Pharmaceutical structure

Beam Deceleration Technology

The Beam Deceleration Technology (BDT) consists of the Beam Deceleration Mode (BDM), and a state-of-the-art In-Beam detector designed to detect high-angle BSE under standard operating conditions and SE signal in the BDM. In the BDM, the energy of the electrons in the beam is decreased before they impact the surface of the specimen by means of a negative bias voltage which is applied to the sample stage. Ultra-low landing energies down to 50 eV (or 0 eV in manual control) are achievable. BDM enhances the performance of the electron column by reducing optical aberrations, thus allowing small spot sizes and high-resolution imaging at low energies. Low electron energies are advantageous for reducing charging effects in non-conductive samples as well as for imaging beam-sensitive samples such as biological specimens. It is highly recommended to combine the BDT with a decontaminator device.

User-Friendly Software

- Multi-user environment is localized in many languages
- Four levels of user expertise/rights, including an EasySEM™ mode for quick routine investigations
- Image management and report creation
- Built-in self-diagnostics for system readiness checks
- Network operations and remote access/diagnostics
- Modular software architecture enables several extensions to be attached

Rapid Maintenance

Keeping the microscope in optimal condition is now easy, requiring a minimum downtime of the microscope. Every detail has been carefully designed to maximize the microscope performance and minimize the operator's effort.

Automated Procedures

Automatic set-up of the microscope and many other automated operations are characteristic features of the equipment. There are many other automated procedures which significantly reduce the time for tuning-up the microscope, enable automated manipulator navigation and automated analyses. The Shark SEM remote control interface enables access to most of the microscope features, including microscope vacuum control, optics control, stage control, image acquisition, etc. The compact Python scripting library offers all these features.

Software Tools

Image Processing	☑
Analysis & Measurement	☑
Object Area	☑
Hardness	☑
Tolerance	☑
Multi Image Calibrator	☑
Switch-Off Timer	☑
3D Scanning	☑
X-Positioner	☑
EasySEM™	☑
Live Video	☑
Histogram	☑

Particles Basic	☐
Particles Advanced	☐
Image Snapper	☐
DrawBeam Basic	☐
DrawBeam Advanced	☐
Sample Observer	☐
System Examiner	☐
TESCAN TRACE GSR	☐
EasyEDX Integration Software	☐
3D Metrology (MeX)	☐
Cell Counter	☐
Coral (Correlative microscopy module for Life Sciences)	☐
SYNOPSYS Avalon™	☐

☑ standard, ☐ option

Electron-Beam Lithography by TESCAN

Electron-beam lithography (EBL) has been established as a very flexible and reliable technique for nanotechnology applications. The main advantage of EBL compared to other lithographic techniques is the higher achieved resolution. The current instruments for EBL allow creating features of the size of a few nanometers. Such ultimate resolution is, however, not easily achievable. The process requires a systematic methodology in sample preparation and, an optimal system adjustment.

TESCAN SEMs users can make the most of EBL by using the DrawBeam - an advanced CAD-like editor and exposure controller - and the electrostatic Beam Blanker – a tool used to divert the electron beam from the optical axis of the SEM column, preventing in this way, unwanted exposure of the sample surface during the flying movement of the beam and the following settling time.

The DrawBeam is a powerful software tool dedicated to electron/ion beam lithography applications. It provides a user-friendly environment for pattern design as well as for exposure control using 16-bit scanning ramp DACs (65,536 x 65,536 virtual write field). Electron-beam lithography is a complex process in which the ultimate resolution is determined by a number of factors (such as the resist, the exposure conditions, the development process, etc.). Contrary to the case of optical lithography, which is limited mainly by the wavelength of light, the electron wavelength is of the order of 10^{-12} m (assuming an electron energy of 30 keV) and the electron beam can readily be focused to a spot size of about 1–2 nm. However, only features of a few tens of nanometers (about 20 nm) in size can be fabricated controllably and repeatedly by using TESCAN SEMs equipped with the DrawBeam software and the electrostatic Beam Blanker.

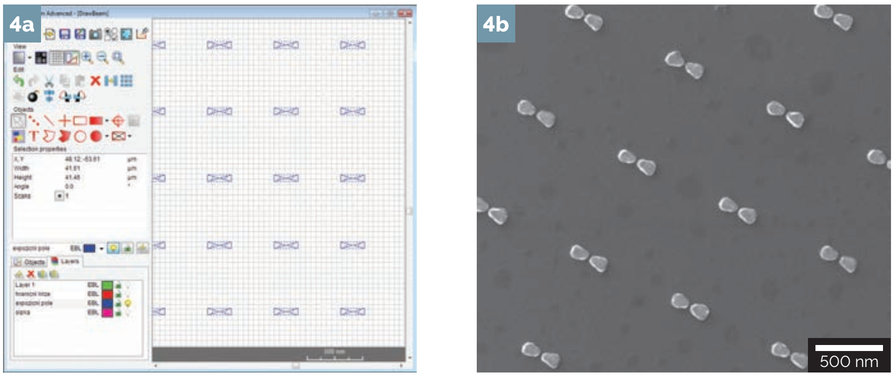


Fig. 4(a-b): SEM detail of a square array of antennas prepared by the lift-off method (soaking in RT acetone for 1 hour and ultrasonic assistance for 60 seconds)

Electron Channelling Pattern Acquisition on Polycrystalline Materials

The electron channelling pattern (ECP) is an image of the pseudo-Kikuchi lines that can be acquired on a crystalline material with the scanning electron microscope (SEM). In the special scanning mode called Channelling the beam is rocking around one point and creates a selected area channelling pattern (SACP). The latest generation of TESCAN scanning electron microscopes have improved this method also for the evaluation of the individual grain orientation in some polycrystalline materials.

Experiment

High quality of the surface is necessary for electron channelling contrast. Standard metallographic sample preparation is not sufficient and should be followed by either colloidal silica polishing (OPS), or better by electropolishing or ion beam polishing. Semiconductor grade monocrystalline silicon was used for basic testing (without further preparation). An electropolished stainless steel (austenite 304) cross-section was used as a polycrystalline example. MIRA3 with an annular YAG-scintillator BSE detector was used for all of the experiments.

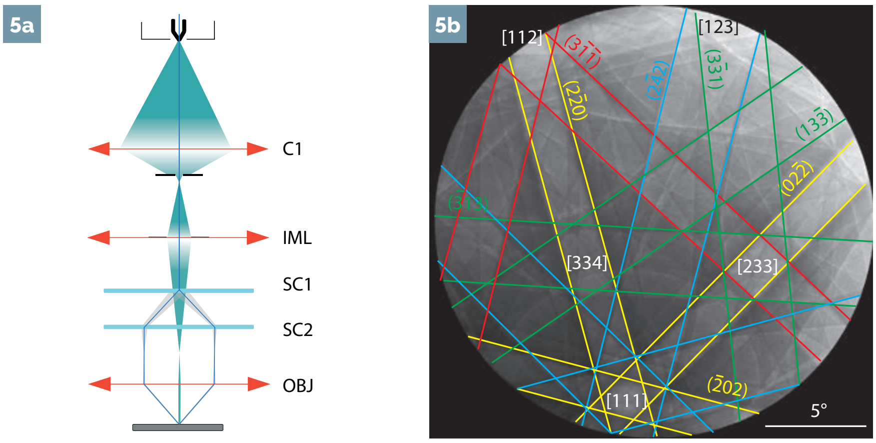


Fig. 5: (a) - schematics of the Channelling scan mode in TESCAN MIRA FE-SEM. **(b)** - electron channelling pattern on a semiconductor grade monocrystalline silicon with the main bands marked. The field of view represents a beam tilt by 22°.

■ Channelling Scan Mode

The special Channelling scan mode is provided by TESCAN SEMs. In this mode, a thin parallel beam is rocking around a point creating bright pseudo-Kikuchi bands on the crystal planes (plane channels).
The resulting image of ECP shows the pseudo-Kikuchi lines typical for the material.

■ Interpreting ECPs

The individual bands can be determined with the help of a known Kikuchi map and a table of the plane spacing (*d*) for the current crystal system (Fig. 5b) The width of the band (2Θ) depends on the crystal plane spacings (*d*) (see also Tab.1) and on the diffraction condition defined by the Brag's law: $\lambda = 2\, d \sin \Theta$

Crystal plane {h k l}	d-spacing [Å]	2Θ band width [deg]
{331}	1.246	3.525
{311}	1.637	2.683
{220}	1.920	2.288
{422}	1.109	3.963

Tab. 1: List of crystal planes, their d-spacings and computed bandwidth for the conditions in Fig 5b. i.e. for diamond f.c.c. crystalline silicon, a=5.4307 Å, accelerating voltage =25 kV (λ=7.67x10^{-3} Å)

■ Rocking Beam vs. Channelling scan mode

The situation is slightly more difficult in polycrystalline materials because of the limitation of the "point of rocking" size vs. grain size. Without any correction (Fig. 6a) the spatial resolution rarely exceeds 50 µm, as a consequence of the large spherical aberration of the probe forming lens. This limitation practically eliminates the usage of the non-corrected Rocking Beam techniques on most of the polycrystalline materials. The new Channelling mode takes advantage of the TESCAN proprietary adaptive electron optics technology that can correct the spherical aberration of the rocking beam mode (Fig. 6b)

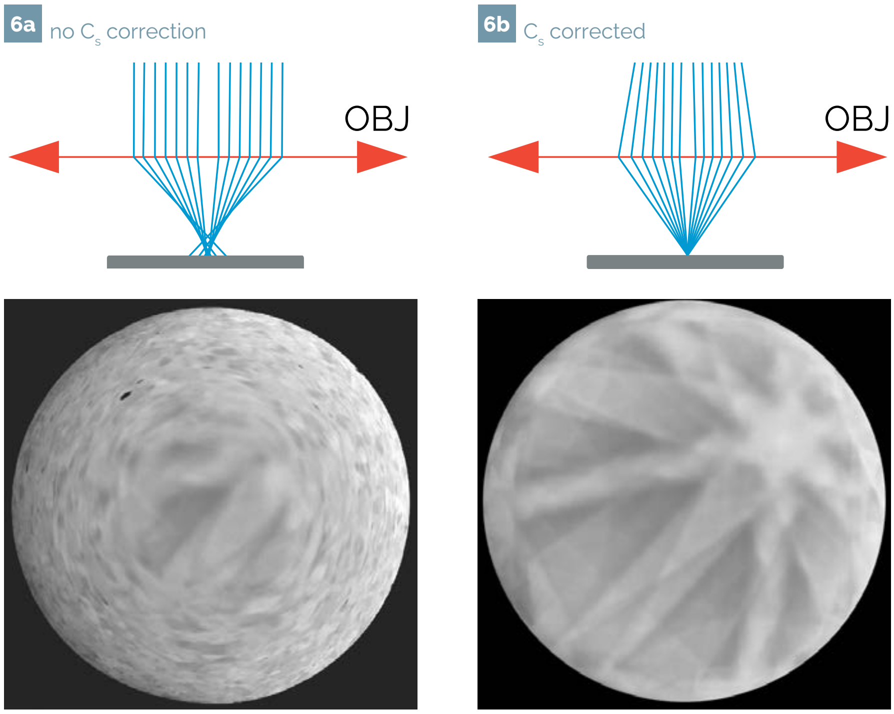


Fig. 6: Comparison of the ordinary Rocking Beam mode without the correction of spherical aberration **(a)** and a TESCAN Channelling mode **(b)** with spherical aberration correction. The images are from polycrystalline stainless steel with a grain size of approx. 20 µm.

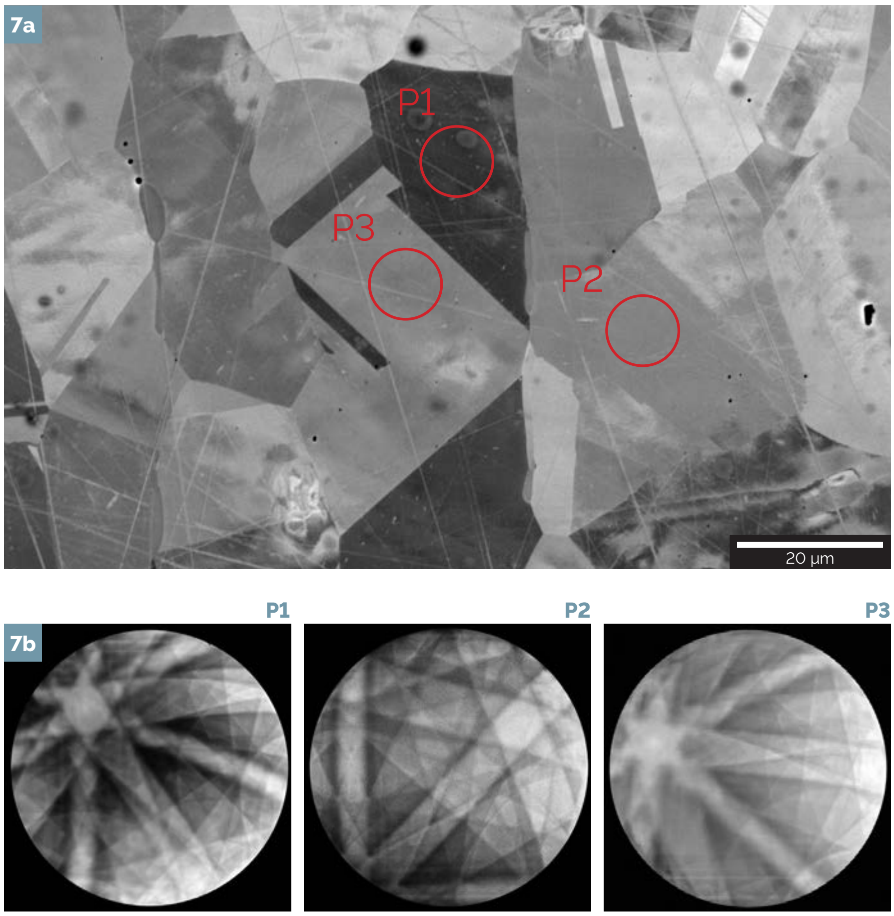


Fig. 7: (a) An electropolished cross-section of austenitic stainless steel. The grains are enhanced by different electron channelling contrast. **(b)** SACPs acquired in marked grains.

Common Applications

- **Materials Science**

Characterization of materials such as metals, ceramics, polymers, composites, coatings. Metallurgy, fracture analysis, degradation processes, ferromagnetic materials, etc.

- **Semiconductor and Microelectronics**

MEMS inspection, inspection of cross-sections and failure analysis in 3D-ICs and advanced packaging technologies, large wafer inspection, etc.

- **Electro-technical Engineering**

Solar cell inspection, microelectronics inspection, PN junction visualization, lithography, etc.

- **Forensic Investigations**

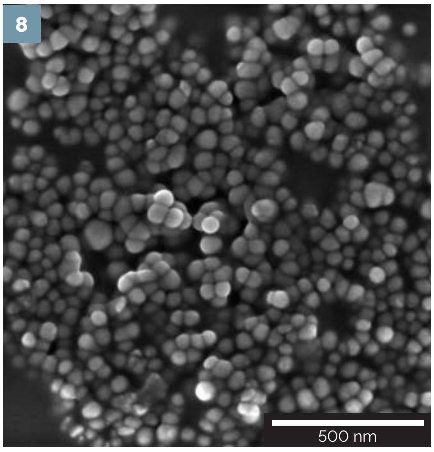
Gunshot residue analysis, bullet and cartridge investigation, tool mark comparison, analysis of hairs, fibres, textiles and papers, paints, ink and print characterization, line crossings, examination of counterfeit documents, etc.

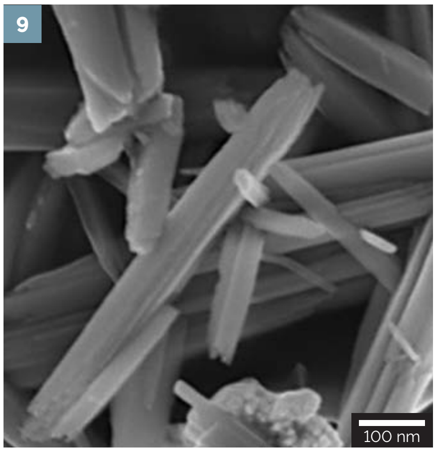
- **Research**

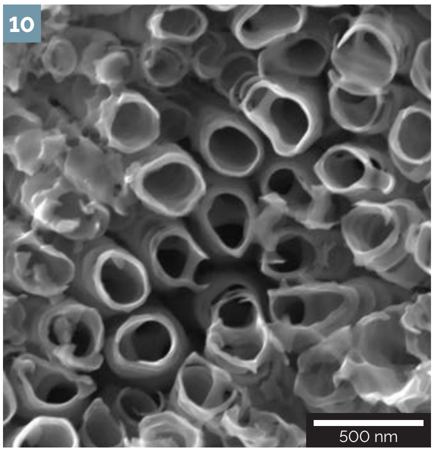
Mineralogy, geology, palaeontology, archaeology, chemistry, environmental studies, particle analysis, applied physics, nanotechnology, nanoprototyping, etc.

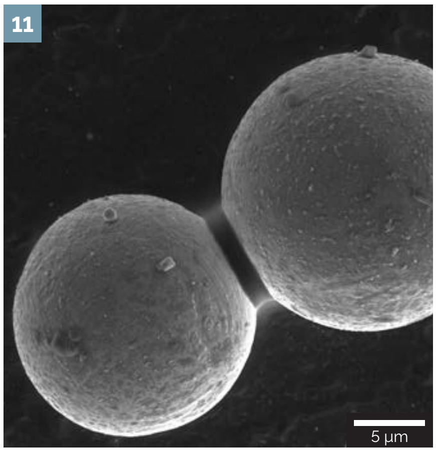
- **Life Sciences**

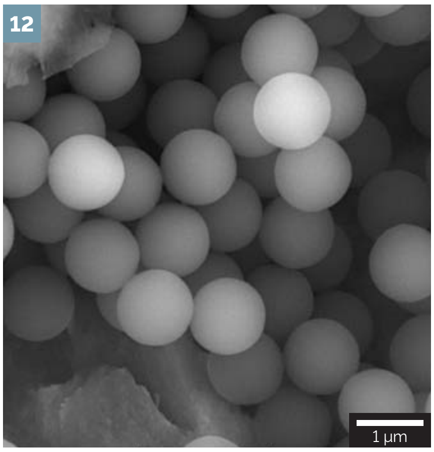
Botany, parasitology, pharmaceutics, STEM histology, dental implants, etc.

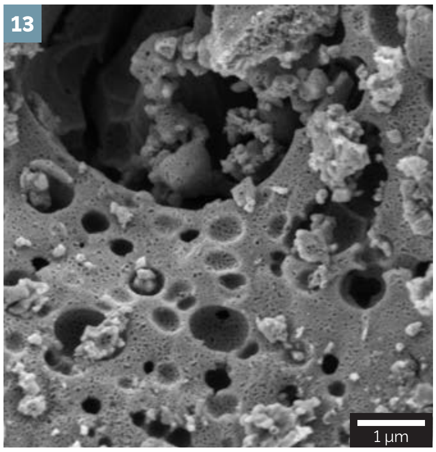


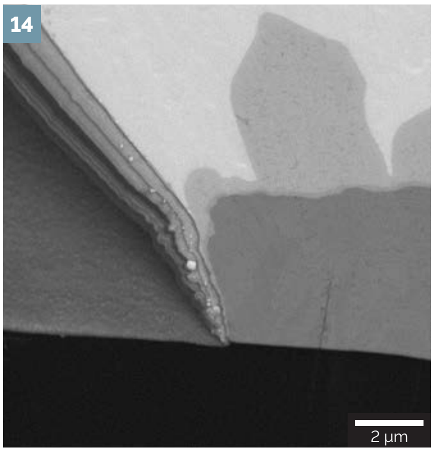












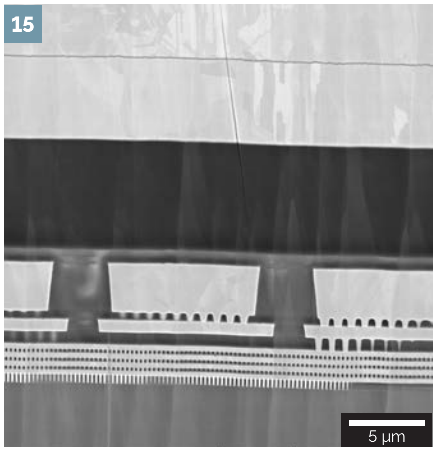


Fig. 8: Silicon powder imaged uncoated at 2 keV with the SE (BDM) detector

Fig. 9: Goethite powder FeO(OH) imaged uncoated at 3 keV with the SE (BDM) detector

Fig. 10: TiO_2 nanotubes imaged at 10 keV with the In-Beam detector

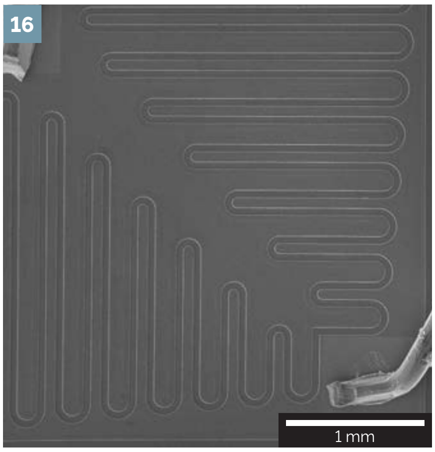
Fig. 11: Zn spheres imaged at 5 keV with the In-Beam detector

Fig. 12: Latex imaged at 10 keV at low vacuum with the LVSTD detector

Fig. 13: Sample of $LiFePO_4$ imaged at 3 keV with the In-Beam SE detector

Fig. 14: Interface of a solder bump imaged at 10 keV with the In-Beam BSE detector

Fig. 15: Detailed image of the structure under a cross-sectioned solder bump imaged at 10 keV with the SE detector



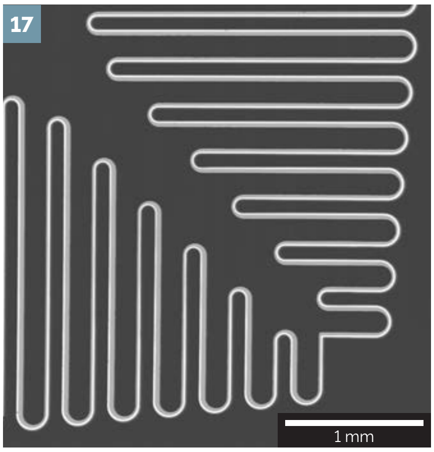
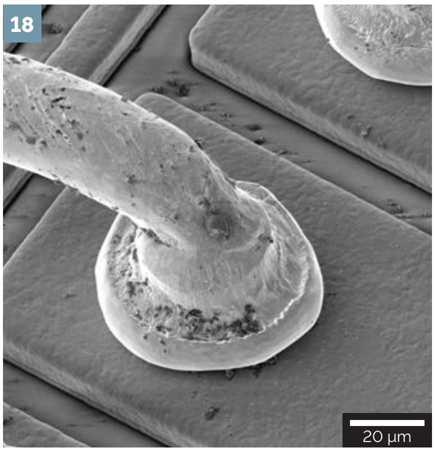


Fig. 16: Surface of a transistor imaged at 25 keV with the SE detector

Fig. 17: Surface of a transistor imaged at 25 keV with the EBIC detector



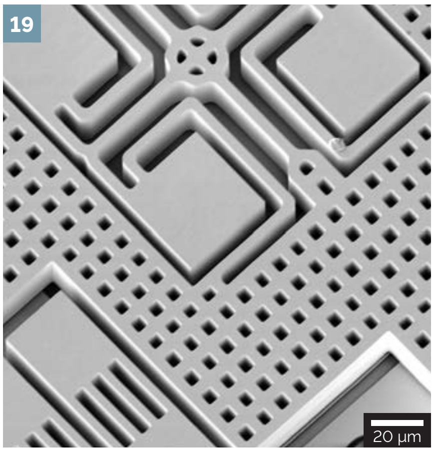
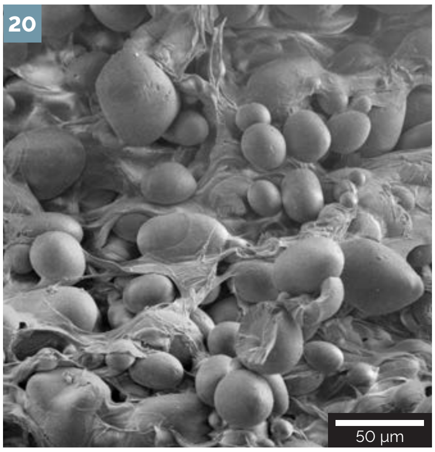


Fig. 18: A wire bond in a chip imaged at 5 keV with the SE detector

Fig. 19: A MEMS gyroscope imaged at 5 keV with the SE detector



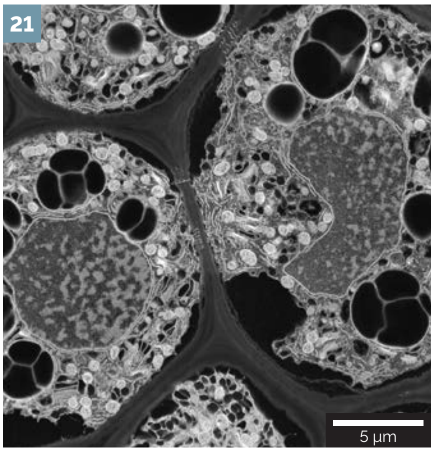
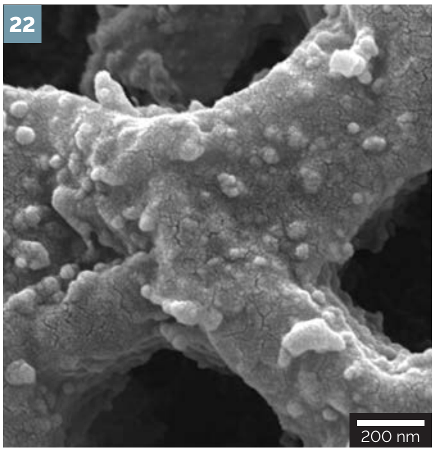


Fig. 20: Cryo-frozen hydrogel imaged in its hydrated state at low vacuum conditions and at 5 keV with the LVSTD and the LE-BSE detector

Fig. 21: A cross-section of a resin-embedded plant root imaged at 5 keV with the LE-BSE detector



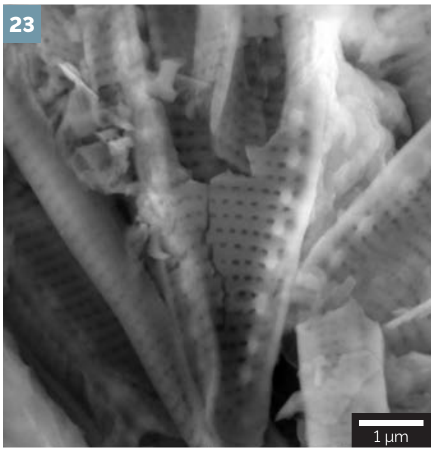


Fig. 22: A flower seed imaged at 5 keV with the In-Beam SE detector

Fig. 23: Diatoms imaged at low vacuum conditions and 15 keV with the LVSTD detector

MIRA3 Configurations

MIRA3 can be configured in different chamber sizes so to meet your specific requirements of analysis. In particular, the XM and GM configurations extend the analytical capabilities, providing the ability to perform fine observations of the sample surface even for extra-large specimens. In addition, TESCAN has designed a special range of chambers that can comply with demands for even larger space. The extended XM and GM chambers and the extraordinarily large AMU chamber are aimed at accommodating specimens that far exceed the volume and/or weight bearing capacities of the standard chambers. All these chambers contain a large number of ports which result in extending the analytical potential of MIRA3, allowing different detectors such as SE, BSE, LVSTD, EDX, WDX, EBSD, CL, and STEM to be attached.

MIRA3 LM / XM / GM

These chambers have an optimised geometry for multi-detectors and capable of both low and high vacuum operations which make it possible the imaging of non-conductive specimens in their natural uncoated state and conductive samples respectively.

Extended XM and GM chambers

TESCAN has further extended the volume capabilities of the standard XM and GM chambers by means of special frontal chamber frames. Larger analytical chambers mean a wider range of applications in science and technology. For instance, such extended chambers offer a concrete solution for the semiconductor industry and fabs as make it possible the inspection of large wafers. The extended XM chamber with a modified Y-axis and an extension frame allows the MIRA3 system to accommodate 6" and 8" wafers. The extended GM chamber equipped with a dedicated cradle stage and a special holder enables the loading of 6", 8" and 12" size wafers for their inspection.

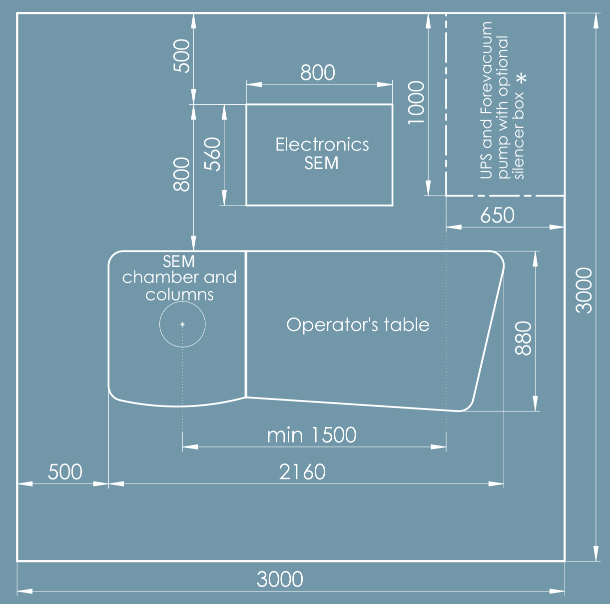
	LM Chamber	XM Chamber	GM Chamber
Internal size	Ø 230 mm	290 mm (width) × 340 mm (depth)	340 mm (width) × 315 mm (depth)
Door	148 mm (width)	290 mm (width) × 322 mm (height)	340 mm (width) × 320 mm (height)
Number of ports	11+	12+	20+
Chamber suspension	pneumatic or optional active vibration isolation system	pneumatic or optional active vibration isolation system	integrated active vibration isolation system

	Specimen Stage in LM Chamber	Specimen Stage in XM Chamber	Specimen Stage in GM Chamber
Type	compucentric	compucentric	compucentric
Movements	5-axis fully motorized X = 80 mm (–40 mm to +40 mm) Y = 60 mm (-30 mm to +30 mm) Z = 47 mm Rotation = 360° continuous Tilt = -80° to +80°	5-axis fully motorized X = 130 mm (–50 mm to +80 mm) Y = 130 mm (–65 mm to +65 mm) Z = 100 mm Rotation = 360° continuous Tilt = -30° to +90°	5-axis fully motorized X = 130 mm (–65 mm to +65 mm) Y = 130 mm (–65 mm to +65 mm) Z = 100 mm Rotation = 360° continuous Tilt = -80° to +90°
Maximum specimen height	54 mm (with rotation stage) 81 mm (without rotation stage)	106 mm (with rotation stage) 147 mm (without rotation stage)	106 mm (with rotation stage) 147 mm (without rotation stage)

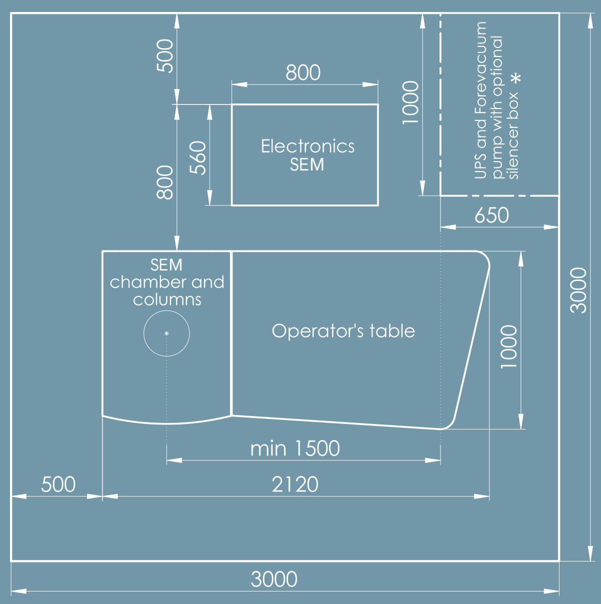
	Extended XM Chamber	Extended GM Chamber
Internal size	290 mm (width) × 430 mm (depth)	340 mm (width) × 400 mm (depth) (6" and 8" wafers) 340 mm (width) × 475 mm (depth) (up to 12" wafers)
Door	290 mm (width) × 322 mm (depth)	340 mm (width) × 320 mm (height)
Maximum Specimen Height*	106 mm (with rotation stage) 147 mm (without rotation stage)	65 mm (with rotation stage) 110 mm (without rotation stage)
Number of ports	12+	20+
Chamber suspension	integrated active vibration isolation system	integrated active vibration isolation system

	Specimen Stage in Extended XM Chamber	Specimen Stage in Extended GM Chamber
Type	compucentric	compucentric
Movements	X = 130 mm (-50 mm to +80 mm) Y = 130 mm (-120 mm to +10 mm) Z = 100 mm	X = 250 mm (-170 mm to +80 mm) Y = 156 mm (-78 mm to +78 mm) Z = 62 mm
Rotation	360° continuous	360° continuous
Tilt	-30° to +90° (Depending on the WD and the size of the sample)	-5° to +70°

■ Footprint of the MIRA3 LM/XM microscope



■ Footprint of the MIRA3 GM microscope



(all dimensions in mm)

■ AMU Chamber: a unique super-sized chamber capable of accommodating extremely large and heavy samples.

It is very often in fields such as forensic sciences and archaeology or, in the automotive and aeronautic industries that the only way to perform the analysis of interest requires that the integrity of the specimen is preserved. This is the case when the sample represents a piece of evidence or the whole sample is essential to the analysis or study, or the sample is a precious specimen with historical value. In such cases, the specimens could exceed the volume and even weight capabilities of standard chambers. For this purpose, TESCAN offers the AMU chamber, a unique chamber that stands out for its capabilities to accommodate extremely large and heavy samples making SEM analysis of such large samples possible.

■ AMU Applications

- **Life Sciences:** large biological specimens imaging, analysis of whole bones
- **Materials science:** characterisation of whole large samples
- **Automotive and Aeronautic Industries:** wearing and fatigue studies, failure analysis, forensics
- **Semiconductors and Microelectronics:** large wafer SEM inspection (maximum sample diameter 30")

	AMU Chamber
Internal size	880 mm (width) × 1200 mm (depth)
Door width	880 mm (width) × 456 mm (height)
Max. Specimen Diameter	762 mm (30") and height 127 mm (5")
Max. Specimen Weight	25 Kg
Number of ports	6+
Chamber suspension	integrated active vibration isolation system

	Specimen Stage in AMU Chamber
Type	fully motorised
Movements	X = 410 mm (-400 mm to +10 mm) Y = 50 mm (-25 mm to +25 mm) Z = 65 mm (55 effective, 10 mm used for large/heavy specimen handling)
Rotation	360° continuous

MIRA3 Specifications

	LM/XM/GM	AMU
Resolution in high-vacuum mode		
SE	1.2 nm at 30 keV 2.5 nm at 3 keV	2.0 nm at 30 keV 2.5 nm at 15 keV
In-Beam SE (option)	1.0 nm at 30 keV	1.5 nm at 30 keV
Beam Deceleration Mode (option)	1.5 nm at 3 keV 2.5 nm at 200 eV	Ø Ø
STEM	0.8 nm at 30 keV	
Resolution in low-vacuum mode		
BSE	2.0 nm at 30 keV	2.5 nm at 30 keV
LVSTD (option)	1.5 nm at 30 keV	2.5 nm at 30 keV

Working vacuum	
Chamber – High – vacuum mode	< 9×10^{-3} Pa*
Chamber – Low – vacuum mode (available only for UniVac)	7 – 500 Pa**
Gun vacuum	< 3×10^{-7} Pa
	* pressure < 5×10^{-4} Pa can be displayed with an optional WRG vacuum gauge (on request, not applicable to MIRA3 AMU). ** with low vacuum aperture inserted
Electron optics working modes	
High-vacuum mode	Resolution, Depth, Field, Wide Field, Channelling
Low-vacuum mode	Resolution, Depth
Magnification	Continuous from: 2 × to 1,000,000 × (LM); 1 × to 1,000,000 × (XM, GM) (for 5" image width in Continual Wide Field / Resolution mode) For AMU chamber the maximum useful magnification: 100,000 × / 50,000 × / 10,000 × for samples weighting < 0.5 kg / < 5 kg / > 5 kg
Field of view	LM, XM, GM: 6.4 mm at $WD_{analytical}$ 10 mm , AMU: 10 mm at $WD_{analytical}$ 15 mm 20 mm at WD 30 mm
Accelerating / landing voltage	200 V to 30 kV / 50 V to 30 kV with BDT (Beam Deceleration Technology) option
Electron gun	High Brightness Schottky Emitter
Probe current	2 pA to 200 nA
Scanning speed	From 20 ns to 10 ms per pixel adjustable in steps or continuously
Scanning features	Focus window (shape, size and position continuously adjustable) Dynamic Focus, Point & Line Scan, Image rotation, Image shift, Tilt compensation, 3D Beam, Life Stereoscopic Imaging (SEM); other scanning shapes are available through the optional DrawBeam software
Image size	16,384 × 16,384 pixels, adjustable separately for live image (in 3 steps) and for stored images (11 steps), selectable square or 4:3 or 2:1 rectangle. Unlimited large panorama image size (up to storage capacity).
Microscope control	All microscope functions are PC-controlled using a trackball, mouse and keyboard via the program MiraTC using Windows™ platforms.
Automated operations	In-Flight Beam Tracing™ beam optimization, Spot Size and Beam Current Continual, WD (focus) & Stigmator, Contrast & Brightness, Scanning Speed (according to Signal-Noise Ratio), Gun Centering, Column Centering, Vacuum Control, Compensation for kV, Look-Up Table, Auto-diagnostics
Remote control	Via TCP/IP, open protocol

Detectors*	LMH XMH GMH	LMU XMU GMU AMU
SE Detector	☑	☑
Retractable BSE Detector[1]	☐	☑
In-Beam SE Detector	☐	☐
Low Vacuum Secondary Electron TESCAN Detector (LVSTD)[2]	⊘	☐
Beam Deceleration Technology[3,4]	☐	☐
In-Beam BSE Detector	☐	☐
In-Beam LE-BSE Detector	☐	☐
LE-BSE Detector[1]	☐	☐
R Dual Scintillator BSE Detector[1,4]	☐	☐
R 4-Quadrant BSE Detector[1]	☐	☐
STEM Detector	☐	☐
HADF R-STEM Detector[4] **(motor.)**	☐	☐
CL Detector[1,5]	☐	☐
Rainbow CL Detector[1,5]	☐	☐
Al-coated BSE Detector[1,4]	☐	☐
BSE/CL Detector[6]	☐	☐
EBIC	☐	☐
EasyEDX[4,7]	☐	☐
EDX[7]	☐	☐
WDX[4,7,8]	☐	☐
EBSD[4,7]	☐	☐
WiTec Raman (RISE)	⊘/⊘/☐	⊘/⊘/☐/⊘

Accessories*	LMH XMH GMH	LMU XMU GMU AMU
pA Meter	☑	☑
Touch Alarm	☑	☑
IR TV Camera	☑	☑
Peltier Cooling Stage[4]	☐	☐
Water Vapor Inlet[4]	⊘	☐
Beam Blanker for SEM column	☐	☐
Load Lock[4,**]	☐	☐
Control Panel	☐	☐
Optical Stage Navigation[4,***]	☐	☐
Nanomanipulators[4]	☐	☐
Decontaminator/plasma cleaner[4]	☐	☐
Active vibration isolation	☐/☐/☑	☐/☐/☑/☑

☑ standard, ☐ option, ⊘ not available

*Possible combinations of optional detectors and other accessories must be discussed with TESCAN

**Manual and motorised options available

***Not available for the extended chambers

[1]Motorised mechanics as an option for LM/XM chambers and standard for GM/AMU chambers.

[2]For low-vacuum operations up to 500 Pa.

[3]The BDT includes an In-Beam BSE detector or, optionally, an In-Beam LE-BSE detector. A package including a decontaminator is also available.

[4]Not available for the AMU chamber.

[5]Compact version available specially designed for simultaneous CL and BSE detection (Only the compact version is available for AMU chamber).

[6]Not available for GM/AMU chambers.

[7]Fully integrated third party products.

[8]Integrated active vibration isolation necessary.

Requirements

Installation requirements	For the LM, XM and GM chambers: Power 230 V ± 10% / 50 Hz (or 120 V / 60 Hz - optional), 2200 VA For the AMU chamber: 230 V ± 10% / 50 Hz (or 120 V / 60 Hz - optional), max. 6200 VA, branch circuit overcurrent protection 35 A at 230 V No water cooling Compressed dry nitrogen for venting: 150 - 500 kPa (1.5 - 5 Bars) Compressed air: 600 - 800 kPa (6 - 8 Bars)	
Environmental requirements	Environment temperature:	17°C - 24°C with stability better than 2°C with the rate of change 1°C/hour (0.017°C/min)
	Relative humidity:	< 80 %
	Acoustic:	For the LM, XM and GM chambers: < 60 dBC For the AMU chamber: < 55 dBC
	Vibration:	
	For pneumatic suspension:	< 5 µm/s below 30 Hz < 10 µm/s above 30 Hz
	For active isolation (option):	< 10 µm/s below 30 Hz < 20 µm/s above 30 Hz
	Background magnetic field:	synchronous < 300 nT asynchronous < 100 nT
	Altitude:	max. 3000 , above sea level
	Room for installation requirements:	LM, XM, GM min. 3 m × 3 m, min. door width 0.9 m AMU chamber: min. 6 m × 4 m; min. door width 1.2 m and height 2.1 m

We are constantly improving the performance of our products, therefore all specifications and external designs of instruments are subject to change without previous notice.

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