TESCAN

PERFORMANCE IN NANOSPACE

PRODUCT OVERVIEW

TESCAN's product range includes:

- thermal emission systems
- LaB_6 systems
- field emission systems
- FIB and Plasma FIB systems
- detection systems
- supplementary accessories for SEMs, FE-SEMs, FIB-SEMs.

TESCAN Brno, s.r.o. was established as subsidiary of a multi-national company **TESCAN ORSAY HOLDING** after the merger (August 2013) of Czech company TESCAN, a global supplier of SEMs and focused ion beam workstations, and the French company ORSAY PHYSICS, a world leader in customized Focused Ion Beam and Electron Beam technology.

TESCAN brand (founded in the summer of 1991) is well known for its innovation and openness to work with researchers and customizing applications to fit specific analytical needs. TESCAN excels in development of integrated solutions for scanning electron and focused ion beam microscopy, scientific hardware and software innovations.
TESCAN – the leading provider of scientific instrumentation continues the tradition of excellence in SEMs. During the 23 years of its existence, the TESCAN brand has built a reputation of quality, reliability and innovation, with over 1600+ SEMs installed in more than 60 countries.

TESCAN PRODUCTS

By following progress in electron microscopy and by pioneering and applying new technological possibilities, TESCAN is producing its microscopes to the highest level of technical excellence. By using TESCAN superior tools you will experience the most advanced scanning electron line of instruments.

Features of TESCAN Products

Modern Optics

The development of the entire range of TESCAN systems focuses on the highest standards and competitive advantage for its customers. All TESCAN instruments are equipped with modern optics incorporating advanced technology:

- A unique Wide Field Optics™ design with a proprietary Intermediate Lens (IML) in addition to the conventional objective lens offers a variety of working and displaying modes: so called Resolution mode for the highest resolution, Field mode for enhanced field of view, Depth mode for extended depth of focus, Channeling mode for rocking the beam in order to obtain electron channeling patterns and Wide Field mode for extra large field of view.
- Real time In-Flight Beam Tracing™ for ultimate performance and beam optimization. Originally developed by TESCAN, this method represents an active way of controlling the electron-optical system. By using a very precise calculation of all optical parameters, it is possible to control the beam current precisely and directly and the spot size continuously for the whole range of the beam energy.
- TESCAN was first to offer live stereoscopic imaging using advanced 3D Beam Technology which opens up the micro and nano-world for an amazing 3D experience and 3D navigation. 3D Beam Technology allows the scanning axis to tilt around the center of the view field and therefore true live stereo-imaging is possible. The important feature of observation and acquiring of three-dimensional images using TESCAN SEMs is the possibility to generate image series and video sequences by tilting either the beam or stage. Together with 3D reconstruction software, it provides a revolutionary tool for 3D surface analysis.
- Fast imaging rate without sacrificing image quality.
- Fully automated electron-optics set-up and alignment.
- E-Beam lithography available with an optional Beam Blanker.

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Analytical Potential

The highest quality and reliability of the TESCAN product range mirrors its strong analytical potential:

- First-class YAG scintillator-based detectors
- Selection of optional detectors and accessories
- Fast and easy attainment of a clean chamber vacuum
- Investigation of non-conductive samples in variable-pressure mode versions
- Option of extra-large XM or analytical GM chambers with robust stage able to accommodate large samples (including heavy samples up to 8 kg).
- LM, XM, GM chamber models provide superior specimen handling using a full 5-axis motorized compucentric stage and ideal geometry for microanalysis.
- Numerous interface ports with optimized analytical geometry for EDX, WDX and EBSD as well as for attaching many other detectors
- 3D measurements on a reconstructed surface utilizing 3D metrology software
- Several chamber suspension options ensure effective reduction of ambient vibrations in the laboratory. Unique integrated active vibration isolation for analytical GM chamber delivered as standard.

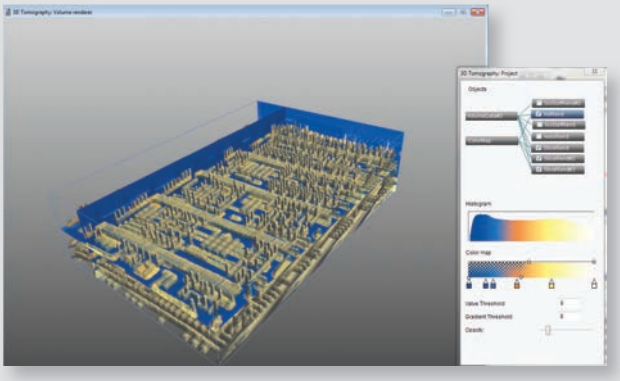


Fig. Screenshot showing 3D Tomography module.

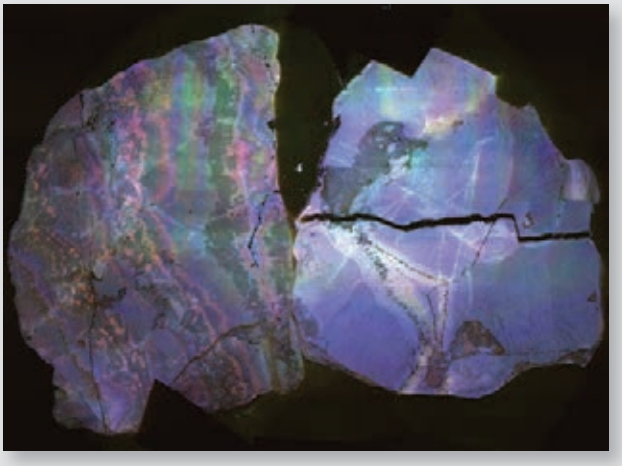


Fig. TESCAN Color CL detector image of a Fluorite.

Automated Procedures

Filament heating and alignment of the electron gun for optimal beam performance is achieved automatically with just one click. There are many other automated procedures which reduce the operator's tune-up time significantly, including automated manipulator navigation and automated analyses. SharkSEM remote control interface enables access to most microscope features, including microscope vacuum control, optics control, stage control, image acquisition, etc. The compact Python scripting library offers all these features.

User-Friendly Software and Software Tools

- Multi-user environment is localized in many languages.
- Easy control of the SEM even for inexperienced users; four levels of user expertise/rights, including an EasySEM™ mode for quick routine investigations
- Built-in image management and report creation
- Built-in self-diagnostics for system readiness checks
- Network operations and remote control/diagnostics
- Modular software architecture enables several extensions to be attached.
- Basic set of plug-ins, such as Measurement, Image Processing, Object Area, available as standard
- Several optional modules or dedicated applications optimized for automatic sample examination procedures, such as particle analysis or 3D surface reconstruction, etc.

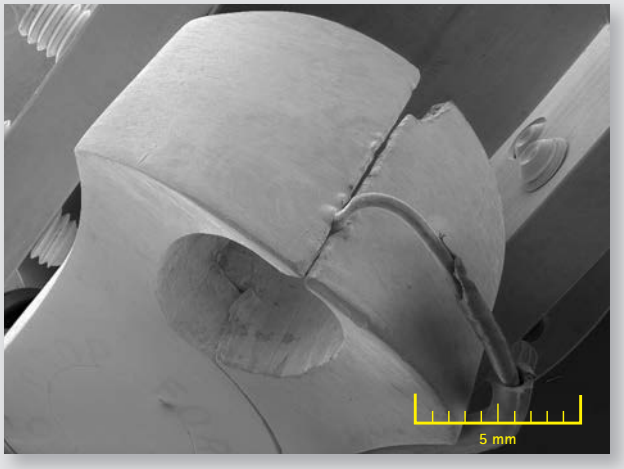
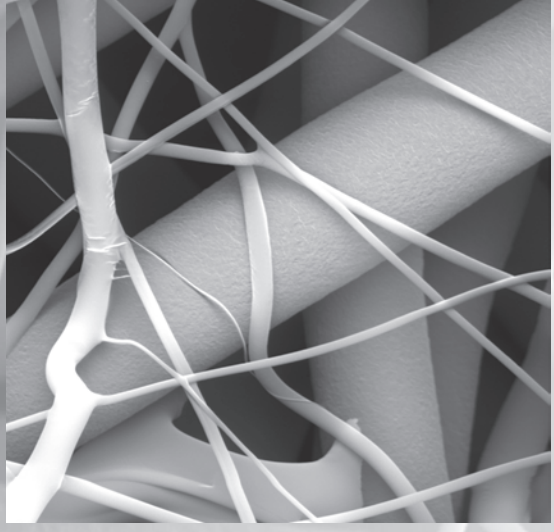


Fig. Image in the Wide Field Mode (forensic tool mark analysis).



VEGA3

3rd Generation of VEGA SEMs

VEGA is a SEM with conventional tungsten heated cathode intended both for high vacuum as well as for low vacuum operations. After 12 years of continuous development VEGA has matured to its 3rd generation. The column design without any mechanical centering elements enables fully automated column set-up and alignment.

The creation of favorable conditions for complex analysis of specimens, combined with high performance imaging capabilities, were a high priority in the design of the VEGA microscopes from the beginning. The conical objective lens, carefully considered chamber design, high precision compucentric or eucentric stages, wide choice of detectors and supplementary accessories, all combined to make the VEGA3 SEM a versatile and powerful analytical tool.

VEGA3 Modifications

High Resolution Imaging with LaB_6 Emitter

Besides the tungsten heated filament TESCAN offers the LaB_6 – (lanthanum hexaboride) electron source as an option.

The LaB_6 provides higher current density at lower cathode temperatures compared to tungsten emitters. It offers greater brightness, a reasonably improved resolution over the whole range of accelerating voltages and a longer cathode lifetime. Due to the higher current and smaller spot size, the LaB_6 emitter is the right choice for applications where large beam currents and improved resolution are required.

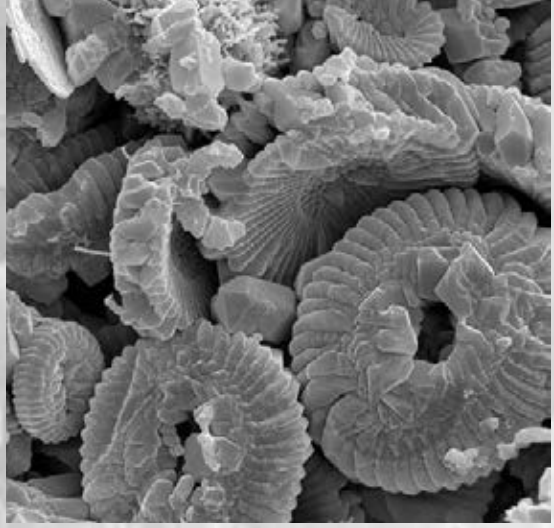
VEGA3

Chamber type	**SB**	**LM**
Specimen height	max. 36 mm	max. 81 mm
Chamber type	**XM**	**GM**
Specimen height	max. 145 mm	max. 145 mm
Electron gun	Tungsten heated cathode / optionally LaB_6 * ** LaB_6 not available for VEGA3 SB*	
Resolution In high vacuum mode (SE) In low vacuum mode (BSE)	3.0 nm at 30 kV / 2.0 nm at 30 kV (LaB_6) 3.5 nm at 30 kV / 2.5 nm at 30 kV (LaB_6)	
Acceleration voltage	200 V to 30 kV	
Probe current	1 pA to 2 µA	

VEGA3 SB – EasyProbe

Small Chamber, Motorized Stage, Integrated EDX, High Vacuum Operation

The VEGA3 SB – EasyProbe is a compact scanning electron microscope fully integrated with a selected energy dispersive X-ray microanalyser.
Superior imaging quality, high level of automation, easy usage and quick quantitative elemental results directly in the live image are characteristic features of the instrument.



MIRA3

3rd Generation of MIRA FE-SEMs

The new generation of MIRA field emission scanning electron microscopes is based on a high resolution Schottky field emission emitter. MIRA3 provides users with the advantages of the latest technology, such as, new improved high-performance electronics for faster image acquisition, an ultra-fast scanning system with compensation for static and dynamic image aberrations or scripting for user-defined applications, while at the same time maintaining the best price to performance ratio.

Its excellent resolution at high beam currents has proved to be advantageous for analytical applications such as EBSD and WDX.

Since MIRA3 model 2012 was launched there is the possibility to set up the optional configuration including the Beam Deceleration Technology for the entire range of TESCAN field emission gun SEMs (MIRA3, LYRA3, FERA3).

Beam Deceleration Technology (BDT)

Maintaining the primary beam at low energy allows a microscope user to determine very fine surface details which would not be observable at higher beam energies. However, better electron-optical performance of a SEM is achieved at high accelerating voltage.

BDT combines both factors, as it is obvious that the best results can be achieved if the primary beam is accelerated to high energy in the electron column and decelerated to low energy shortly before it interacts with the sample.

BDT launched by TESCAN consists of a Beam Deceleration Mode (BDM) and a state-of-the-art In-Beam detector designed to detect both the high-angle Back Scattered Electrons under the standard operating conditions and the Secondary Electrons signal in the BDM

Beam Deceleration Technology significantly improves resolution at low accelerating voltage and the detected signal is outstanding. It can be also used for achieving very low landing energies – down to 50 eV.

MIRA3

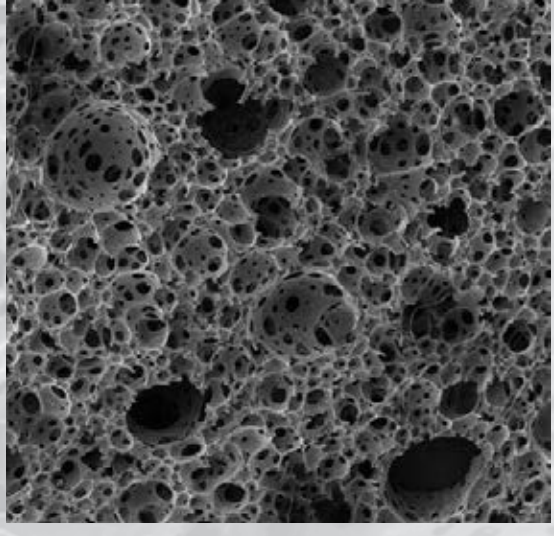
Chamber type	LM	XM	GM
Specimen height	max. 81 mm	max. 145 mm	max. 145 mm
Electron gun	High brightness Schottky emitter		
Resolution In high vacuum mode (SE) In low vacuum mode (BSE) In high vacuum BDM (Beam Deceleration Mode)	1.2 nm at 30 kV 2 nm at 30 kV 1.8 at 1 kV		
Acceleration / landing voltage	200 V to 30 kV / 50 V to 30 kV with BDT (Beam Deceleration Technology) option		
Probe current	2 pA to 200 nA		

Decontaminator

The Decontaminator is highly recommended for even better improvement in image quality. In order to remove carbon and organics from the chamber TESCAN offers the decontaminator device as an option.

Advantages of Using a Decontaminator

The reaction of ubiquitous volatile hydrocarbon molecules in the SEM chamber with the electron beam during scanning results the creation of a dark contamination layer on the specimen surface during sample observation and devalues the investigation. This is even more significant when using a low energy electron beam which has a higher reactivity with carbon containing molecules.



MAIA3

MAIA3

Charging of non-conductive materials, observation of very thin layers, damaging of sensitive samples – these are the problems which many scientists are faced with using scanning electron microscopy e.g. in biology, bioengineering, nanosensor or semiconductor research. The analytical scanning electron microscope MAIA3 is the perfect choice for such applications. MAIA3 demonstrates ultra-high resolution of 1 nm at 15 kV. The resolution performance **at 1 kV is 1.4 nm** using secondary electrons and 0.8 nm at 30 kV in STEM mode.

MAIA3 provides user with ultra-high resolution without compromise

The ultra-high resolution scanning electron microscope MAIA3 is based on TESCAN's proven three-lens column equipped with a Schottky field emission gun and the unique construction of TESCAN's 60 degree immersion objective lens. Concerning a wide range of specimens, including non-conductive materials, which set the requirement to keep the primary beam at low energy, the analytical performance of MAIA3 might be further enhanced by Beam Deceleration Technology (BDT) utilization.

The BDT option enables the ultra-low electron landing energy imaging with automation down to 50 eV and thus the precise determination of very fine surface details without charging effect or possible damage of the sample. It is highly recommended to combine the BDT with decontaminator.

MAIA3

Chamber type	LM	XM	GM
Specimen height	max. 71 mm	max. 135 mm	max. 135 mm
Electron gun	High brightness Schottky emitter		
Resolution In high vacuum mode (In-Beam SE) In low vacuum mode (BSE) In high vacuum BDM (Beam Deceleration Mode)	1.0 nm at 15 kV 2 nm at 30 kV 1.4 nm at 1 kV		
Acceleration / landing voltage	200 V to 30 kV / down to 50 V with BDT (Beam Deceleration Technology) option		
Probe current	2 pA to 200 nA		

Analytical features of MAIA3

The specimen observed in MAIA3 is totally immersed in the strong magnetic field induced by the 60 degree immersion objective lens, which extends into the specimen chamber. The objective lens is narrower than a conventional non-immersion objective, dramatically decreases optical aberrations and provides even more space around samples.

Like other TESCAN series, the MAIA3 optics is equipped with the customer proven intermediate lens which makes a wide range of imaging modes possible, e.g. FIELD provides large field of view while the sample remains free of any magnetic field.

The detection system consists of TESCAN's proprietary detectors, In-Beam SE, In-Beam BSE as well as SE in Beam Deceleration Mode, all of which are placed inside the column to provide a variety of signals in addition to the standard SE, BSE or STEM detectors placed in the specimen chamber.

TIMA

TIMA3 / TIMA3 FEG

The TESCAN Integrated Mineral Analyzer (TIMA*) is a SEM-based automated mineralogy solution for the mining and minerals processing industries. TIMA measures mineral abundance, size by size liberation, mineral association and grain size automatically on multiple samples of grain mounts, thin sections or polished sections. Applications include ore characterization, process optimization, remediation and the search for precious metals and rare earths.

The TESCAN TIMA is based either on MIRA Schottky field emission (TIMA3 FEG) or VEGA thermal emission scanning electron microscope (TIMA3). Special VEGA column design with permanent gun high-vacuum and the isolation valve significantly increases emission stability and tungsten filament lifetime. The system is available in high-vacuum version as the standard, low-vacuum version as an option.

TESCAN's unique technology is based on a completely integrated EDX system which performs full spectrum acquisition at very fast scan speeds. The level of hardware integration of SEM and EDX allows unprecedented acquisition speeds for fully automated data collection, resulting in fast, accurate and reliable results.

TIMA software is developed for BSE and EDX data acquisition, processing and analysis. It provides three measurement modules – Modal Analysis module, Liberation Analysis module and Bright Phase Search module, each of which is designed to be used for specific task. The Modal Analysis module provides information about mass fractions of minerals in a sample. Liberation analysis module gives information about texture of individual particles. The Bright Phase Search module provides information about associations among minerals of interest and other minerals. TIMA software offers two types of Bright Phase Search analysis – basic and advanced with phase filtering. The Classification Builder, a special tool for efficient and understandable classification of minerals, is also integrated into TIMA software. Its important part is a library of minerals, which consists of more than hundred of mineral definitions.

TIMA3 / TIMA3 FEG

	TIMA3	TIMA3 FEG
Electron gun	Tungsten heated cathode with extraordinary emission stability and filament lifetime (typically 2500 hours)	High brightness Schottky emitter
Resolution In high vacuum mode (SE) In low vacuum mode (BSE)	 3.0 nm at 30 kV 3.5 nm at 30 kV	 1.2 nm at 30 kV 2 nm at 30 kV
Acceleration voltage	200 V to 30 kV	
Probe current	1 pA to 2 µA	2 pA to 200 nA

Detectors and Accessories	
Detectors	BSE – premium YAG scintillator BSE detector (manual or motorized retractable); SE – Everhart-Thornley
EDX Detectors	4 Silicon Drift Detector (SDD), Peltier cooled (no liquid nitrogen required)
Accessories	Probe current measurement; Touch alarm; IR chamber view camera

** TIMA is available with LM and GM chambers.*

TIMA Advantages

- Very fast and fully automated data acquisition process enabled via SEM and EDX high level hardware integration
- System based on MIRA FE-SEM or VEGA SEM platform proven by customers in many countries
- Special VEGA column design significantly extending tungsten filament lifetime
- Exchangeable sample holder with integrated fixed BSE/EDX calibration standard and Faraday cup
- Possibility to modify size of samples according to customer demands
- Up to 4 integrated EDX detectors for maximum system performance
- Peltier cooled EDX detector type for thermal stability guarantee
- Improved approach to data analysis increasing the speed and reliability of the process
- Variable dwell time and EDX analysis duration adapting to each part of the sample
- Software released in three editions
- Various modules for data analysis
- Customizable classification rules
- Favourable price performance ratio
- Customised solution possibilities

LYRA3

LYRA3

The LYRA3 FIB-SEM brings a combination of the electron and high performance ion columns. Built on the MIRA3 platform, LYRA3 extends the imaging qualities of a field emission (high resolution Schottky FEG-SEM Column) scanning electron microscope with the ability to perform surface modification by utilizing a focused ion beam.

The LYRA3 series was designed with respect to a wide range of FIB-SEM applications and needs in today's research and industry. Its excellent resolution at high beam currents has proved to be advantageous for analytical applications such as EDX, WDX, EBSD, 3D tomography. The powerful software turns these TESCAN FIB-SEMs into excellent tools for a variety of other applications, such as electron/ion lithography or TEM sample preparation. LYRA3 focused ion beam scanning electron microscope is manufactured in configurations with XM and GM chambers.

High Performance Ion Optics

The series of focused ion beam scanning electron microscopes LYRA3 are manufactured to incorporate High Performance in Ion Optics.

There are two versions of **FIB column** available:

- Sophisticated high performance CANION FIB system for fast and precise cross-sectioning and TEM sample preparation
- Optional ultra-high resolution COBRA-FIB column represents the highest level of technology in terms of resolution both for imaging and milling. This is one of the most precise FIB instruments for nano-engineering in the world.

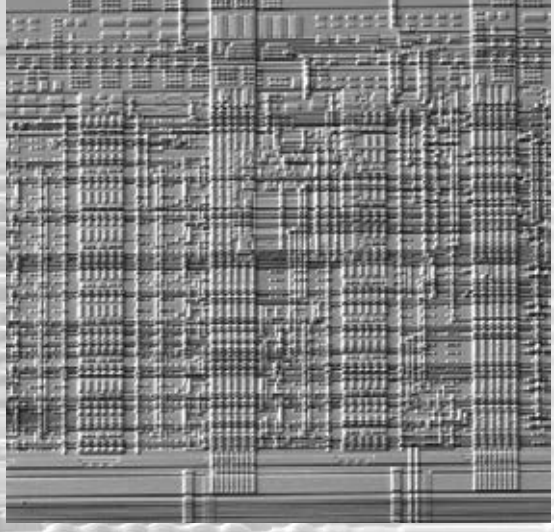
LYRA3

Chamber type	**XM**	**GM**
Specimen height LYRA3	maximum 139 mm	maximum 139 mm
Electron optics		
Electron gun	High brightness Schottky emitter	
Resolution In high vacuum mode (SE) In low vacuum mode (BSE)	1.2 nm at 30 kV 2 nm at 30 kV	
Acceleration voltage	200 V to 30 kV / 50 V to 30 kV with BDT (Beam Deceleration Technology) option	
Probe current	2 pA to 200 nA	
Ion optics		
Ion column	Canion / Cobra	
Resolution	<5 nm at 30 kV / <2.5 nm at 30 kV (at SEM-FIB coincidence point)	
Accelerating Voltage	0.5 kV to 30 kV	
Ion Gun	Ga Liquid Metal Ion Source	
Probe Current	1 pA to 40 nA / 1 pA to 50 nA	
SEM-FIB Coincidence at	WD 9 mm for SEM, WD 12 mm for FIB	

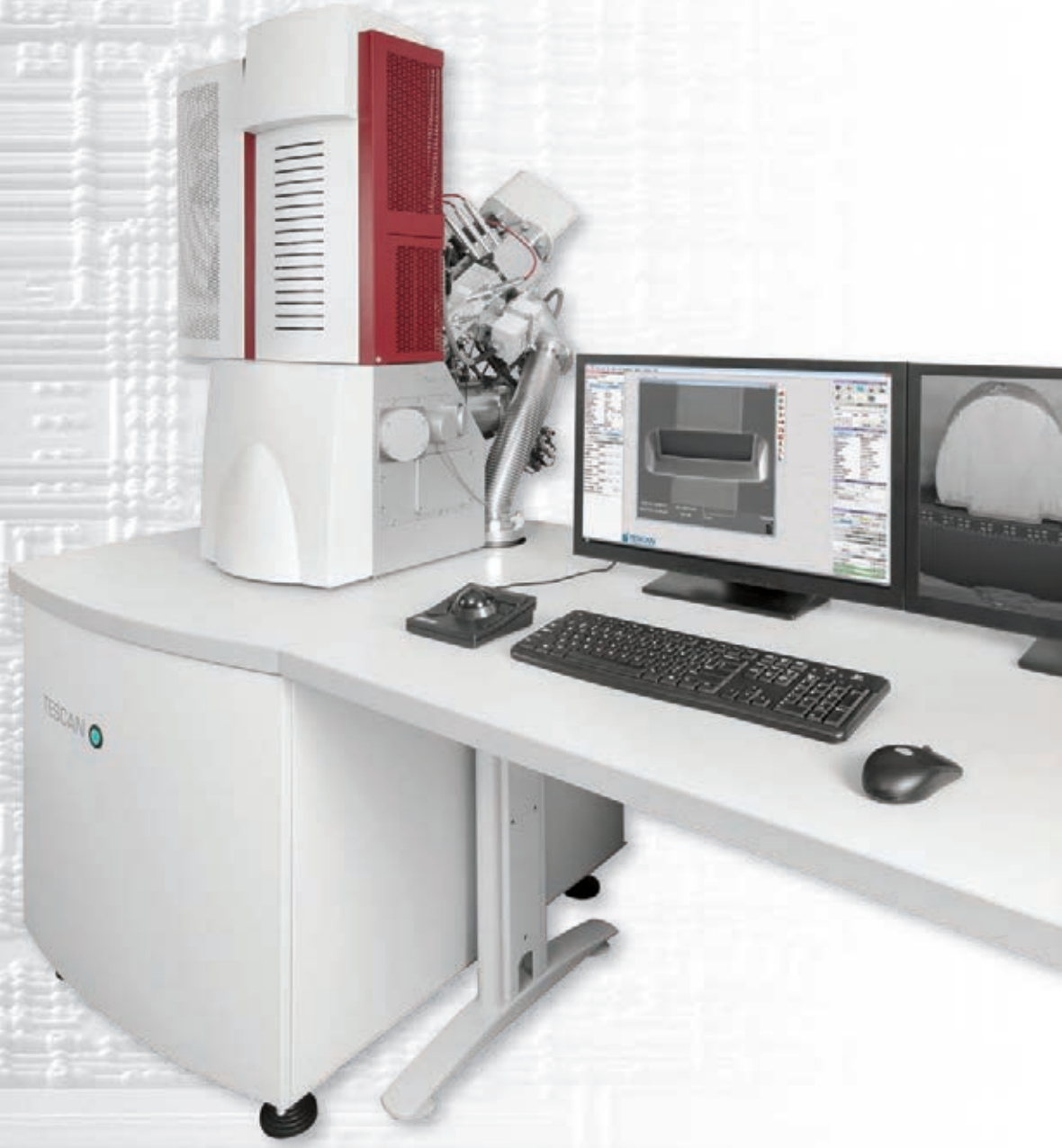
Every TESCAN FIB-SEM user takes advantage of following

FIB characteristics:

- Unique ion optic column, differentially pumped, with 2 ion pumps, for ultra-low ion scattering effect
- Motorized aperture changer with ultra-high reproducibility
- Beam Blanker and Faraday cup included as a standard
- Simultaneous SEM imaging with FIB etching or deposition
- FIB control is fully integrated in the SEM software
- Powerful and user friendly toolbox for delineation of both basic and complex shape creation with programmable process parameters
- Micro/nano machining
- Ion beam lithography



FERA3



FERA3

The world's first fully integrated Xenon Plasma source FIB with SEM enables extremely high ion currents of up to 2 µA thus increasing material sputtering rate. Compared to existing FIB technologies with gallium sources, the material removal rate achievable for silicon with the Plasma FIB-SEM is about 50 times faster. For this reason the FERA3 is well suited for applications requiring the removal of large volumes of material, particularly in the semiconductor packaging environment where TSV technology is being utilized.

The unique combination of Xenon plasma source and electron emitter integrates the advantages of high resolution of the SEM with FIB potential into one single device. Therefore, FERA3 allows the user to easily employ the direct observation techniques of the prepared sample; importantly, the positioning of milling without any additional damage to the sample is possible. Generally, systems of this kind can not only be used in materials science, research, forensic investigations but mainly in semiconductor industry for example for 3D metrology, defect and failure analysis or designing of MEMS and TSVs.

FERA3

Chamber type	**XM**	**GM**
Specimen height	maximum 139 mm	maximum 139 mm
Electron optics		
Electron gun	High brightness Schottky emitter	
Resolution In high vacuum mode (SE) In low vacuum mode (BSE)	1.2 nm at 30 kV 2 nm at 30 kV	
Acceleration / landing voltage	200 V to 30 kV / 50 V to 30 kV with BDT (Beam Deceleration Technology) option	
Probe current	2 pA to 200 nA	
Ion optics		
Ion column	i-FIB	
Resolution	25 nm at 30kV at SEM-FIB coincidence point	
Accelerating Voltage	3 kV to 30 kV	
Ion Gun	Xe Plasma Ion Source	
Probe Current	20 pA to 2 µA	
SEM-FIB Coincidence at	WD 9 mm for SEM – WD 12 mm for FIB	

FERA3 Plasma FIB-SEM configurations

Sophisticated high performance Plasma FIB-SEM system for both extremely fast and precise cross sectioning and high volume material removal.

FERA3 Plasma FIB-SEM can be configured with gas injection systems, nanomanipulators, and a wide variety of detectors including, for example, SE (Secondary Electron) detector, BSE (Backscattered Electron) detector, SI (Secondary Ion) detector, CL (Cathodoluminescence) detector, EDX and EBSD microanalyzers.

CHAMBER TYPES

SB

LM

XM

GM

TESCAN chamber types – overview

Chamber type	SB	LM	XM	GM
Internal dimensions	Ø 160 mm	Ø 230 mm	285 mm (width) x 340 mm (depth)	340 mm (width) x 315 mm (depth)
Door	120 mm (width)	148 mm (width)	285 mm (width) x 320 mm (height)	340 mm (width) x 320 mm (height)
Number of ports	10	11+	12+	20+
Chamber suspension	mechanical	pneumatic	pneumatic	Active vibration isolation (integrated)
Speciment stage	semi-motorized	fully motorized	fully motorized	fully motorized
Type	eucentric	compucentric	compucentric	compucentric
Movements	X = 45 mm - mot. Y = 45 mm - mot. Z= 27 mm Z'= 6 mm Rotation: 360˚ mot.	X= 80 mm Y= 60 mm Z= 47 mm Rotation: 360˚ cont.	X= 130 mm Y= 130 mm Z= 100 mm Rotation: 360˚ cont.	X = 130 mm Y = 130 mm Z = 100 mm Rotation: 360˚ cont.

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AXT

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