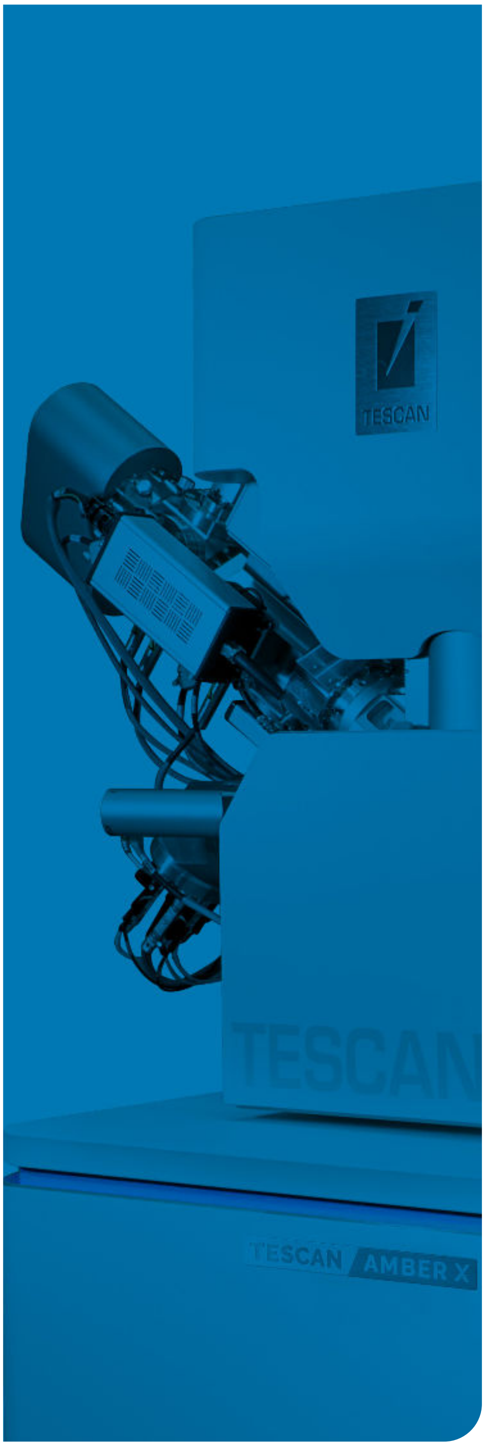
TESCAN
AMBER X

A unique combination of Plasma FIB and field-free UHR FE-SEM for the widest range of multiscale materials characterization applications



- CROSS-SECTIONING
- DUAL BEAM (FIB-SEM)
- IN-COLUMN DETECTORS
- FIB-SEM TOMOGRAPHY
- XE PLASMA FIB COLUMN
- BEAM DECELERATION TECHNOLOGY
- LARGE SCALE ANALYSIS
- FIELD-FREE UHR SEM
- VARIABLE PRESSURE

Expand your range of materials characterization applications with the unique combination of plasma FIB and field-free UHR FE-SEM

TESCAN AMBER X is the analytical plasma FIB and ultra high resolution (UHR) SEM solution built to deliver materials characterization for samples that have proven challenging for typical Ga FIB and FE-SEM instruments.

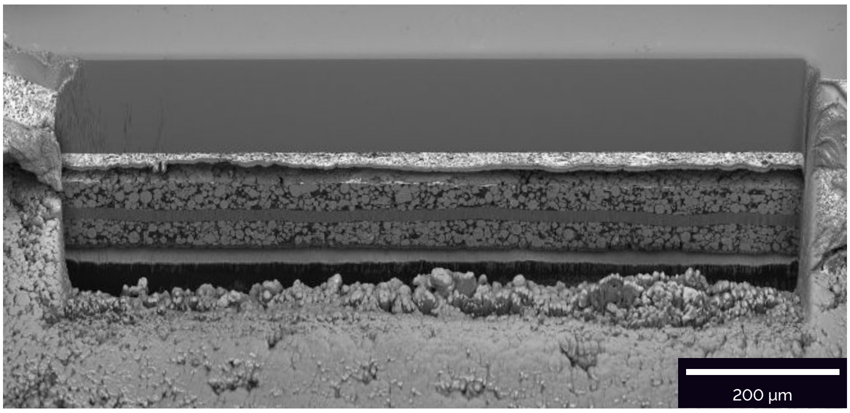
TESCAN AMBER X pairs a Xe plasma FIB with BrightBeam™ SEM optics to provide high throughput, large area ion milling and field-free ultra-high resolution imaging for 2D and 3D multi-modal characterization on the widest range of conventional and novel materials.

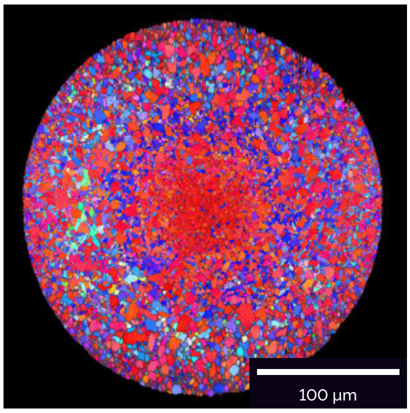
With AMBER X you can cover the materials investigation needs you have today as well as be ready for your future needs.

Key features:

High throughput, large area FIB processing

AMBER X's plasma FIB enables the fast milling of large cross-sections, up to 1 mm, as well as routine milling and polishing for sample preparation. The Xe plasma beam does minimum damage and doesn't introduce contamination from implantation.

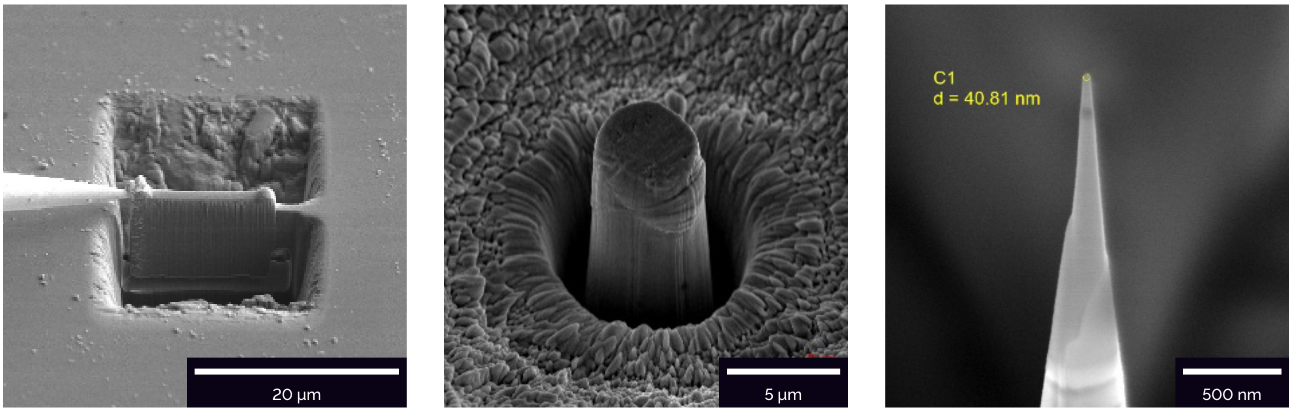




▲ (Left) This 1 mm wide polished cross section of a Li-ion battery electrode was prepared in 3.5 hours by Xe plasma FIB at 1 µA ion beam current. (Right) An EBSD map from a cross section of a 300 µm diameter copper wire.

Ga-free microsample preparation

The inert nature of xenon ions means contamination-free microsample preparation for materials like aluminum can be achieved, without the risk that microstructural and/or mechanical properties may be altered by contamination or implantation of gallium ions when prepared by a conventional liquid metal ion FIB.

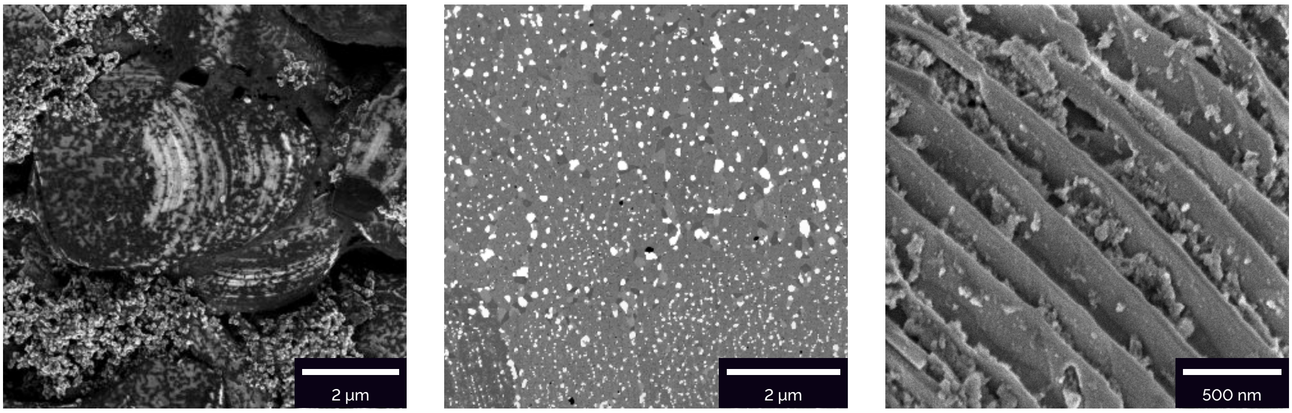


▲ (Left) A TEM lamella prepared using plasma FIB, (Center) A micro-pillar prepared from ultra-fine grain aluminum after compression testing, (Right) Ga-free atom probe tip sample preparation using plasma FIB

Field-free ultra high resolution low energy electron beam imaging

Low beam energies are needed to achieve the highest quality SEM images and analytical results on challenging materials such as those that are magnetic, beam-sensitive or non-conductive. But using low beam energies often means compromising your resolution requirement.

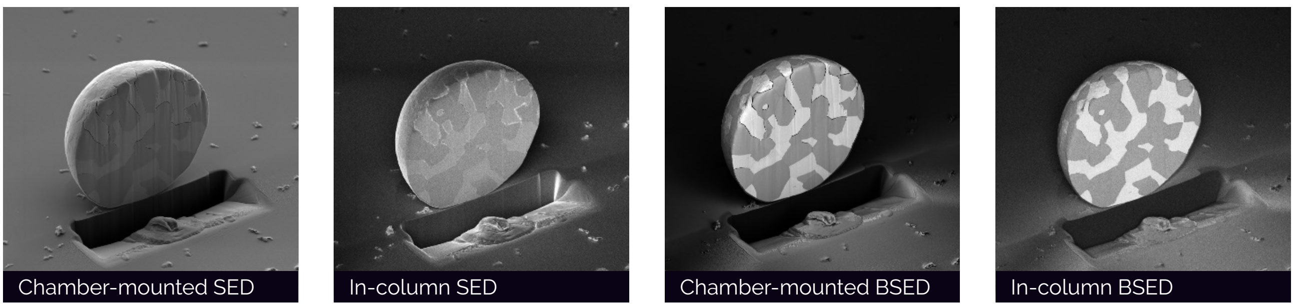
AMBER X's BrightBeam™ SEM column enables field-free UHR imaging to expand high resolution characterization to these materials that might otherwise be affected by the magnetic field below the final lens, which is common for non field-free UHR electron optical designs.



▲ (Left) Li-ion battery imaged at 500 eV, (Center) Steel alloy produced by additive manufacturing, imaged from a plasma FIB cross section at 5 keV, (Right) Pearlitic steel lamellae (ferromagnetic sample) imaged at 2 keV

In-beam SE and BSE detection

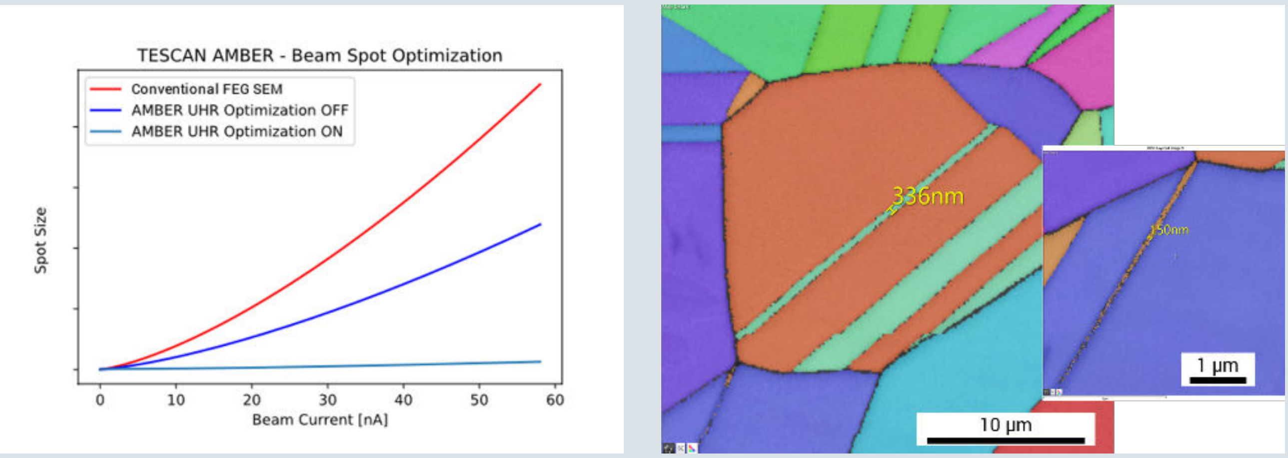
TESCAN AMBER X is fitted with a dual in-column detection system featuring multiple SE and BSE detection modes. Optimized arrangements of the in-column detectors enable simultaneous acquisition of topographic and compositional contrast from the sample.



Optimized e-beam performance for high-throughput, multi-modal FIB-SEM tomography

Successful multi-modal FIB-SEM tomography relies on fast acquisition of microanalysis data (EDS, EBSD) in conjunction with ultra-high resolution SEM imaging. AMBER X features TESCAN's In-flight Beam Tracing™ to optimize the electron beam spot size at high currents, ensuring the best possible imaging and analytical performance at conditions typically required for acquistion of 3D FIB-SEM data.

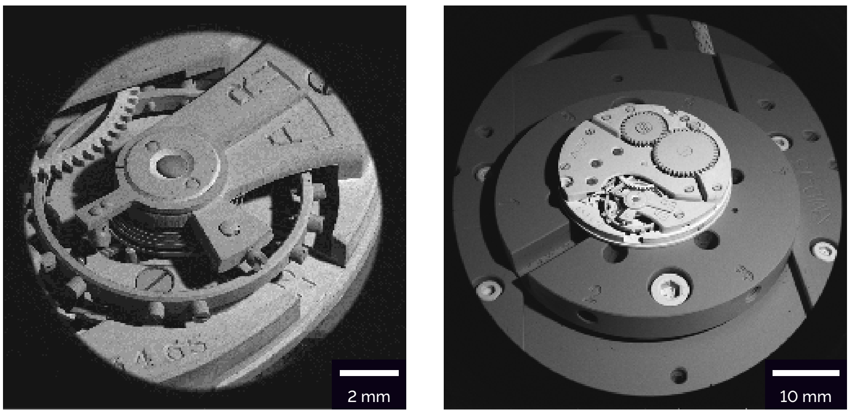
AMBER X is extremely well suited to multiscale, multimodal material characterization. Its novel FIB-SEM tomography module supports a wide selection of imaging and analytical detectors which, combined with the high milling speed of the plasma FIB, rapidly produces detailed 3D visualizations.



▲ Fig. TESCAN's In-flight Beam Tracing™ automatically optimizes the spot size for high beam currents to assure fast acquisition of high spatial-resolution EBSD maps. (Left) Graph illustrates electron beam spot size as a function of beam current for conventional FE-SEMs; Amber X with optimization OFF; and Amber X with optimization ON. (Right) a high spatial resolution EBSD map acquired at 20nA and 20keV.

Superior field of view for easy navigation

TESCAN's Wide Field Optics™ design enhances the depth of focus and/or the field of view that can be achieved to an extraordinary 5 cm, facilitating navigation on even the largest samples or holders loaded with multiple samples.



▲ (Left) Image in **Overview Mode** with field of view of 13 mm and depth of focus over 40 mm. (Right) The **WideField Mode** offers an extra-large field of view up to 50 mm for live navigation on the sample

Enabling technologies:

Plasma focused ion beam

TESCAN is a leading supplier of both gallium liquid metal and xenon plasma FIB optical solutions, which we combine with high resolution SEM imaging and a broad range of analytical techniques, including EDS, WDS, EBSD and even TOF-SIMS.

Xenon plasma FIB differs from the more widely used gallium liquid metal ion FIB technology with its ability to focus more ions into the beam, thereby achieving higher ion beam currents than what is possible with liquid metal ion species. The benefit of higher ion beam currents, up to 3 µA for TESCAN AMBER X's HR plasma FIB configuration, is that it enables significantly higher milling rates: one order of magnitude and more.

Depending on your application, plasma FIB may or may not be the best beam for the job. On the one hand, the interaction volume of xenon ions compared to gallium ions can be half at the equivalent acceleration voltage. On the other hand, gallium ions can be focused in a spot that is smaller than the achievable spot with xenon: approximately 2.5 nm resolution for gallium versus 12 nm for xenon. Thus, gallium FIB technology is preferred for the highest precision milling requirements, while plasma FIB forms an appealing alternative for applications that may not necessarily require the ultimate milling precision, but benefit from enhanced milling rates for higher throughput, to access significantly larger volumes for multiscale, multimodal FIB-SEM tomography. And last, but not least, plasma FIB avoids the contamination of nanostructures from liquid metal implantation.

Field-free UHR FE-SEM Optics

TESCAN is also a leading supplier of conventional, field-free, and immersion-lens FE-SEM solutions such as TESCAN MIRA, TESCAN CLARA and TESCAN MAGNA respectively. TESCAN AMBER X uses the field-free BrightBeam™ UHR FE-SEM optical design similar to our TESCAN CLARA UHR FE-SEM solution with only minor adaptations.

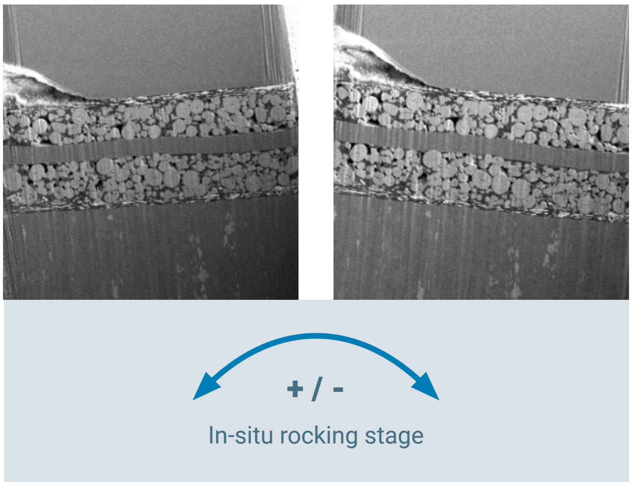
While our Triglav™ immersion lens optical design, found in TESCAN SOLARIS X FIB-SEM and TESCAN MAGNA FE-SEM solutions, still achieves the best electron beam performance at low electron beam acceleration voltages for superior imaging resolution (1.2 nm @ 1 kV), the field-free BrightBeam™ compound magnetic-electrostatic design on TESCAN AMBER X extends investigations to a wider range of materials, like those that would be affected by the magnetic field that immerses the sample below the pole piece, while still achieving ultra-high resolution (1.5 nm @ 1 kV).

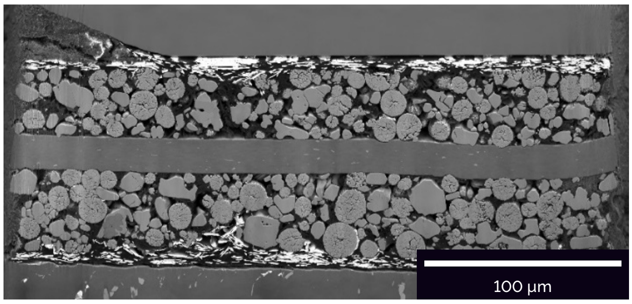
TESCAN AMBER X excels at delivering ultra-high resolution SE and BSE imaging performance for the widest range of materials, whether metallic, magnetic, non-conductive or beam (dose) sensitive, thanks to in-column detector technologies. Furthermore, our Wide Field Optics™ design offers best-in-class large fields-of-view at the lowest imaging magnifications, making navigation to your region of interest easy and fast.

Applications – Ideal for:

Milling and polishing of large cross sections

High FIB milling rates can induce artifacts on the resulting cross sections. Known as curtaining, these artifacts are caused by topography on the cross-section surface, composition inhomogeneity resulting from preferential milling, or milling selectivity with respect to the crystal orientation in the sample. TESCAN offers a range of techniques to help their instrument users achieve the highest quality cross sections without having to compromise the higher milling speeds provided by the plasma focused ion beam. The most efficient way is using our proprietary Rocking Stage, which utilizes a secondary tilt in the plane of the cross section, greatly reducing the curtaining artifacts. The rocking stage process, which is compatible with *in-situ* monitoring of the cross section quality, also keeps the cross section strictly perpendicular to the surface.



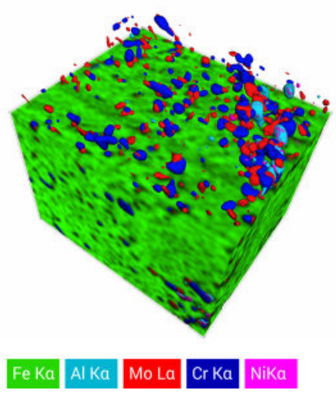


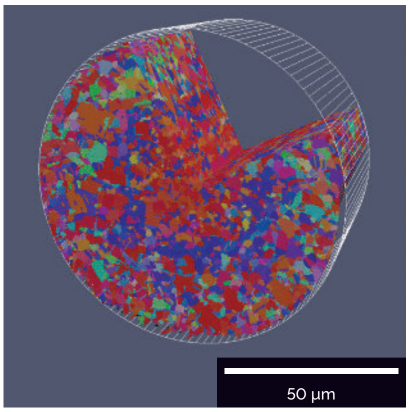
▲ Fig. A Li-ion battery cross section polished using the Rocking Stage for curtaining reduction. A thin silicon mask was used to suppress the surface tomography.

Multiscale, multi-modal FIB-SEM tomography

TESCAN's patented geometry for static 3D EBSD applications allows rapid and more precise 3D microanalysis results with minimum user input at acquisition setup.

Our novel FIB-SEM tomography module, which supports a wide range of imaging and analytical detectors, is embedded in AMBER X's Essence™ graphical user interface. This, plus high speed plasma FIB milling and optimized analytical performance, makes AMBER X a preferred solution for 3D microstructure characterization.





▲ (Left) A 3D EDS visualization of precipitates in high-alloy steel.
(Right) An EBSD map of a 90 µm diameter cold-drawn copper wire.

Technical Specifications

Electron Optics:

Electron Gun:	High brightness Schottky emitter		
Electron Optics:	BrightBeam™ column		
Resolution:	**Standard mode:** 0.9 nm at 15 keV 1.5 nm at 1 keV	**Beam Deceleration mode:** 1.3 nm at 1 keV	**STEM:** 0.8 nm at 30 keV
Maximum Field of View:	50 mm at WD = 70 mm		
Electron Beam Energy:	50 eV to 30 keV		
Probe Current:	up to 400 nA		
Low vacuum mode (option)	up to 500 Pa		

Ion Optics:

Ion Column:	i-FIB+
Ion Gun:	Xe plasma ion source (ECR type)
Resolution:	< 12 nm at 30 keV
Ion Beam Energy:	3 keV to 30 keV
Probe Current:	1 pA to 3 μA
SEM-FIB Coincidence at:	WD_{SEM} = 6 mm

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