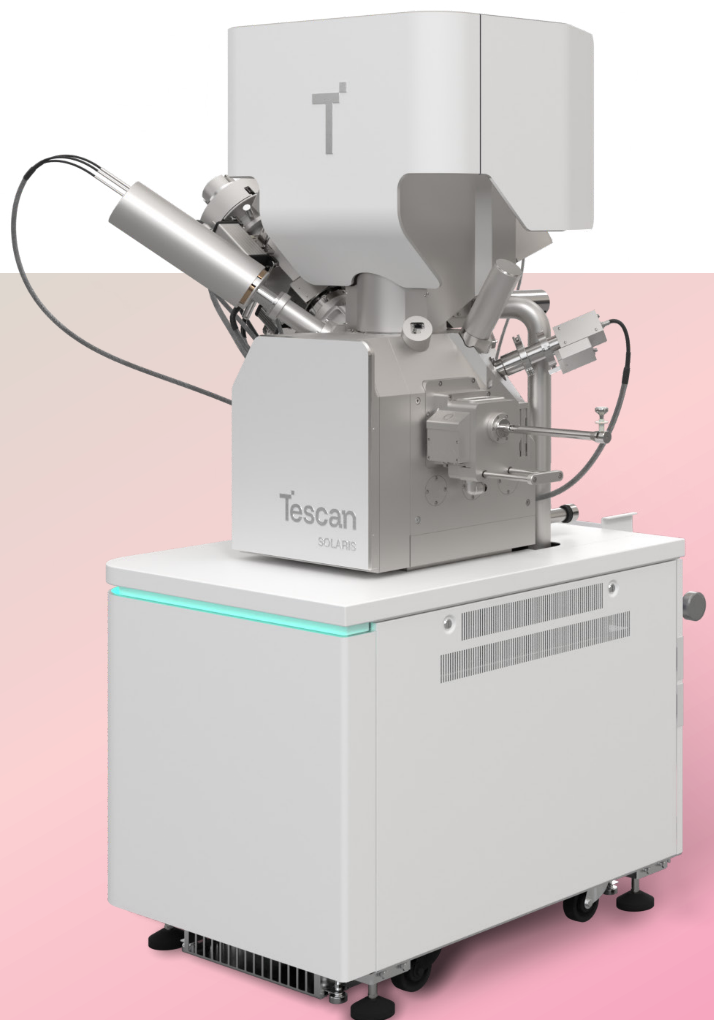
Tescan SOLARIS 2 FIB-SEM

Ga^+ FIB-SEM solution for high quality automated TEM sample preparation

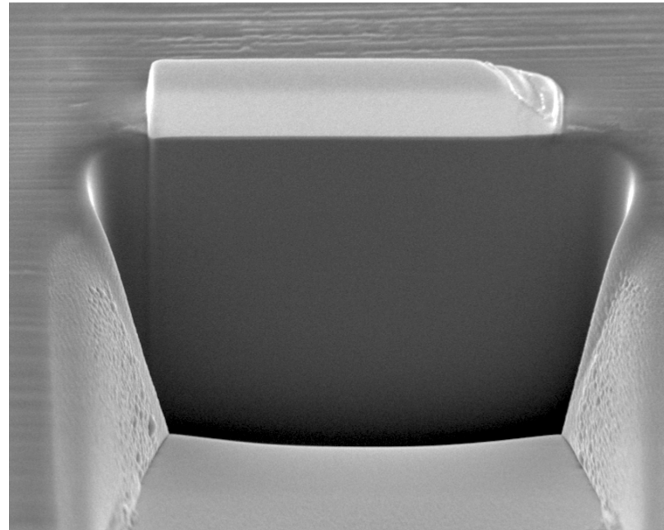


Tescan SOLARIS 2 is a fully automated Ga+ FIB-SEM designed for high-quality TEM lamella preparation, equipped with AI-driven TEM AutoPrep™ Pro software. Engineered for applications in Failure Analysis, R&D, and Quality Control, Tescan SOLARIS 2 seamlessly integrates advanced SEM and FIB alignments, ensuring consistent system readiness and reducing time to data. It excels in handling a wide range of electronic devices, including the latest in logic, memory, power, and display technologies.

The Tescan SOLARIS 2 is designed to meet the industry's demands providing precise and dependable data to accelerate research, development, and failure analysis with fully automated TEM sample preparation. Tescan SOLARIS 2 is equipped with new Orage™ 2 FIB column delivering unmatched 500 eV performance and extreme high beam current density up to 100 nA — providing users with up to 40% faster TEM specimen preparation. It's not just for standard (top-down) lamella preparation - you'll also master inverted, planar, and double-cross lamella preparation with our optimized single-step in situ lift-out geometries, ensuring that you can characterize your device from multiple cut-planes to develop a better understanding of a failure's root-cause.

The techniques can also involve automated, unattended FIB cross-sectioning, FIB-SEM tomography including 3D EDS/EBSD microanalysis, UHR-SEM imaging of beam sensitive materials and IC layout/defect navigation according GDSII or KLARF data on die level or wafer level.

In this brochure, you will learn more about key features that make Tescan SOLARIS 2 the ideal solution to maximize your TEM sample preparation throughput and lower the cost per sample.

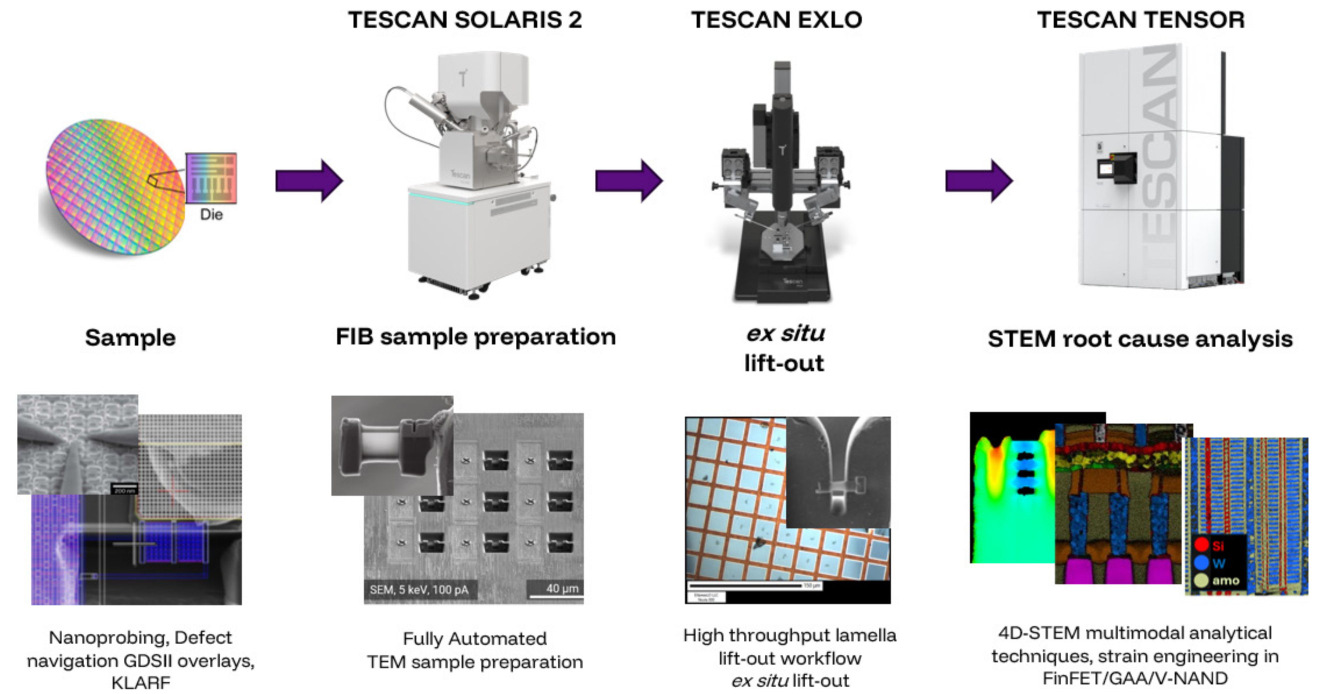


(top right) 30 µm-wide SiC substrate cross section prepared in 15 minutes with excellent surface quality. (bottom) Array of automatically prepared lamellae ready for *ex situ* lift-out process prepared by TEM AutoPrep™ Pro.

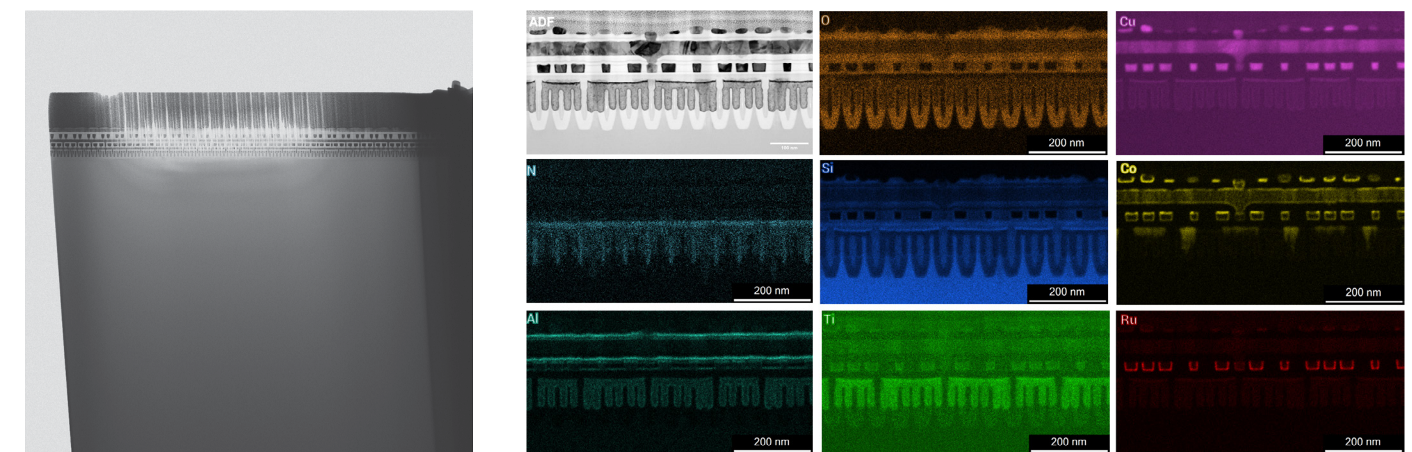
Comprehensive Semiconductor Analysis Workflow with Tescan

From initial sample inspection to root cause analysis, Tescan offers a fully integrated solution for semiconductor failure analysis/R&D and quality control. This multimodal approach supports strain engineering in FinFET, GAA, and V-NAND technologies, delivering precision and efficiency at every stage.

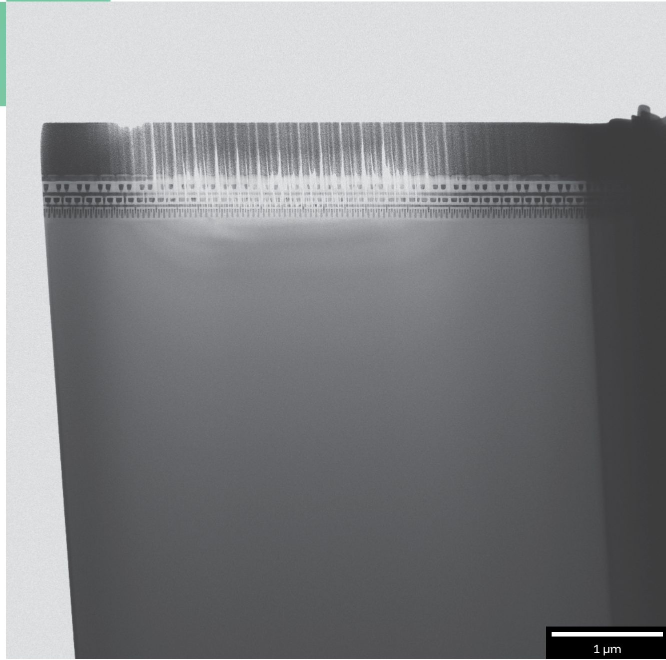
Semiconductor FA/R&D/Metrology workflow using Tescan instruments.



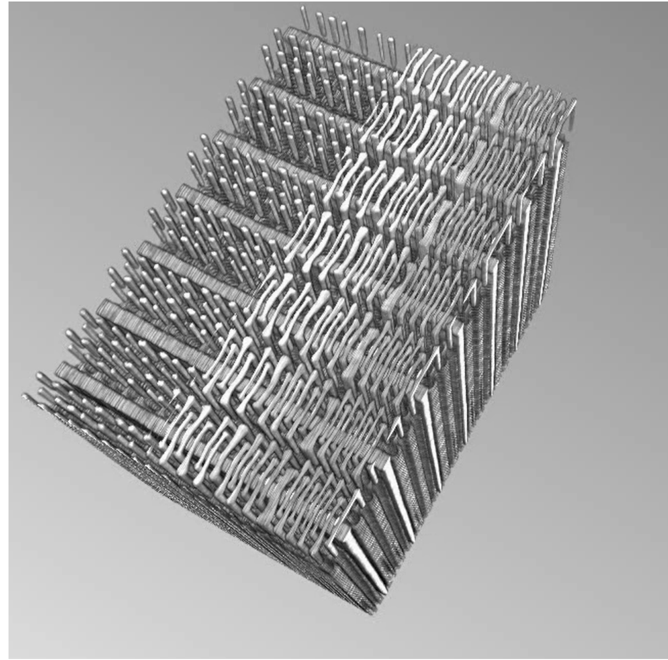
Less routine, more focus on results and their interpretation



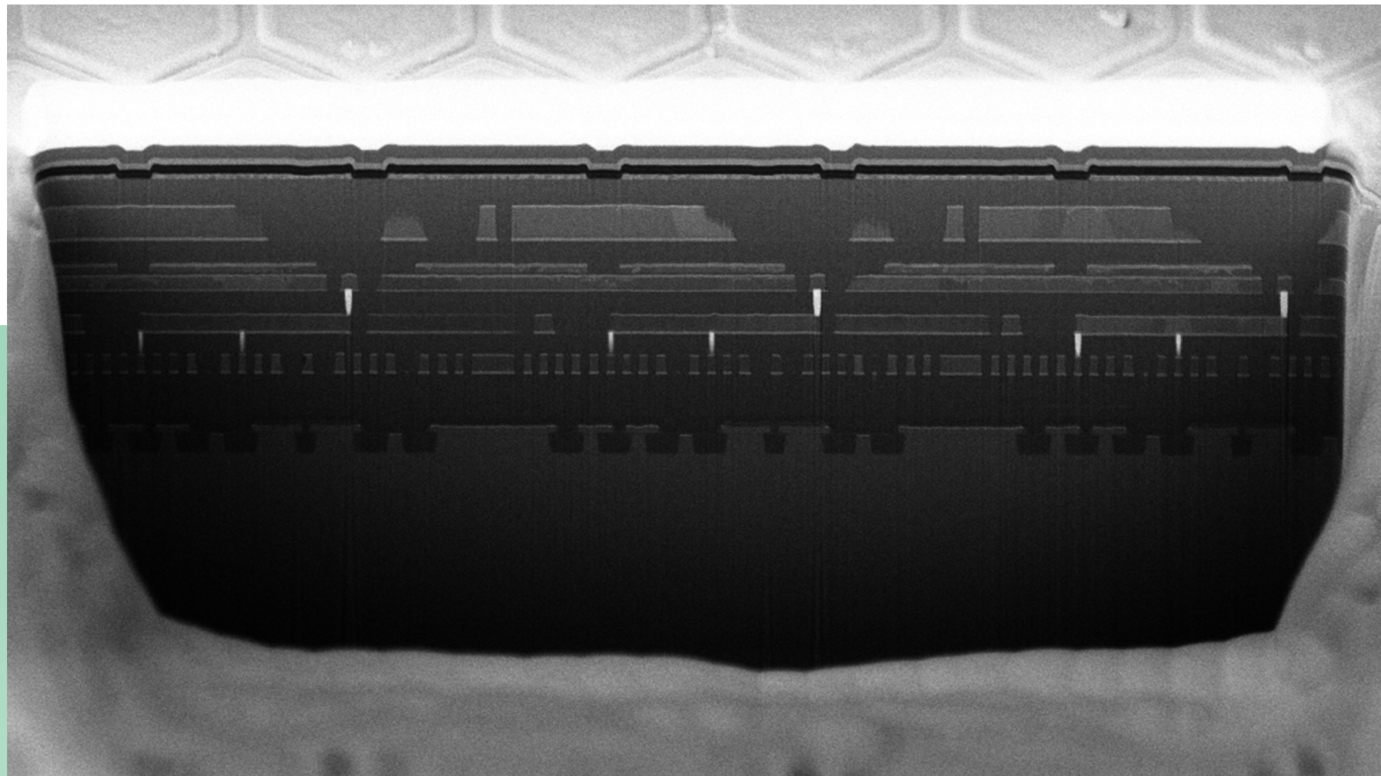
left) Inverted TEM sample from 3-nm FinFET transistors in Fin-cut orientation. (right) Bright-field STEM and EDS compositional analysis of the 3-nm FinFET sample done by multimodal analytical



STEM microscope (Tescan TENSOR).



Tomographic visualization of 3D NAND composed from 7 nm thin slices (1400 in total). The grayscale intensity interval is based on the In-Beam BSE signal to differentiate between memory cells and contacts.

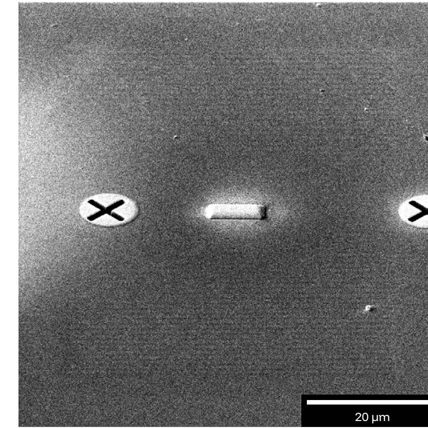


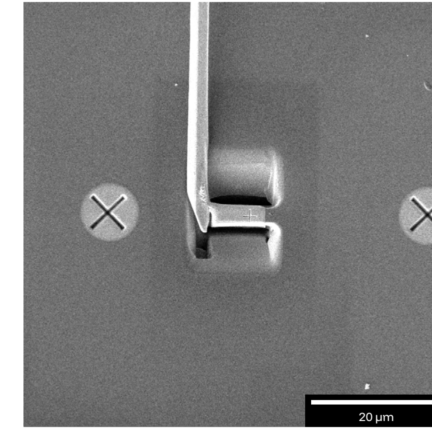
30 µm wide OLED display cross section prepared in less than 30 minutes. Mid-Angle BSE image at 2 keV.

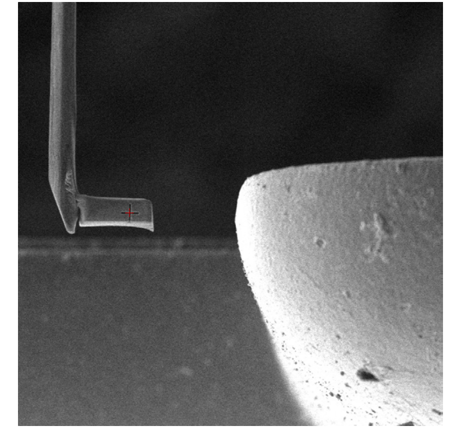
Maximize Productivity in Your Lab with Automated FIB-SEM Workflows

AI-Powered Automated TEM Sample Preparation

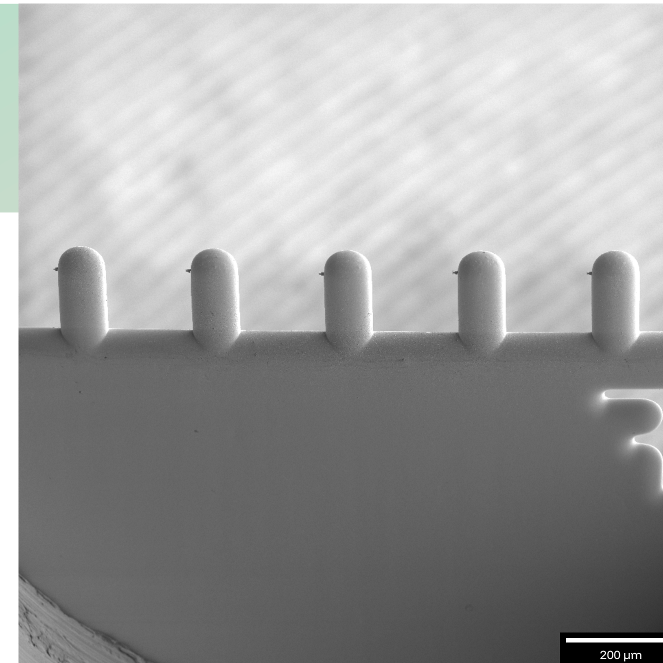
The workflow begins with marking and protection layer deposition to prepare the sample surface. Next, needle attachment and bulk cutting are performed to isolate the region of interest. This is followed by lamella lift-out and attachment to a TEM grid. Once the grid is populated with five TEM samples, on-grid thinning is carried out using both high keV and low keV milling to achieve the final electron-transparent lamellae.

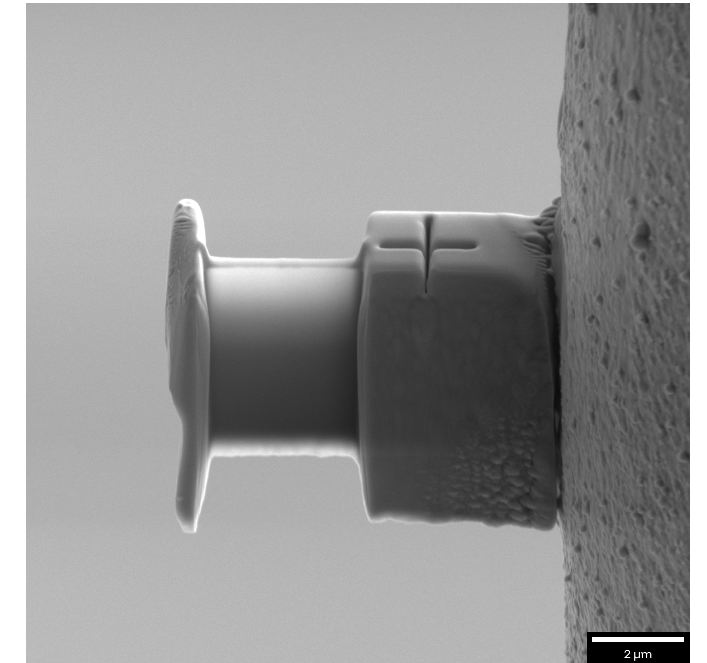






(left) Marking and protection layer deposition (center) Needle attach and bulk cut (right) Lamella lift-out and attachment

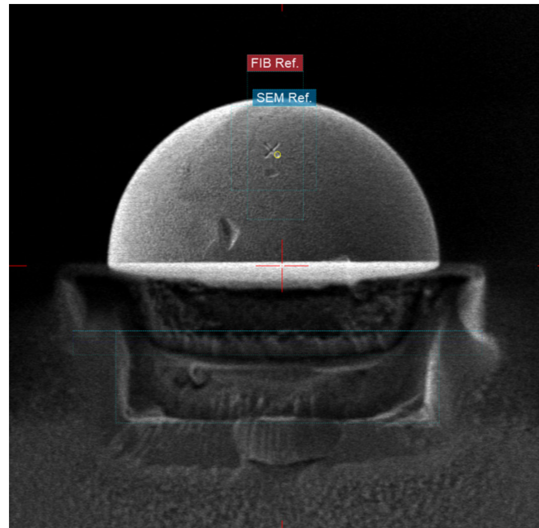


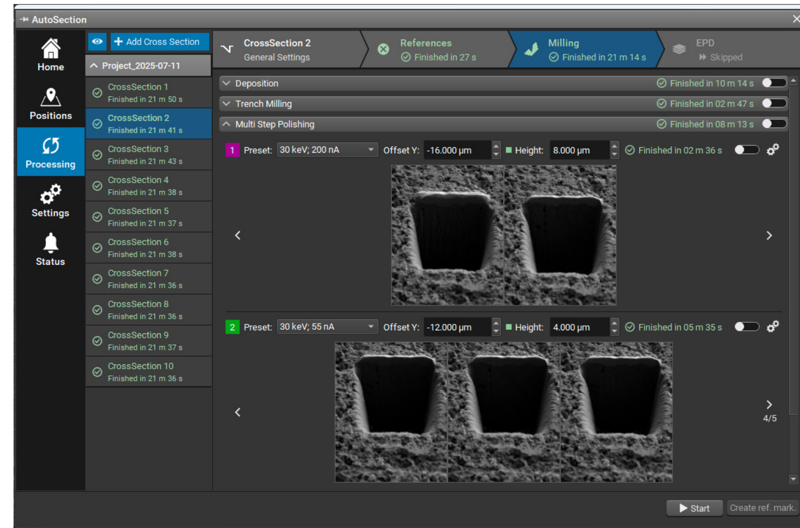


(left) Grid populated with 5 TEM samples (right) On-grid high keV and low keV thinning

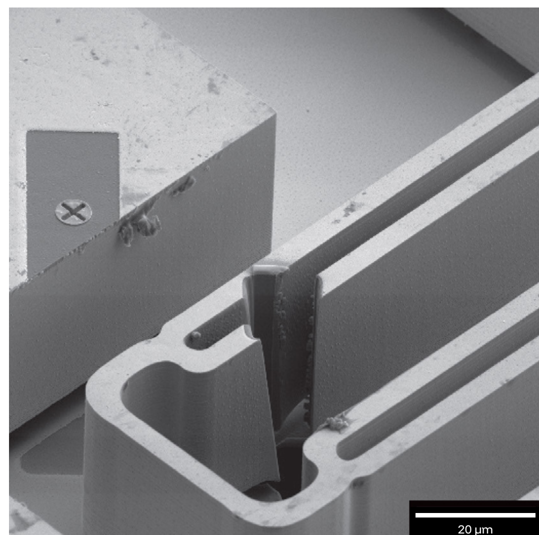
Automated FIB Cross Section Preparation

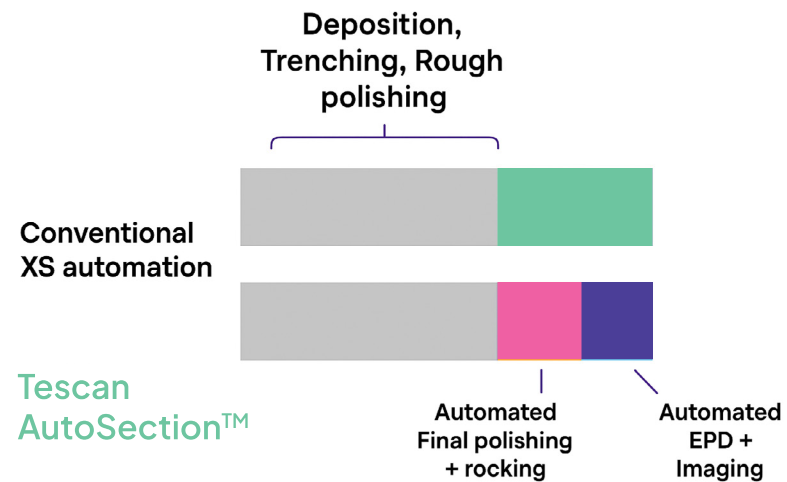
The software automates multi-site cross-sectioning to free operators for higher-value tasks, handling routine preparation without expert supervision. It maintains speed and quality on tough materials through Rocking Polishing, delivering fast, clean results even for challenging samples. The system provides precise navigation and alignment using optical, CAD, or micro-CT inputs, and ensures accurate stopping of the polishing process with automated endpointing based on sample feature dimensions (e.g. diameter of the solder bump) or total object area.





(left) Automated end-point detection on final FIB polishing to the center of the solder bump. (right) Tescan AutoSection™ GUI allows simple and straightforward definition of multi-site cross-sectioning tasks.

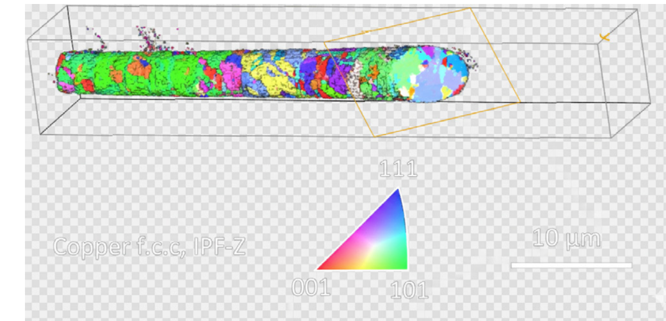


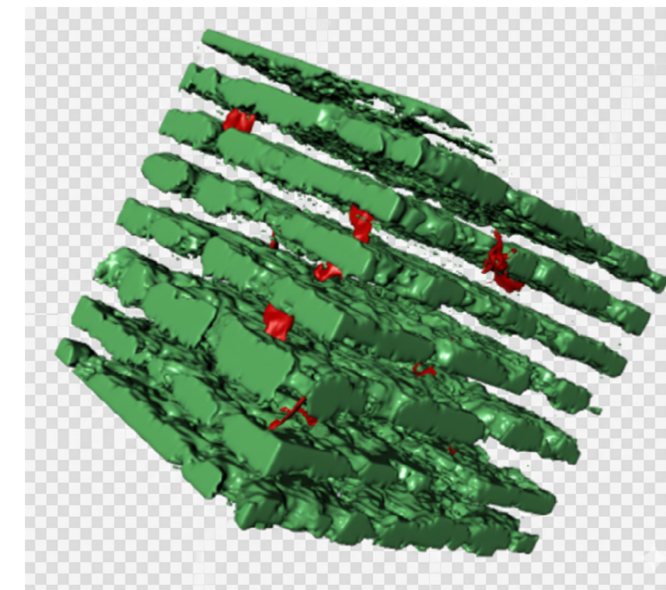


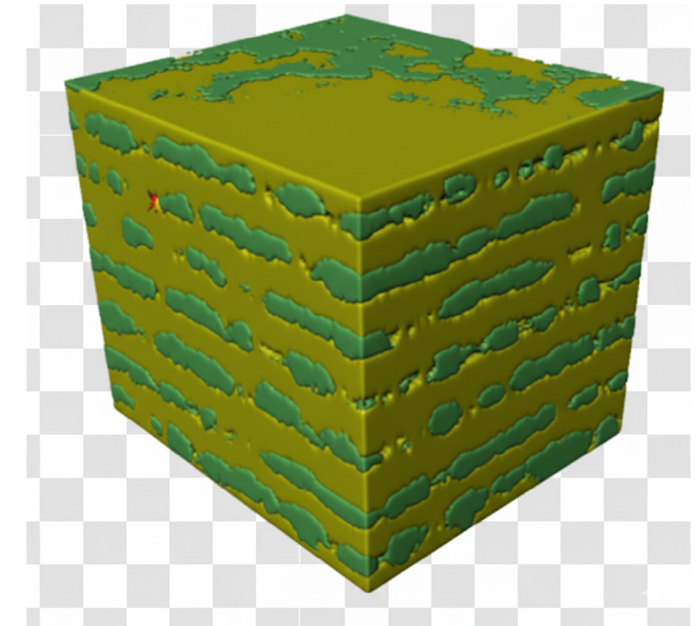
(left) Automated cross-section on MEMS device, showing the possibility of usage even on surface topography-challenging samples. (right) Tescan AutoSection™ allows to automate more preparation steps enabling to process more samples per shift/overnight compared to conventional solutions.

3D EDS/EBSD FIB-SEM tomography

Traditional EDS/EBSD gives 2D compositional and crystallographic maps. But in advanced semiconductor devices, materials are layered and structured in complex 3D geometries. Tescan's Essence Tomography module combined with Tescan 3D Viewer software allows researchers to easily collect datasets and visualize structure, composition, and crystallography in 3D. Making it possible to detect buried interfaces, diffusion zones, and understand failure mechanisms.







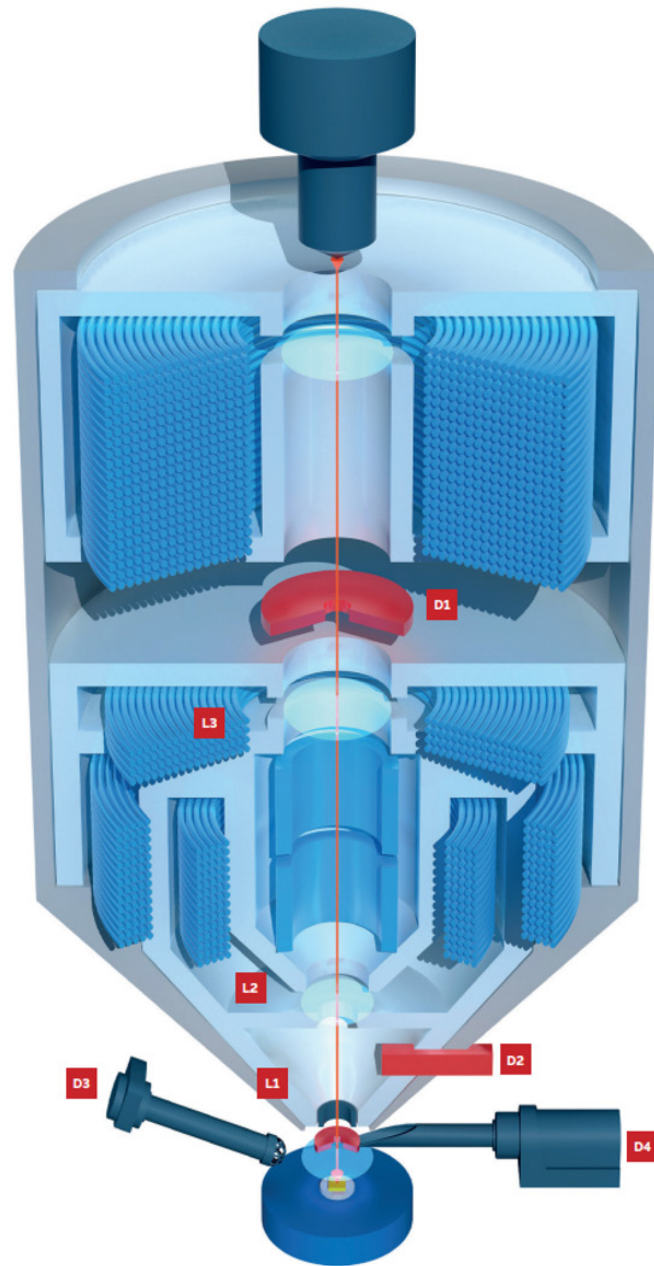
(top left) 3D EBSD visualisation of a single 5×50 µm copper TSV with virtual cross section at an arbitrary angle. (top right) 3D visualisation of MLCC volume (25×25×25 µm3) from EDS data. Yellow – barium titanate ceramics, green – nickel plates, red – silicon inclusions (bottom left) 3D reconstruction of MLCC volume from EDS data. Green – nickel plates, red – silicon inclusions.

The Technology Behind Tescan SOLARIS 2 FIB-SEM

Tescan SOLARIS 2 is designed to deliver the highest quality TEM specimens from a wide range of electronic devices, including the latest in logic, memory, power semiconductors, and display technologies, providing reliable performance, accelerated learning curve and overall system stability for your most demanding sample preparation needs.

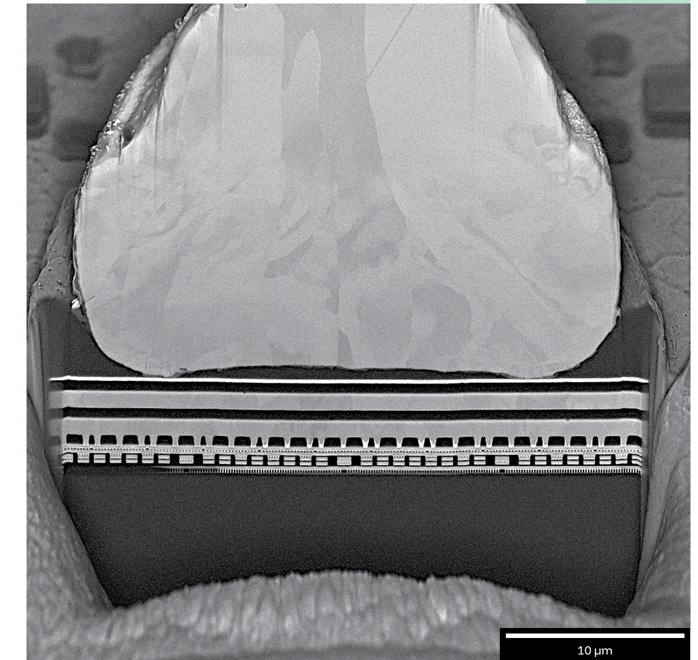
Ultra-high-resolution SEM with Triglav™ immersion optics

The powerful combination of Ga^{+} focused ion beam and UHR SEM with magnetic immersion optics is designed to deliver ultimate resolution and best signal strength at the FIB and SEM beams coincidence point. This integration ensures top-tier performance in SEM end-pointing – allowing to target single transistor lines in GAA or FinFET devices or stop exactly at the defect without overmilling the region of interest.

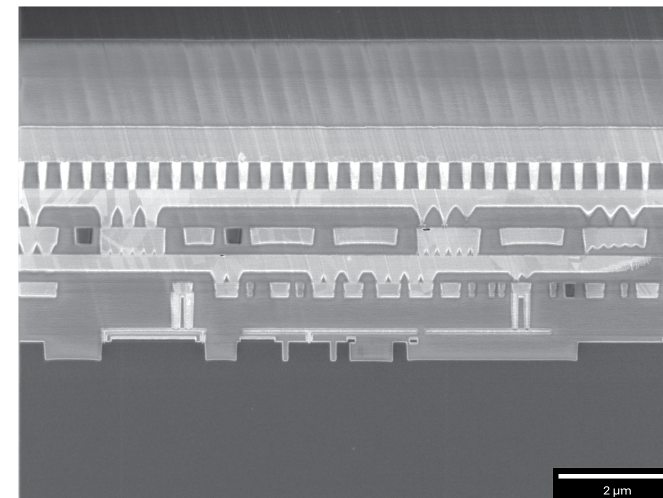


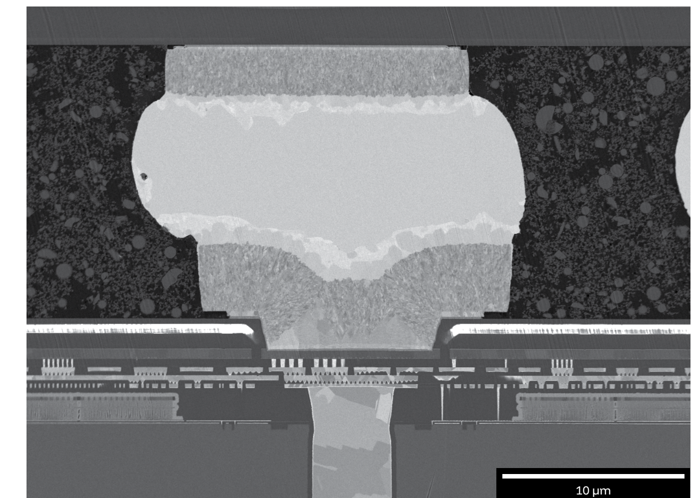
L1 UH-resolution lens, L2 Analytical lens, L3 Third objective lens, D1 In-Beam f-BSE detector, D2 In-Beam SE / Mid-Angle, BSE detector, D3 SE detector, D4 R-BSE detector.

Beam Deceleration Technology (stage bias 5 keV)*
* Optional equipment



(both) Au ball bond imaging at 2 keV, Everhart-Thornley SE detector.



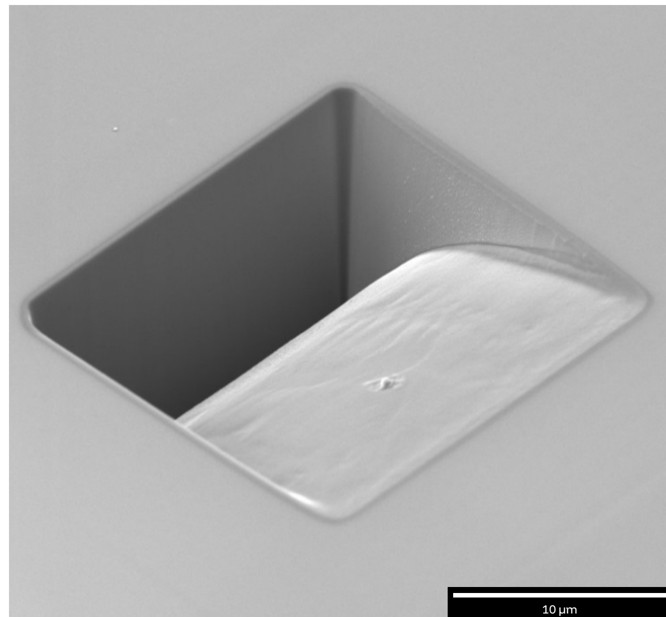


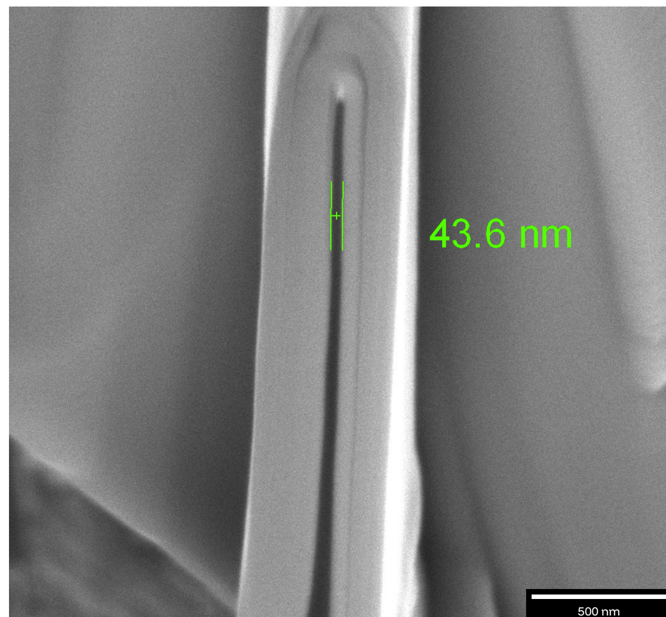
(left) 1 keV, InBeam SE detector. (right) 2 keV, InBeam f-BSE detector.

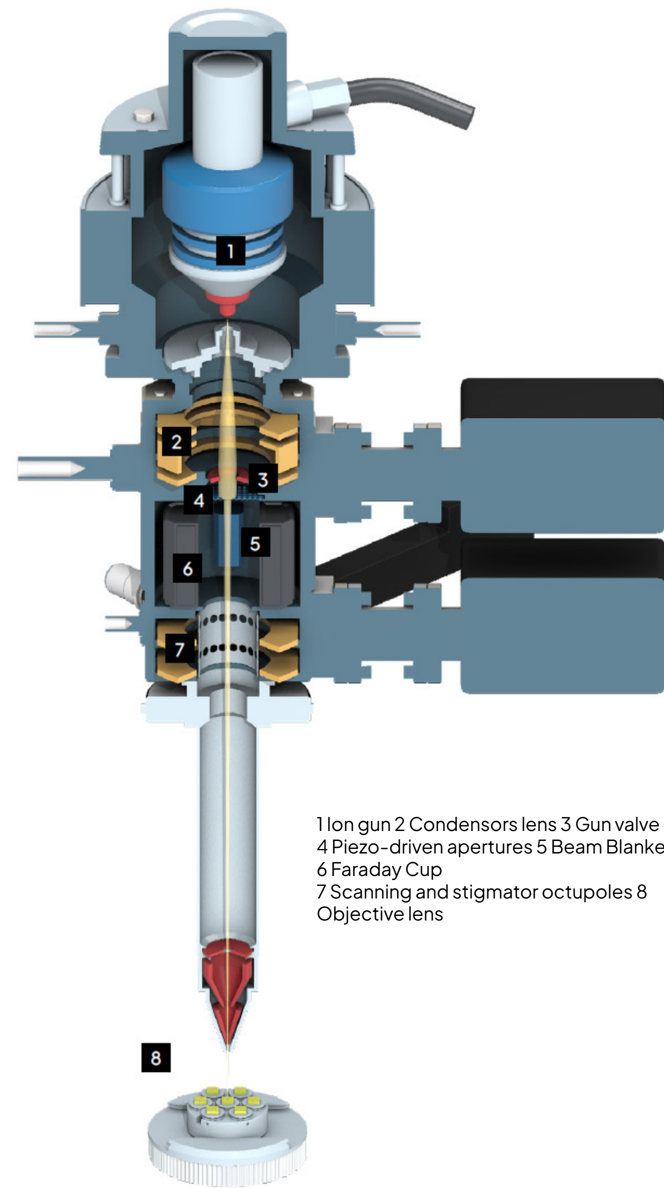
Imaging of integrated circuits is challenging due to their complex, multilayered structures and the presence of beam-sensitive materials (low-k dielectrics, metal interconnects). The Triglav™ SEM column, engineered for ultra-high-resolution imaging, delivers exceptional surface sensitivity and contrast to resolve even the smallest variances.

Orage™ 2 FIB Column

Orage™ 2 is Tescan's new Ga⁺ FIB column, engineered to push the boundaries of throughput and accuracy in TEM sample preparation, cross-sectioning, and general sample processing. Its enhanced spot profile at high beam currents accelerates milling by up to 40%, making high-volume lamella production more practical and reducing the cost per sample. Simultaneously, unmatched image clarity at 500 eV enables sharp, reliable imaging and polishing object placement during final lamella cleaning in manual and automated workflows in TEM AutoPrep™ Pro.

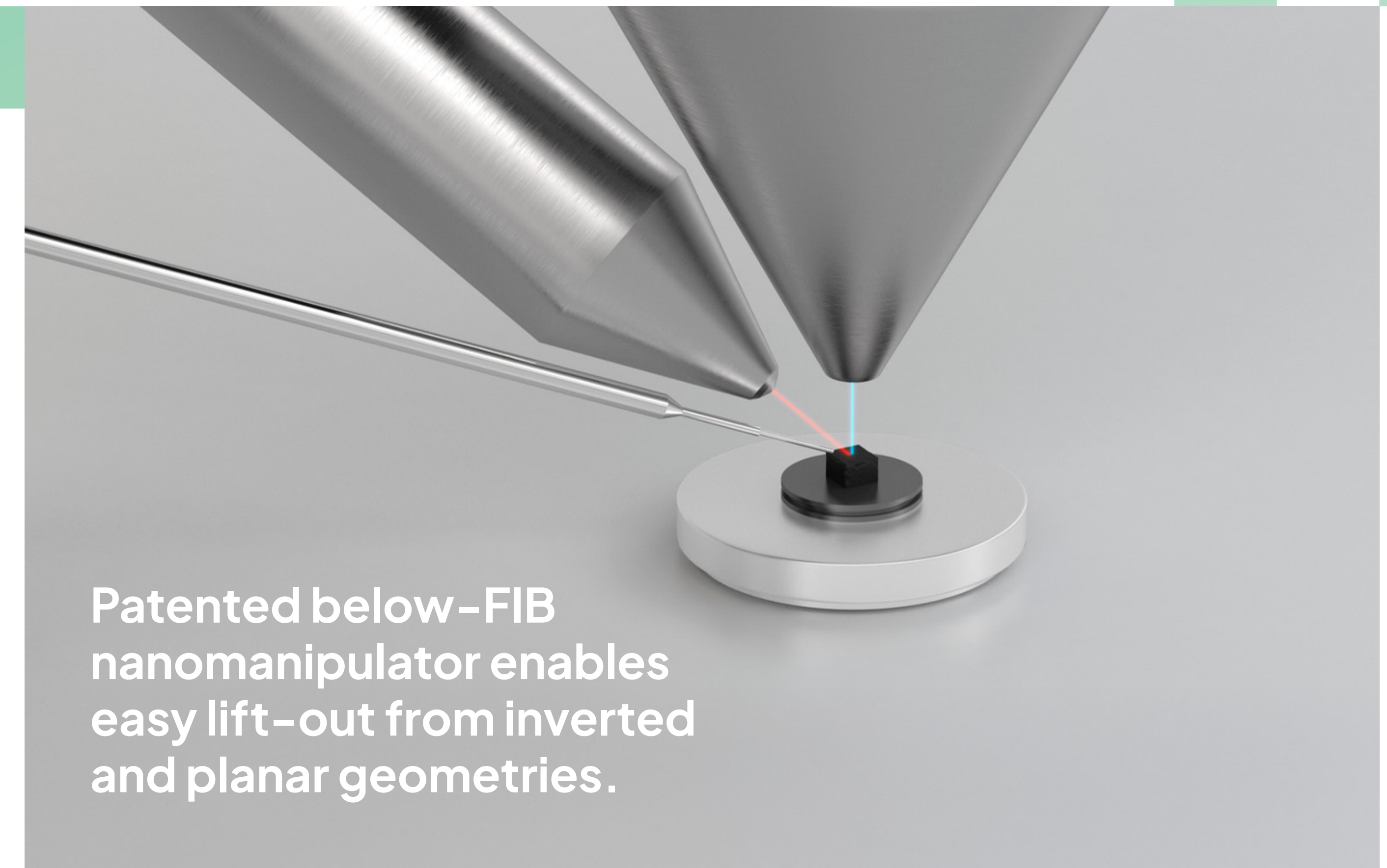


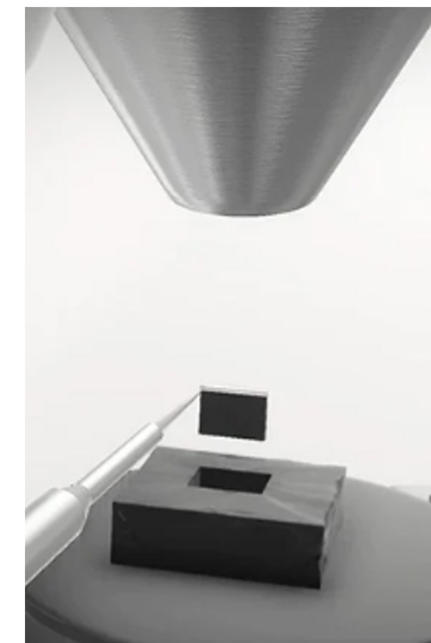




1 Ion gun 2 Condensors lens 3 Gun valve
4 Piezo-driven apertures 5 Beam Blanker
6 Faraday Cup
7 Scanning and stigmator octupoles 8 Objective lens

(up) Excellent edge sharpness and uniformly smooth cut-face achieved during fabrication of a large cross-section on a silicon sample using high-current FIB (20 nA). (bottom) TEM sample prepared on silicon using Orage™ 2, demonstrating excellent thickness uniformity across the entire sample area. Precise thickness measurement (43.6 nm) and shape evaluation were performed in cross-lamella geometry.





Unique, patented position of the nanomanipulator below the FIB enables preparation of planar, inverted, and other TEM sample geometries with ease.

Achieving top-down, inverted, and plan-view TEM sample geometries in a single step—without breaking vacuum or using additional sub-stages — is now possible thanks to our patented below-FIB nanomanipulator design. Tescan SOLARIS 2 leverages this Innovation in combination with Tescan OptiLift™ 4-axis nanomanipulator to enable quick and intuitive lamella manipulation directly on the probe tip. This geometry allows the lamella to be rotated 360° within the FIB column plane, simplifying the entire inverted or plan-view TEM sample preparation process.

Boost your analyses to the next level

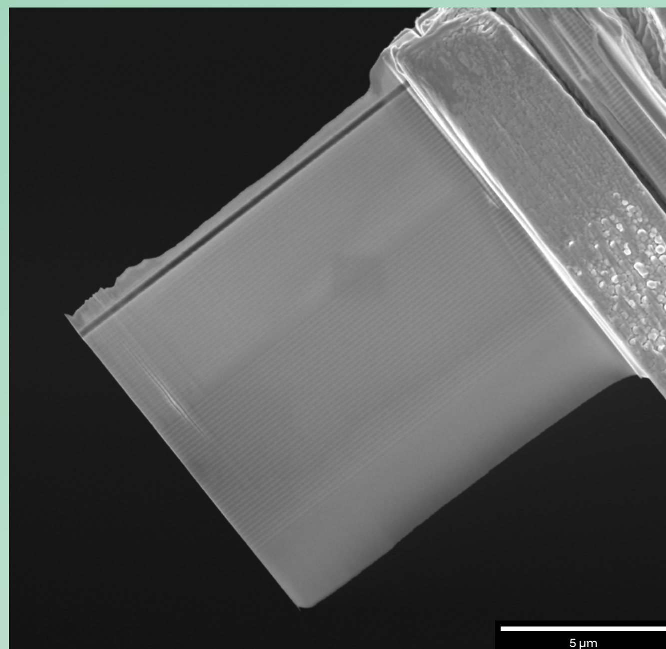
Step into the future of semiconductor innovation with Tescan SOLARIS 2—an advanced FIB-SEM platform featuring a modular extension ecosystem.

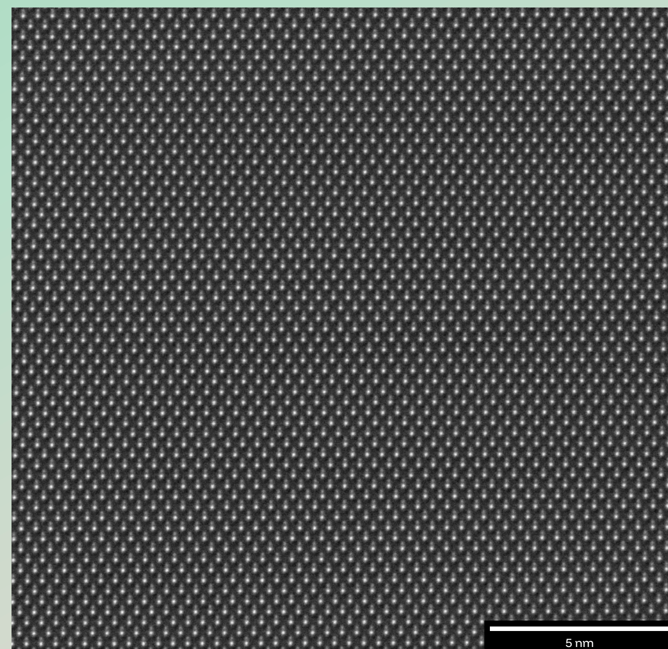
The highest quality TEM specimen preparation with FIB-SEM integrated AURA™ Gentle Ion Beam

The AURA™ Gentle Ion Beam integration with Tescan's FIB-SEM platforms enhances workflow by providing a final polishing step that maintains the crystalline structure of the TEM samples for high-end (S)TEM measurements and applications. Operating at energies as low as 200 eV or even below, the Argon ions interact gently with the sample, ensuring minimal disruption while effectively removing amorphous damage layers. This ensures that TEM specimens are of the highest possible quality and free from the damage layers.

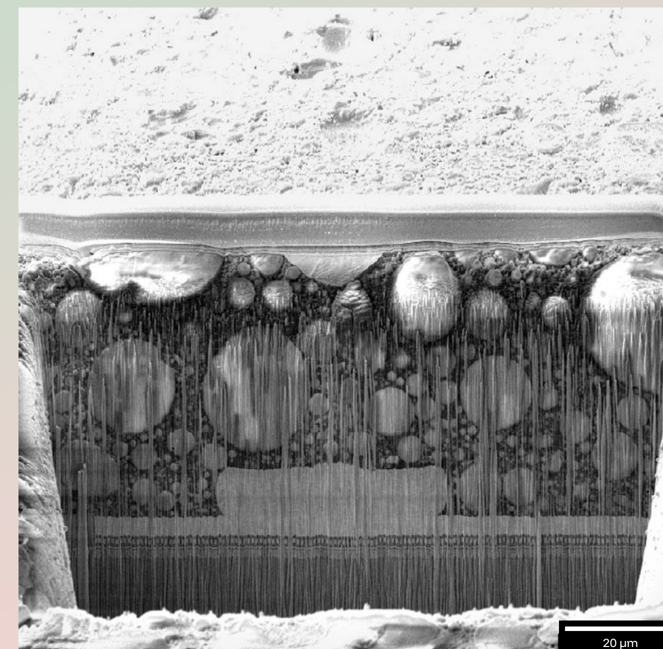
Artifact-Free FIB Cross-Sectioning with Tescan Rocking Stage

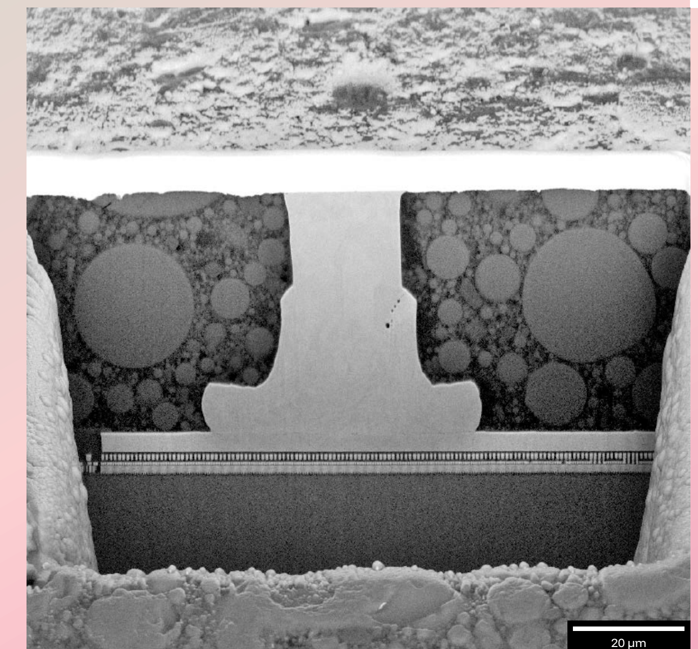
Preferential milling in mixed hard/soft materials, surface topography, or internal sample geometry (e.g., vertical interconnects in semiconductor devices) can result in FIB-induced curtaining artifacts. In such cases, it is recommended to use the Tescan Rocking Stage, which enhances final surface quality by tilting the cross-section plane while keeping high beam currents and therefore short processing times. The Rocking Stage enables precise end-pointing throughout the milling and tilting process by keeping the region of interest centered in the SEM image. This in-house designed Tescan solution maintains full FIB-SEM system compatibility with loadlocks, Beam Deceleration Mode, RSTEM detector, FIB-SEM Tomography and other.



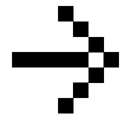


(left) The Brightfield STEM image of GaAs TEM sample polished at 200 eV with AURA™ Gentle Ion Beam integrated in Tescan SOLARIS 2 Ga^{+} FIB-SEM. (right) The high-resolution TEM image revealing an atomic structure of GaAs multilayer at high magnification.





(left) Surface of a large cross section following rough trench milling with the highest FIB current (100 nA) for faster material removal. (right) Surface of a large cross section polished by combining 20 nA FIB current and rocking polishing. Rocking polishing allows higher FIB currents to be used for final polishing which significantly speeds total analysis time.



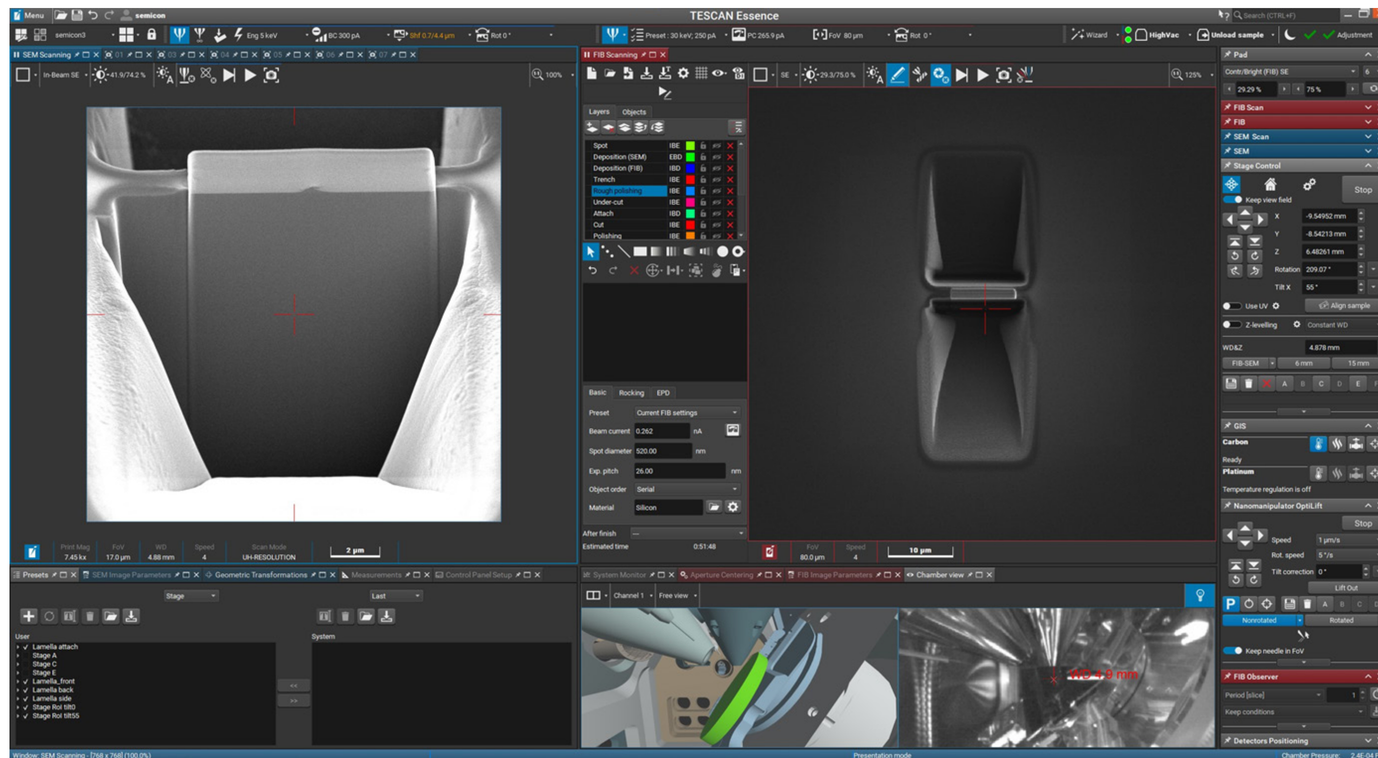
Tescan Essence™ Graphical User Interface: Fast, intuitive access to SOLARIS 2's core functions

Customizable for every user and workflow — boost productivity with smart modules, wizards, and recipes.

Essence™ software

Tescan Essence™ graphical user interface brings the full power of the SOLARIS 2 platform into a single, intuitive live-view environment. Its streamlined layout provides fast access to all key microscope functions, helping users get started quickly—whether they're new to FIB-SEM or transitioning from other systems. Guided workflows ensure consistency without the need to memorize steps, while advanced modules enable AI-driven automation of complex processes. For tailored workflows, Python-based custom scripting with GUI integration supports rapid prototyping to meet specific lab needs.

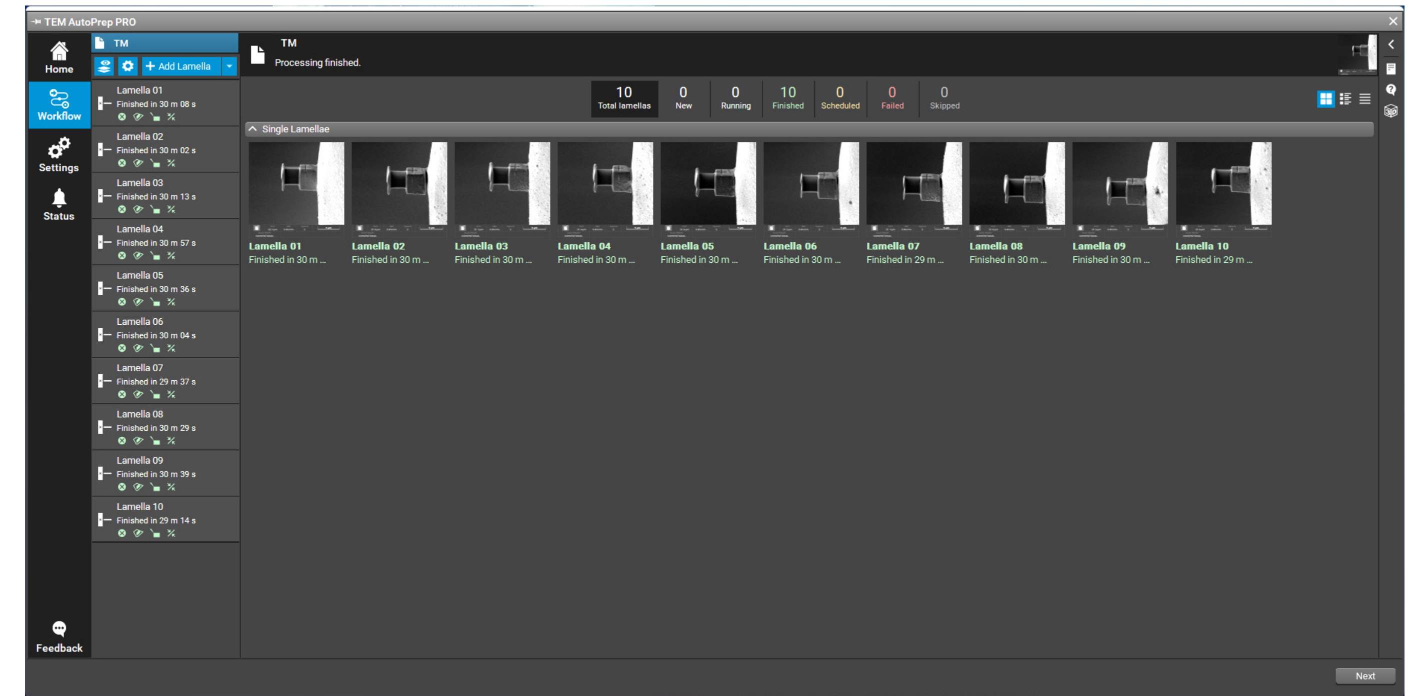
Example of Essence™ software layout for TEM sample preparation. Layouts can be personalized to a user's preferences or to streamline workflow execution. This layout shows both SEM and FIB windows and the camera view to guide live movement in the chamber. The microscope can be controlled using the icons above the SEM and FIB windows, or from the panel on the right.



AI-Powered TEM AutoPrep™ Pro

Tescan TEM AutoPrep™ Pro, a software module included in Tescan Essence™ GUI, delivers fully automated TEM lamella preparation for semiconductor R&D, failure analysis, and quality control. This AI-driven solution automates the entire TEM sample preparation workflow — including *in situ* lift-out, 30 keV on-grid thinning, and final low keV cleaning — ensuring high-quality sub-50 nm TEM samples ready for S/TEM analysis.

Automation significantly enhances the user experience, streamlining TEM sample preparation and enabling the production of high-quality TEM specimens from a wide range of device types — even by users without extensive FIB-SEM operational expertise. Automation also optimizes microscope utilisation with unattended, overnight operation and thus lowering cost per sample.

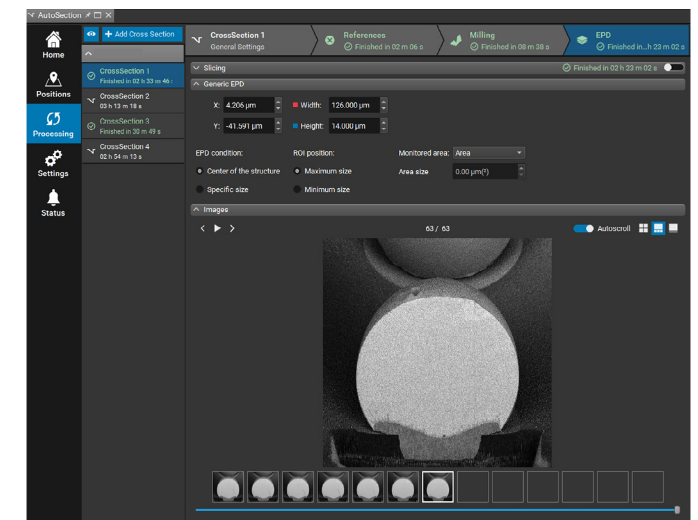


Tescan TEM AutoPrep™ Pro module enables semi-automated or fully automated AI-driven workflows on multiple locations and multiple samples with minimum user interventions during the setup and processing.

AutoSection™ Smarter FIB Cross-Sectioning, from Start to Finish

Tescan AutoSection™ is a dedicated software module for automated multi-site FIB cross-sectioning, supporting the complete FIB cross-sectioning workflow. The module allows users to load bitmap reference files for defect navigation, perform automated rocking polishing, capture SEM images during cross-sectioning, and apply automated end-point detection on specific features to precisely stop FIB polishing at the desired location.

Designed for both routine and advanced workflows, AutoSection™ optimizes system utilization and operator efficiency. It is intended for research and industrial environments where reproducibility, throughput, and precision are of the key value.

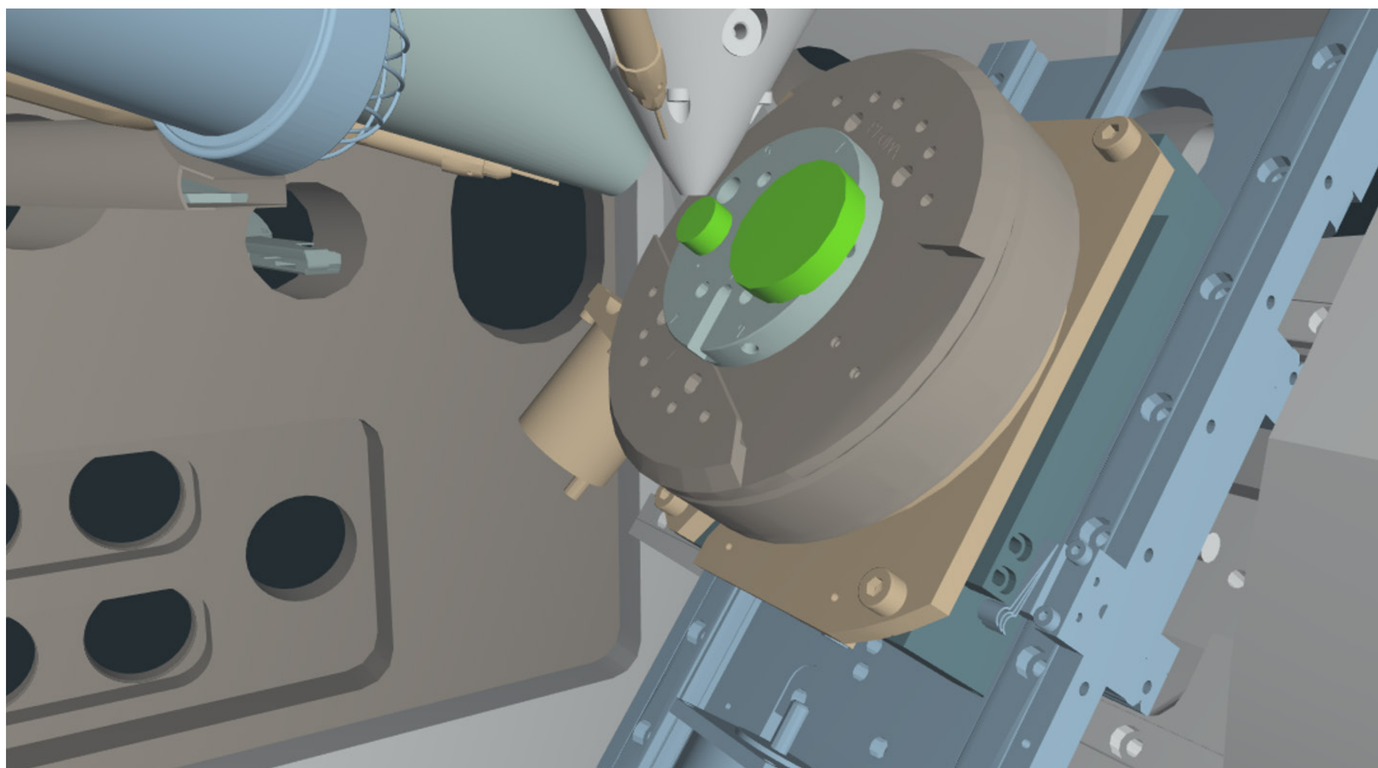


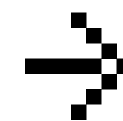
Tescan AutoSection™ module was designed for automated multi-site FIB cross-sectioning and correlative defect navigational workflows. It features end-point detection that automatically stops the FIB polishing process based on predefined conditions (e.g. max. diameter of the C4 bump).

Essence™ 3D Collision model

Essence™ 3D Collision Model is a software module in the Tescan Essence™ suite that helps prevent collisions between the sample, stage, and chamber hardware in FIB-SEM systems. It simulates the chamber interior and predicts hardware movements, allowing users to preview stage motion, sample tilting, and detector positioning to ensure safe, collision-free operation. This functionality can be invaluable in situations where the user has loaded multiple samples or holders with different heights.

The 3D Collision model shows blocks representing the dimensions of samples on the stage, as well as showing other hardware components, to provide a virtual view inside the chamber for collision avoidance.





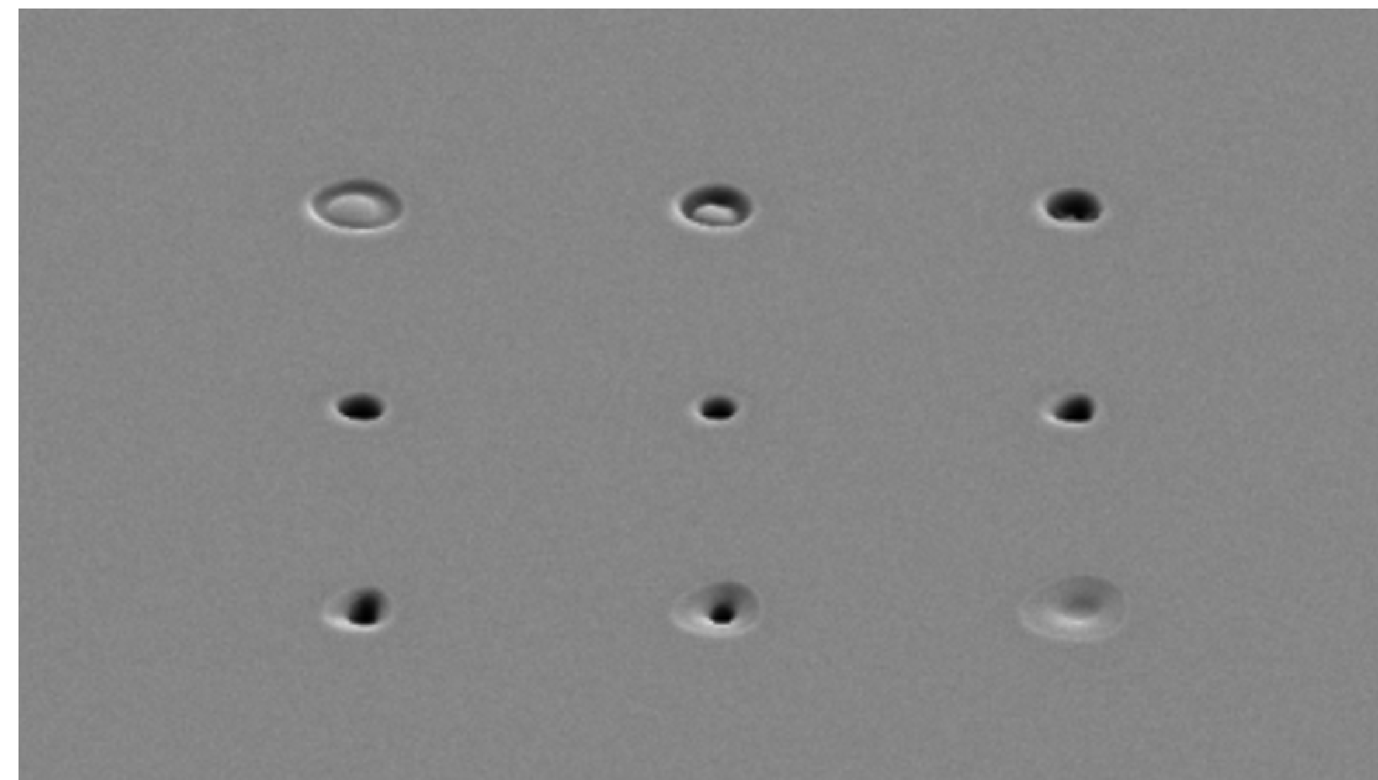
Tescan Essence™ Advanced Functions

Tescan Essence™ is designed not only to simplify microscopy for new users but also to empower advanced users with sophisticated software modules. These modules enable precise control over specific operational parameters to suit various applications. Below are some of the commonly selected advanced modules for Tescan SOLARIS 2 FIB-SEM.

Optimized alignment of FIB and SEM

Before initiating any automated TEM sample preparation process, it is essential to ensure that the FIB-SEM system has properly aligned user presets for FIB and SEM columns.

To address this requirement, the system integrates the FIB Auto Preset Tuner software, which performs automated FIB/SEM beam alignments — such as beam centering, astigmatism correction, and focusing — using a dedicated alignment sample. This process can be executed during unattended operation (e.g., overnight) to maintain optimal system readiness. The module enables stable operation for users without advanced FIB-SEM expertise, while still allowing experienced users full control for manual fine-tuning of parameters as needed for specialized workflows.

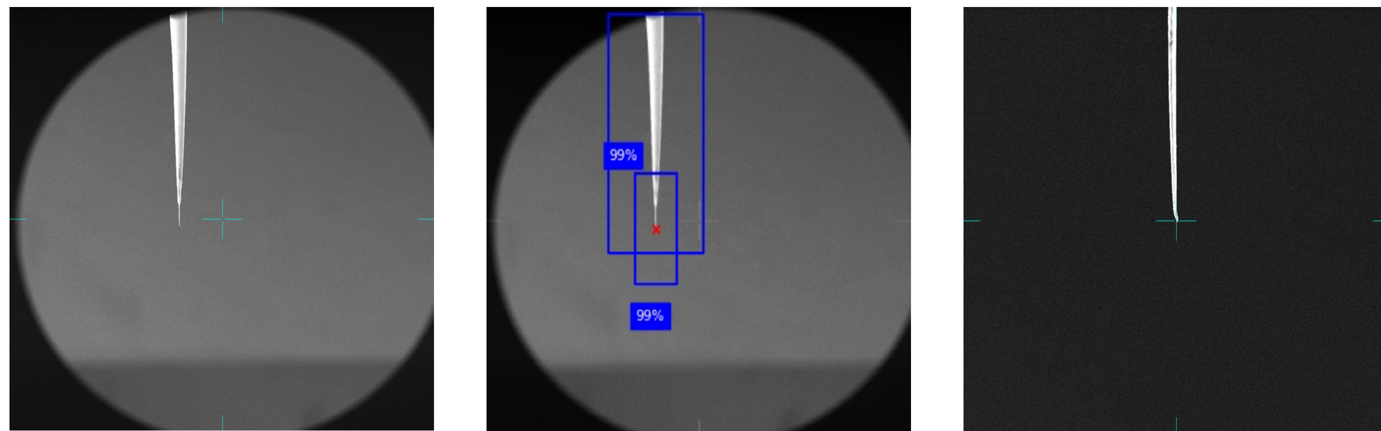


FIB spot tuning with FIB Spots Optimizer

Precision tip-shaping and alignment

Maintaining a sharp needle tip is essential both for geometric precision during manipulation and for accurate detection by AI recognition algorithms. The automation package addresses this by incorporating an automated self-cleaning function during lamella cutting, which preserves needle sharpness. When sharpening becomes necessary, an integrated wizard guides the user. By combining needle tip rotation with FIB-based cleaning, the system restores the tip to its optimal geometry and alignment to the center of the SEM and FIB live window, ensuring consistent performance in subsequent operations.

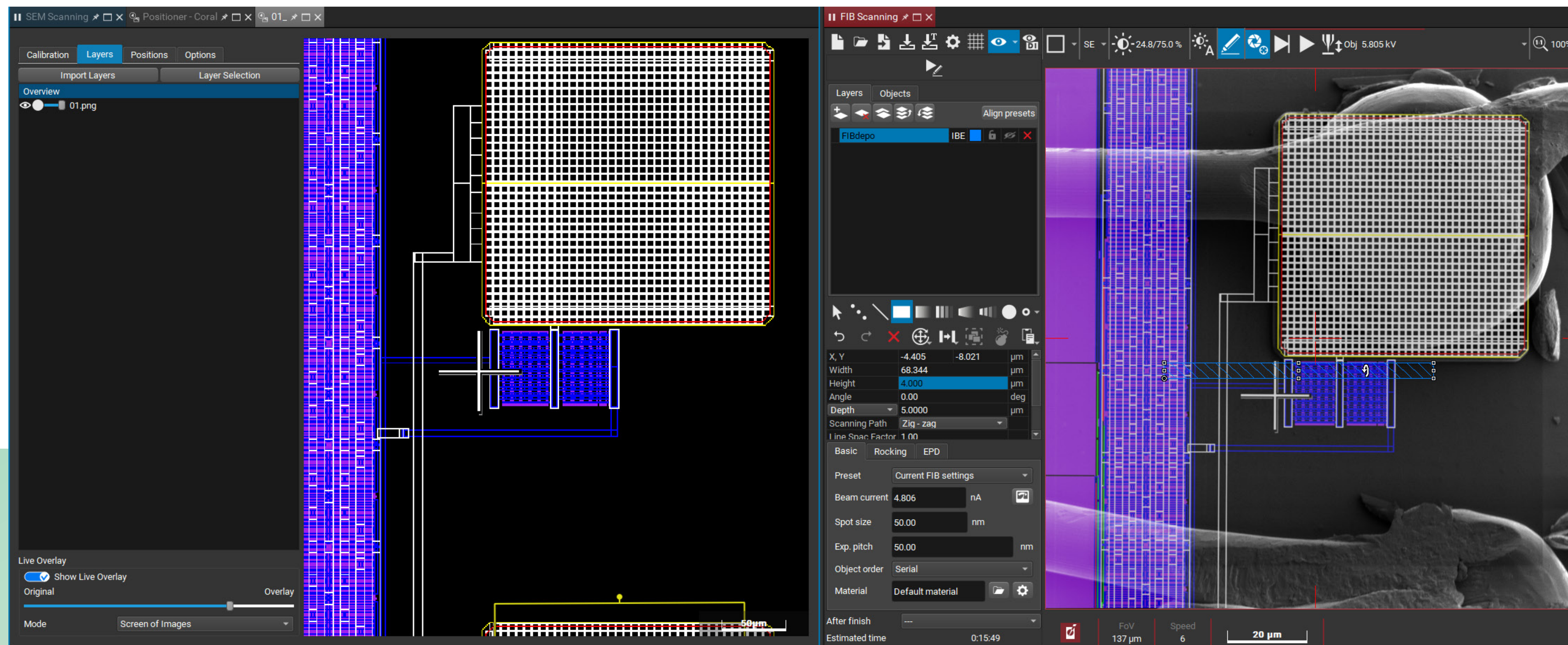
(left) Misaligned needle (center) Needle detection (right) Aligned needle into the center of the SEM live window.



Automation with flexibility of scripting

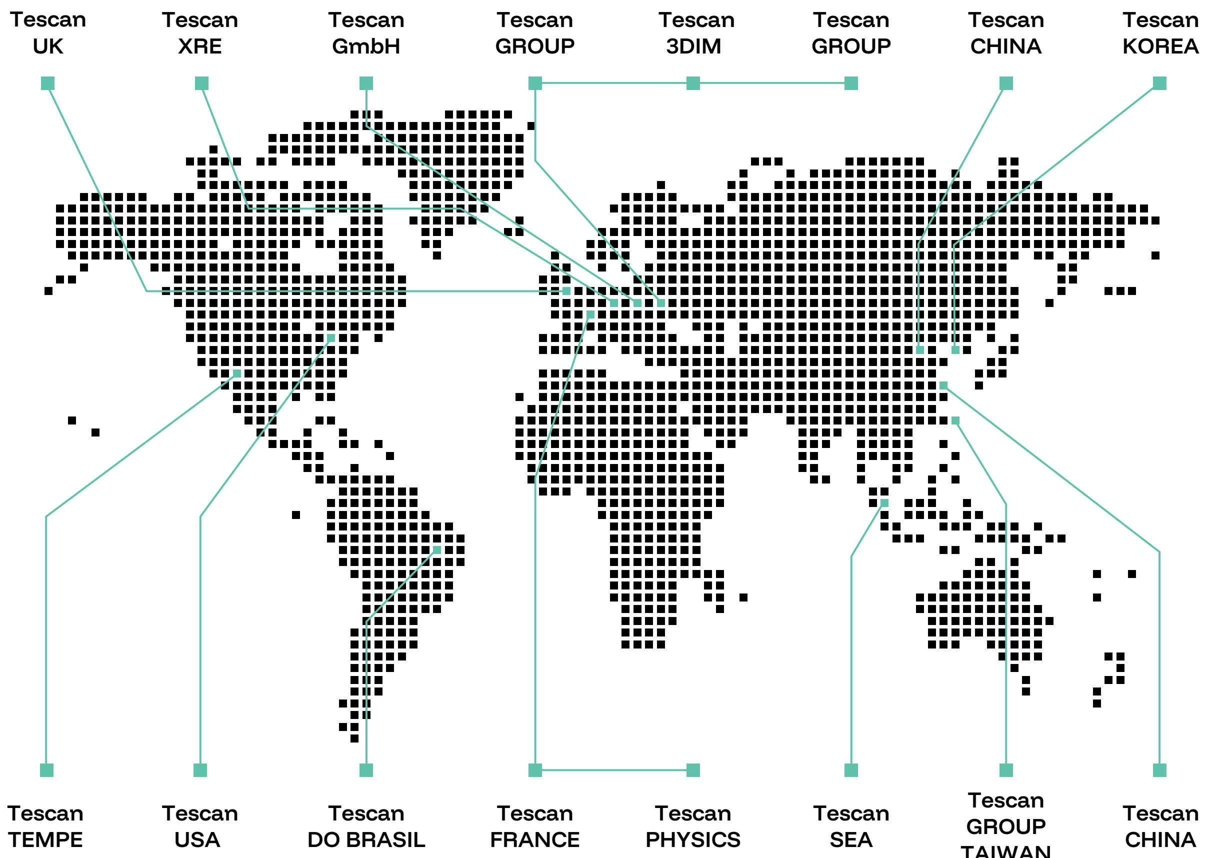
Tescan Essence™ supports Python scripting, enabling advanced automation of FIB-SEM microscopes. Experienced users can develop custom scripts for enhanced control, particularly in non-standard procedures or specialized applications (e.g. automated imaging of coupon-type samples). For non-programmers, the Tescan VisualCoder™ graphical interface allows intuitive control of key microscope components—including electron and ion beams, stage, and more — enabling rapid creation of custom applications without requiring deep programming knowledge.

The Positioner module uses GDSII layout data to overlay the FIB image window, enabling easy navigation to areas of interest and precise end-pointing of the FIB cross-sectioning process of the IC device.



Navigation to specific coordinates

Tescan Essence™ offers several software options for navigating to desired ROIs or defect locations on small samples and full wafers (up to 300 mm), supporting FIB-SEM sample preparation in semiconductor physical failure analysis. Navigation is typically based on coordinate, layout (GDSII) or bitmap image files, which can be obtained from a typical failure and defect localization tools such as micro-CT, Scanning Acoustic Microscopy, wafer defect data (KLARF). This navigational data can be overlaid on live SEM and FIB images to enable fast sample navigation and precise end-pointing during FIB work, or used for direct point-to-point navigation (Tescan Positioner™). Additionally, dedicated software module (Tescan Defect Navigation) enables possibility to start automatic analysis including automatic SEM imaging on filtered list of defects according to various criteria such as defect size, defect type, die number etc.



Tescan Family
Around the World

Tescan enables nanoscale investigation and analysis within the geosciences, materials science, life sciences and semiconductor industries. The company has a 30-year history of developing innovative electron microscopy, micro-computed tomography, and related software solutions for customers in research and industry worldwide. As a result, Tescan has earned a leading position in micro- and nanotechnology.

For more information visit: www.tescan.com

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