TESCAN

S8000X

TESCAN
PERFORMANCE IN NANOSPACE

New generation of FIB-SEM microscope

- iFIB+™ Xe plasma FIB column
- BrightBeam™ electron column
- Field-free UHR SEM
- Low-kV resolution
- Resolution
- Selective signal collection
- UniVac
- IC planar delayering
- Nanoprobing
- Cross-sectioning
- FIB-SEM tomography

Unique analytical platform for large-volume sample characterization and maximum universality in sample preparation

TESCAN S8000X is the most versatile and universal analytical Xe plasma FIB-SEM platform in the market enabling large-volume sample characterization and Ga-free sample preparation and modification. The combination of field-free UHR enabled by the BrightBeam™ SEM column, and the powerful yet precise milling capabilities delivered by the new iFIB+ Xe plasma FIB column, make the TESCAN S8000X the ideal platform for planar delayering, low-kV SEM inspection, and electrical nanoprobing of sub-20 nm node technologies. Physical failure analysis of semiconductor devices that require large-volume sample FIB-processing, such as large-area cross-sectioning in packaging and MEMS, and large-scale 3D micro-characterization of any material are also target applications of the TESCAN S8000X.

- **Gas-assisted Xe plasma FIB delayering and proven recipes**

  The combination of dedicated proprietary gas chemistry with Xe plasma FIB makes it possible to conduct top-down planar delayering of sub-20 node technologies that is suitable for subsequent in-situ electrical nanoprobing. Our proven recipes guarantee excellent uniform planarity in windows that can be larger than 200 × 200 µm² and opened at any location on the chip.

- **Xe plasma FIB column with high ion beam currents and unmatched FoV enabling extremely large-area cross-sectioning**

  The new iFIB+ column enables a large field-of-view of 1 mm at 30 keV for smooth and easy sample navigation, and in combination with high currents, extra-large cross-sections in packaging technologies, MEMS, and other large semiconductor and optoelectronic structures can be completed with ease in short time frames. This is a concrete solution to simplify complex physical failure analysis workflows for both FEOL and BEOL processes.

- **Making the most of electron and ion beam capabilities**

  The new OptiGIS™ is a fast, efficient and high-performance single gas injection system (GIS) essential in all your FIB applications. Up to 6 units can be fitted for maximum versatility and multitask configurations. Different proprietary gas chemistries for top-down IC uniform planar delayering are available.

- **Maximum precision and optimal FIB performance with ease**

  The new iFIB+ column is fitted with an ultra-stable HV supply and precise piezo-driven beam aperture changer allowing ultra-fast switching between FIB presets and high reproducibility. In addition, a semi-automated spot-optimizing wizard allows users to easy select the best beam spot that optimises FIB milling conditions for the particular application.

- **Ga-free sample preparation preserve physical properties of samples unchanged**

  The inert nature of Xe ions prevents the formation of intermetallic compounds with atoms of the milled sample that can result in changes in physical properties of the specimen and, therefore, interfere with electrical measurements or sample microanalysis.

- **Maximum surface sensitivity and versatility in sample characterization**

  The BrightBeam™ SEM column delivers field-free ultra-high-resolution imaging with an excellent performance especially at low beam energies. The electron optics design, in combination with an optimised detection system, guarantees excellent electron signal collection even at ultra-low electron beam energies without relying on beam deceleration for maximum surface sensitivity and versatility in sample characterisation.

- **Enhanced surface sensitivity and maximum contrast**

  Detection system with angle-selective and energy-filtering capabilities gives you complete control on surface sensitivity and the option to explore with different contrast.

- **Reliability and best conditions for microanalysis**

  The BrightBeam™ SEM column comes with aperture optimization resulting in improved resolution at high electron beam currents and beneficial for fast

microanalysis. Thanks to the EquiPower™ lens technology, excellent column stability in time-consuming applications such as 2D and 3D microanalysis is guaranteed.

Enhancement of detection limits in TOF-SIMS analysis and no interference in the elemental spectrum (as opposed to Ga FIBs in which Ga+ peaks can interfere with the detection of other elements such as Ce, Ge and Ga itself).

Large wafer analysis

Thanks to an optimal 70° objective geometry design and a large chamber, SEM and FIB analyse of 8” wafers at any location are possible.

Complex applications easier than ever

The new TESCAN Essence™ software platform is a simplified, multi-user interface with a layout manager that enables fast and easy access to main functions. This user-friendly interface can be customized to best fit particular application, user skill level and preference. A wide range of SW modules, wizards and recipes make the FIB-SEM applications an easy and simple experience for both novice and expert users, thus boosting productivity and contributing to increase throughput in the lab. The new TESCAN Essence™ also offers the Advanced DrawBeam™ vector-based scanning generator for fast and precise FIB machining.

TESCAN Xe Plasma FIB: combining power and precision in one single instrument

Xe plasma FIB is a powerful microanalytical technique that has completely revolutionized the landscape and scope of FIB applications not only in science but also in industry as a whole. What makes Xe plasma FIB so powerful is its capability to achieve very high ion beam currents while maintaining beam quality, a feature that makes it suitable for large-volume milling tasks and the ideal choice to keep up with high throughput and productivity demanded by fabs and semiconductor foundries. The TESCAN S8000X is fitted with the new iFIB+™ Xe+ plasma FIB capable of generating high ion beam currents and an unmatched field of view that redefines conventional large-area FIB cross-sectioning while slashing sample preparation time.

The inert nature of Xe makes it the ideal ion specie to mill or to fabricate structures that require to be Ga-free to not interfere with subsequent measurements – this is the case of IC delayering processes that are followed by electrical nanoprobing, as well as fabrication of Hall probes and atom probe tips, or sample preparation in optoelectronic devices for the purposes of failure analysis.

Benefits:

- ✓ Extensive ion beam current range gives incomparable FIB versatility
- ✓ Up to 50 × faster milling rates than conventional Ga FIBs
- ✓ Large FIB currents for fast milling rates without gas-assisted enhancement
- ✓ Highly-localized and well-controlled sample modification and nanoengineering
- ✓ Significant reduction in surface amorphisation and ion implantation
- ✓ No intermetallic compounds formed during milling
- ✓ Xe ions enhance detection limits in TOF-SIMS analysis
- ✓ Shortest time-to-data, increased throughput, and productivity

TESCAN BrightBeam™ SEM column technology

The electron optics in the new TESCAN BrightBeam™ SEM column technology is based on a combined electrostatic-magnetic objective. A beam guiding tube in the whole column reduces beam broadening while preserving brightness. When the beam guiding tube is enabled electrons from the sample are driven into the column by the electrostatic lens and the signal collection is improved. In addition, thanks to such electron optics design, aberrations are significantly reduced, especially at low beam energies, and the beam is shielded and less susceptible to environmental astray magnetic fields. These features result in excellent quality imaging at low beam energies down to 50 eV, without relying on sample bias beam deceleration. The Wide Field Optics™ enables a variety of imaging and displaying modes including undistorted large field of view thus making operation and navigation across the sample easy, fast and comfortable.

In addition, the TESCAN S8000X is fitted with a robust multi-detector system that allows selectively collecting electrons according to their take-off angle and energy that results in maximum topographic and compositional information from the sample. Furthermore, both the E-T detector, which provides topographical contrast without edge effects, and the Multidetector with energy-filtering capabilities can be used for supressing charging artefacts. The detection system is optimized to maximize signal collection in the entire beam energy range.

Applications

Delayering and nanoprobing of sub-20 nm technology nodes

The TESCAN S8000X has proven to be an effective instrument that enables fully controlled delayering of sub-20 nm node technologies. Delayering is a failure analysis and fault isolation technique used in 3D IC semiconductor devices. It consists in removing top-down layer by layer of microchips, thus enabling SEM inspection at high resolution of the freshly exposed chip layers.

This is a quite complex process due to the heterogeneous composition of each layer. High degree of planarity is mandatory to guarantee easy access and proper contact of the nanoprobes used for in-situ electrical testing and fault isolation.

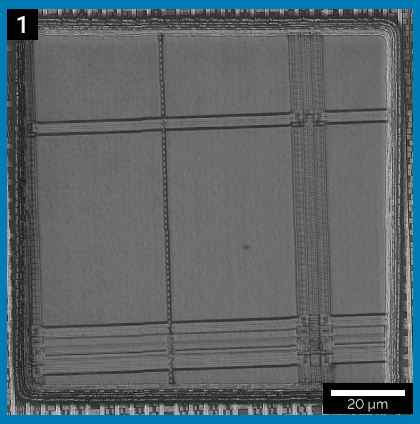
For this purpose, TESCAN has developed an effective gas-assisted delayering technique which combines Xe plasma FIB with proprietary gas chemistry resulting in excellent uniform planarity. A precise end-point detection provides full control of the entire process that can be stopped at any time at a desired metal or via layer. The TESCAN BrightBeam™, a field-free ultra-high-resolution SEM column is ideal to inspect freshly exposed bottom vias or contact layers at low beam energies without relying on beam deceleration suitable for voltage contrast. Unique topographic contrast assists in monitoring delayering processes.

Benefits:

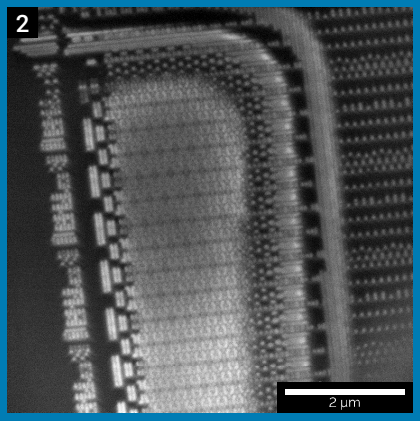
- ✓ Damage-free delayering of sub-20 nm technology nodes
- ✓ Large-area windows > 100 µm × 100 µm at site-specific locations with minimal damage to surroundings
- ✓ Proprietary gas chemistry for uniform planarity on physical layers and absence of layer intermixing
- ✓ Precise end-point detection
- ✓ Integrated probe shuttle for in-situ electrical fault isolation (EBIC, EBAC, RCI, current imaging)

Extremely large cross-sections

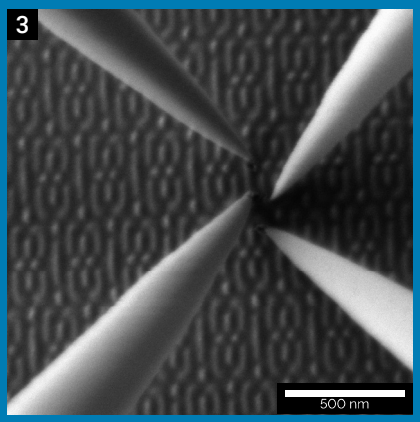
The TESCAN S8000X extends the capabilities of FIB by making large-scale sample analysis feasible. Cross-sectioning of areas of up to 1 mm wide are now tasks that can swiftly and routinely be performed. TSVs, MEMS, solder bumps, Cu pillars, bonding pads, whole BGA areas, and other large structures, can be effortlessly cross-sectioned with Xe plasma FIB for the purposes of physical failure analysis. The TESCAN S8000X has the capabilities that guarantee flawless and the smoothest cross-sections even for the most difficult materials such as dielectrics and composite samples where differences in milling rates of materials make cross-sections prone to FIB-induces artefacts.



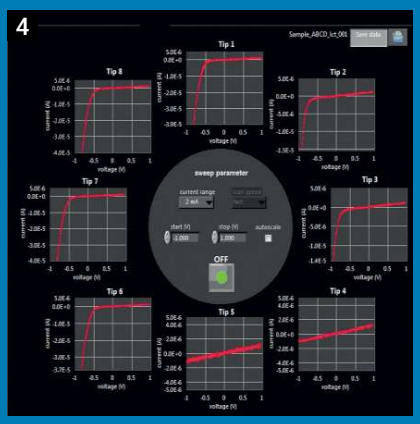
◄ **Fig. 1:** Overview of a 100 × 100 µm² delayered window on a 10 nm node technology.



◄ **Fig. 2:** Region of a delayered window imaged at 200 eV.



◄ **Fig. 3:** PMOS measurement on SRAM transistor bits on 10 nm technology acquired at 500 eV. Topographic contrast of the delayered area can be seen.



◄ **Fig. 4:** 6 probes acquiring transistor functionality.

Applications

Optimizing large-area cross-sectioning: no tradeoffs between speed and quality

The TESCAN Rocking Stage, a 6-axis piezo-movement stage, enables milling the sample from two different directions, a well-known technique for removing curtaining while making simultaneous SEM imaging possible. In addition, TESCAN has developed the innovative TRUE X-sectioning, a cross-sectioning technique that enables artefact-free cross-sections at high ion beam currents thus allowing the user to fully profit from high sputtering rates delivered by Xe plasma FIB. The TRUE X-sectioning technique improves up to 50% preparation time compared to standard milling approaches with plasma FIB increasing throughput in FA workflows.

Benefits:

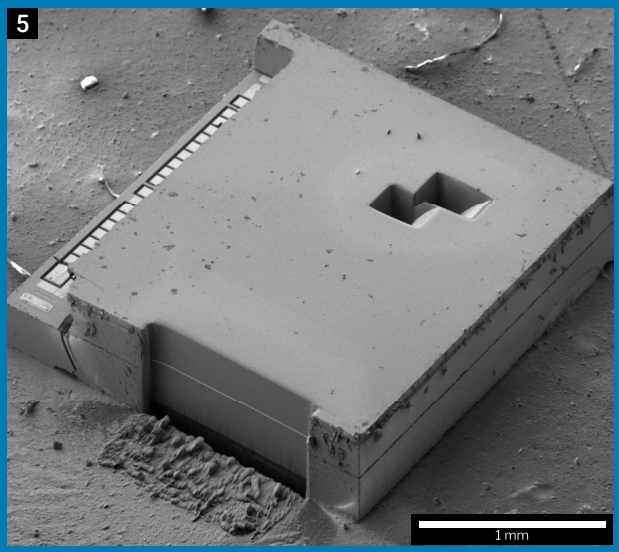
- ✓ Take full advantage high ion-beam currents for fast bulk milling
- ✓ Help to further improve ion beam shape profile
- ✓ Large-area, artefact-free cross-sectioning in short time frames

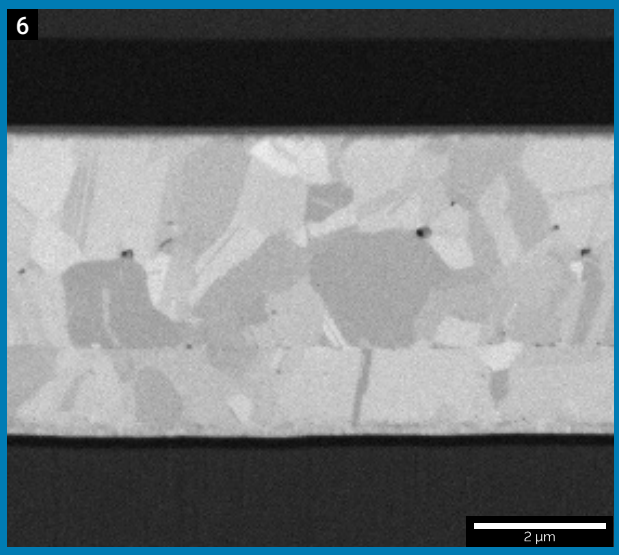
Shortest time frame to achieve 3D sample reconstruction results

FIB-SEM tomography provides unique 3D structural information on materials and specimens with nanoscale resolution that cannot otherwise be obtained by other conventional microanalytical techniques. The TESCAN S8000X makes it feasible to perform large-volume 3D sample reconstructions with excellent contrast, extreme ease and speed by combining a robust in-lens detection system for fast image acquisition with high sputtering rates enabled by the Xe plasma FIB. Our patented TRUE X-sectioning technique can be used to produce artefact-free FIB-slicing resulting in good quality EBSD mapping without the need for complicated stage operations.

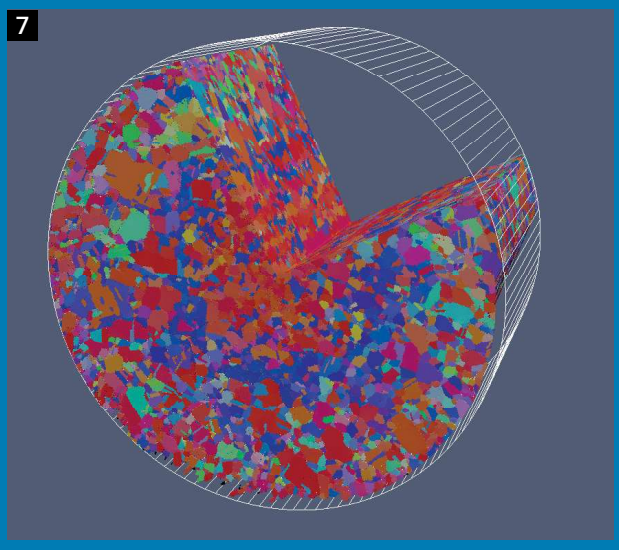
Benefits:

- ✓ Unique view of the ultrastructure of samples
- ✓ Large-volume highly-localized sample analysis
- ✓ Ga-free sample preparation
- ✓ SW modules for data rendering and different data visualization
- ✓ High contrast and artefact-free FIB-slicing
- ✓ 3D EDX for 3D chemical mapping
- ✓ 3D EBSD for volume crystallographic microanalysis
- ✓ Simultaneous EDX and EBSD data acquisition





▲ **Fig. 5:** Large-area cross-section with more than 1 mm wide in a MEMS device. **Fig. 6:** Detail of the cross-section on the left showing metal layers in detail.



▲ **Fig. 7:** 3D EBSD visualization of 90 µm diameter copper wire, cubic voxel size 200 nm

Technical Specifications

Electron Optics:

Electron Gun:	High brightness Schottky emitter	
Electron Optics:	BrightBeam™ column with combined electrostatic-magnetic objective lens and Wide Field Optics™ objective	
Resolution:	**Standard mode:** 0.9 nm at 15 keV 1.7 nm at 1 keV 2.0 nm at 500 eV	**Beam Deceleration mode (option):** 1.4 nm at 1 keV 1.6 nm at 200 eV
	Low Vacuum Mode*: **BSE:** 2.0 nm at 30 keV **LVSTD:** 1.5 nm at 30 keV	**STEM mode (option):** 0.9 nm at 30 keV
Maximum Field of View:	7.0 mm at $WD_{Analytical}$ 6 mm 21.0 mm at WD 30 mm	
Electron Beam Energy:	50 eV to 30 keV	
Probe Current:	2 pA to 400 nA	

Ion Optics:

Ion Column:	iFIB+ / High-resolution iFIB+ (option)
Ion Gun:	Xe ion Plasma FIB
Ion Beam Energy:	3 keV to 30 keV
Probe Current:	1 pA to 2 µA / 1 pA to 1 µA
Resolution:	< 25 nm at 30 keV / < 15 nm at 30 keV (at SEM-FIB coincidence point)
Magnification:	Minimum 150 × at coincidence point and 30 keV (corresponding to 1 mm field of view), maximum 1,000,000 ×
SEM-FIB Coincidence at:	WD 6 mm for SEM - WD 12 mm for FIB
SEM-FIB Angle:	55°

Detectors:

Detectors (standard):	Multidetector (In-Beam) Axial detector (In-Beam) E-T detector (In-Chamber) Retractable BSE (In-Chamber) pA meter Chamber view camera
Optional Detectors:	Beam Deceleration Technology (BDT), LE-BSE, LVSTD, Water-Cooled BSE, 4Q BSE, SITD, HADF R-STEM, EDX, WDX, EBSD, TOF-SIMS, CL, Raman Spectrometry (RISE)
Accessories:	**Standard:** Decontaminator/plasma cleaner. **Optional:** Load Lock, Rocking Stage, Optical Stage Navigation, Flood Gun, Nanomanipulators, Control Panel, Peltier Cooling Stage, Cradle Stage, EDX Piezo Shutter
Gas Injection System:	Single nozzle OptiGIS™ and in-line multi-nozzle 5-GIS. Variety of gas chemistries including proprietary gas for planar IC delayering.
Chamber:	Internal dimensions: 340 mm (width) × 315 mm (depth) × 320 mm (height) Number of ports: 20+ Chamber and Column Suspension: active vibration isolation (integrated)
Specimen Stage:	Compucentric, fully motorised XY = 130 mm (–65 mm to +65 mm), Z = 90 mm Rotation = 360° continuous, Tilt = –60° to +90°

*For variable pressure (UniVac) systems

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