

# TESCAN S9000



New generation of  
SEM microscope



Triglav™  
Electron  
Column



Ultra-High  
Resolution SEM



Resolution



Resolution



Selective Signal  
Detection



UniVac

## Ultimate resolution and excellent performance at low beam energies for nanocharacterization

The TESCAN S9000 is a powerful analytical tool for ultimate surface characterization of nanomaterials and sample microcharacterization. The TESCAN S9000 features the Triglav™ SEM column for ultra-high resolution with excellent performance, especially at low electron beam energies. It also includes an improved in-beam detection system with filtering electron signal collection capabilities that expands the possibilities to new contrasts and enhanced surface sensitivity. In addition, this microscope is fitted with a FE Schottky gun capable of generating high currents up to 400 nA, which coupled with an excellent performance and stability of the Triglav™ SEM column, provides the best conditions for microanalysis and lengthy applications for sample characterization. It is the outstanding performance at low beam energies, and the variety of image contrasts, which make the TESCAN S9000 an ideal system for imaging all type of non-conductive samples, such as ceramics or uncoated biological specimens, as well as beam sensitive samples that are increasingly common in the semiconductor industry or research of new materials. The TESCAN S9000 is controlled by the new TESCAN Essence™ SW interface designed with a user-friendly, application-oriented, customizable layout and SW modules, all features aimed at maximizing control and throughput with exceptional ease.

### ■ Ultimate resolution to resolve nanosized features:

The patented Triglav™ SEM column with proprietary triple objective TriLens™ provides best-in-class versatility. The extraordinary resolution delivered by the UH-resolution lens is ideal for detailed morphological characterization allowing researchers to resolve nanosized features. A completely new high-resolution analytical lens enables field-free imaging that is ideal for observing magnetic samples and used for analytical work (EDX, EBSD). A third objective lens enables a variety of display modes, and spot shape optimization that improves microanalysis.

### ■ Different image contrasts for maximum insight:

Triple BSE detection TriBE™ is for angle and energy selective signal collection. The Mid-Angle BSE and In-Beam f-BSE detectors are located inside the column and detect medium-angle and axial back-scattered electrons, while the in-chamber BSE Detector detects wide-angle electrons. The triple SE detection TriSE™ captures SE signal optimally in all working modes. The In-Beam SE detector inside the column enables detection of electrons at very short working distances. The SE detector for beam deceleration mode gives ultimate resolution in BDM while the in-chamber SE detector delivers excellent topographic contrast.

### ■ Improved and extended imaging capabilities:

The in-beam detection system in the next-generation Triglav™ column has been optimized resulting in more than a three-fold enhancement of signal detection efficiency. In addition, the detection capabilities have been extended and energy-filtered axial BSEs signal collection is now possible. This makes it possible to explore with new contrasts to provide enhanced surface sensitivity by selectively collecting low-loss BSEs.

### ■ Best conditions for microanalysis guaranteed:

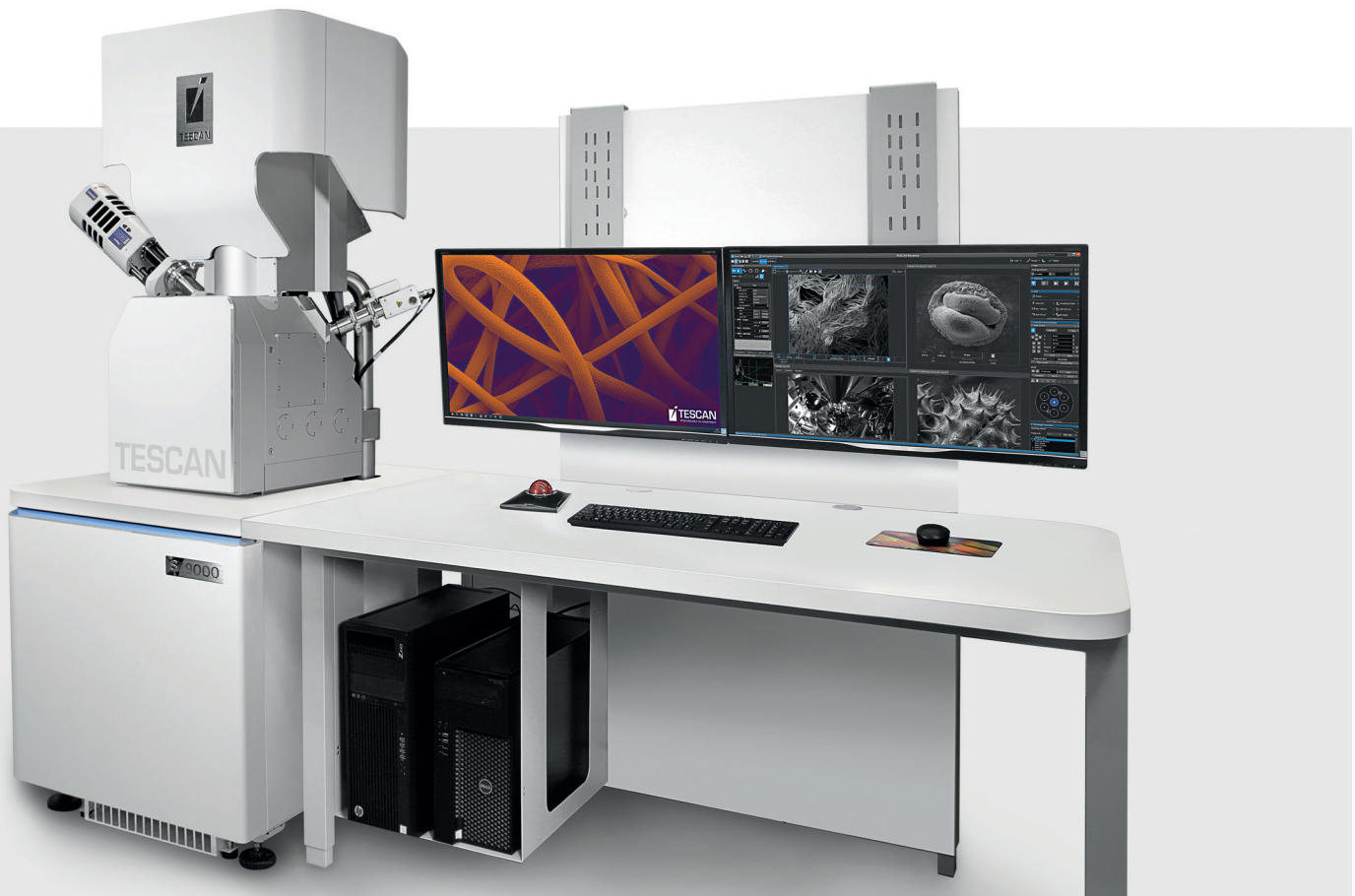
The new generation of Triglav™ also comes with adaptive spot shape optimization, which results in improved resolution at high electron beam currents. Such a feature is beneficial for fast analytical techniques such as EDX, WDS, and EBSD. In addition, the Schottky FE gun is capable of generating beam currents up to 400 nA with rapid beam energy changes guaranteeing an excellent signal for all microanalytical applications.

### ■ Complex applications easier than ever:

The new TESCAN Essence™ software platform is a simplified, multi-user 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 applications, user skill level and preference. A wide range of SW modules, wizards and recipes make all SEM applications an easy and simple experience for both novice and expert users, thus boosting productivity and contributing to increase throughput in the lab.

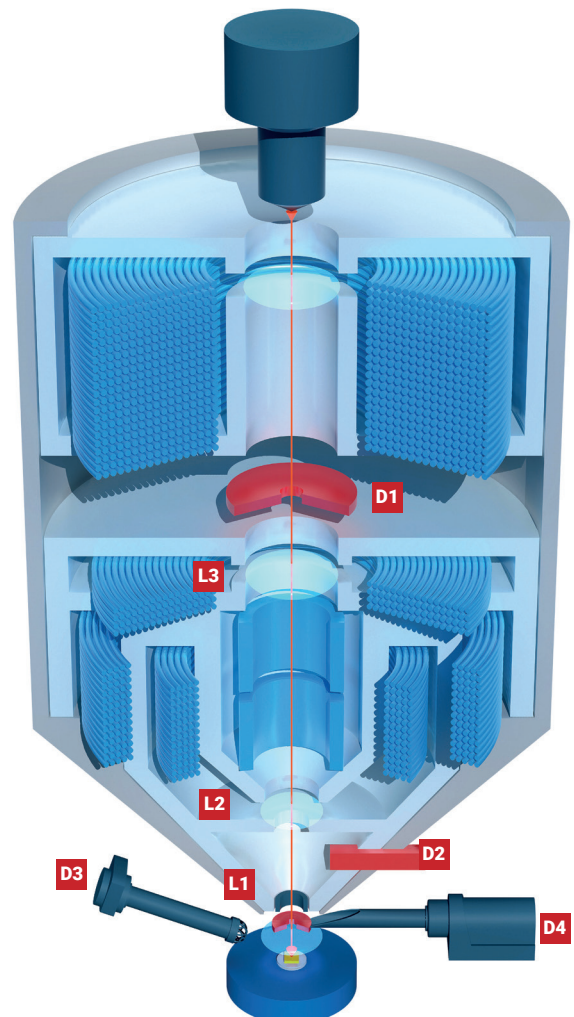


▲ Fig: New TESCAN Essence™ SW interface – customizable layout



## Ultimate resolution and enhanced detection capabilities for sample characterization

The next generation Triglav™ SEM column is based on TriLens™, a three-lens compound objective lens that enables multiple operating modes, including an ultra high-resolution imaging mode and a mode for analytical work. The ultra-high resolution mode can be combined in a unique way with a crossover-free mode resulting in a significant improvement of the beam performance at low beam energies. Microcharacterization (i.e. EDX, EBSD) of samples is performed in the field-free analytical mode, which is also suitable for morphological characterization of magnetic samples. In addition, the analytical mode also provides large field-of-view for fast, smooth, and easy navigation across the surface of samples. Moreover, the imaging system has been optimized giving better contrast at all currents and improved resolution in the transmission mode (0.6 nm at 30 keV). Improved stability and newly-developed electronics enable users to set parameters rapidly and easy.



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



## Powerful detection system

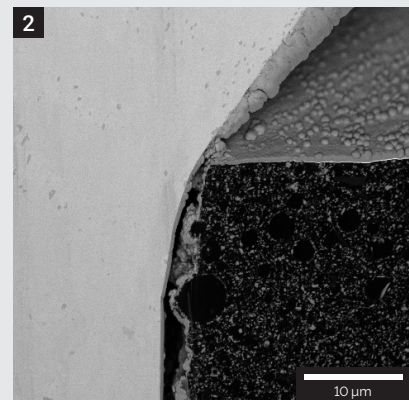
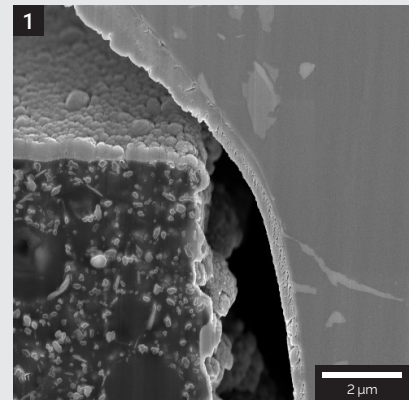
The excellent performance of the Triglav™ column is complemented with a robust and improved in-beam detection system that has been optimized resulting in more than a three-fold enhancement of signal detection efficiency. In addition, the detection capabilities have been extended by adding the In-beam f-BSE detector with energy-filtering capabilities. In this way, electrons that have undergone minimal energy loss (low-loss BSEs) can now be collected for enhanced surface sensitivity.

The in-beam multi-detector configuration makes it possible to collect simultaneous SEs and BSEs in the beam deceleration mode.

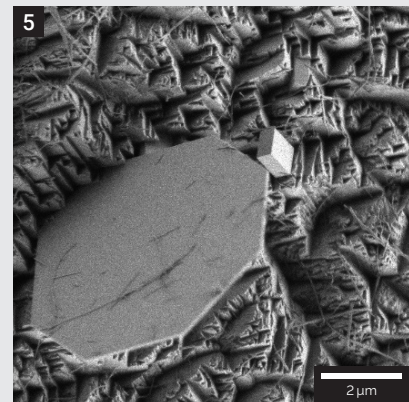
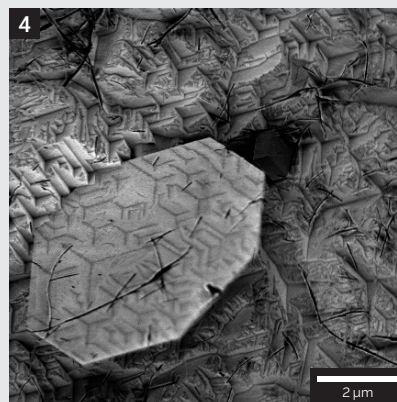
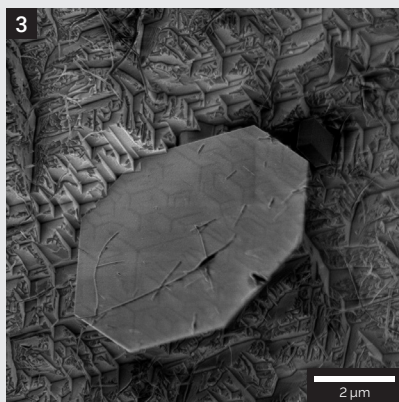
In terms of design, the objective lens has an optimal 60° geometry to achieve imaging of large wafers at any location.

## Key Benefits:

- Ultra-high resolution low-kV imaging
- Fast image acquisition with new generation of In-Beam SE detection system
- Highly-sensitive Mid-Angle BSE for fast imaging of low conductive samples
- Improved column automation to shorten time frames for completing tasks
- Energy filtering capability for achieving specific material contrasts (axial BSE, Low loss BSE)
- Improved resolution at high currents for fast analytical techniques (EBSD, EDX) through adaptive spot shape optimization
- Depth mode for topographic imaging and deep cross-section imaging



▲ Fig. 1, 2: Contact layers under a solder ball imaged at 5 keV with the In-Beam SE detector for topographic contrast (top), and the In-Beam f-BSE detector for material contrast (bottom).



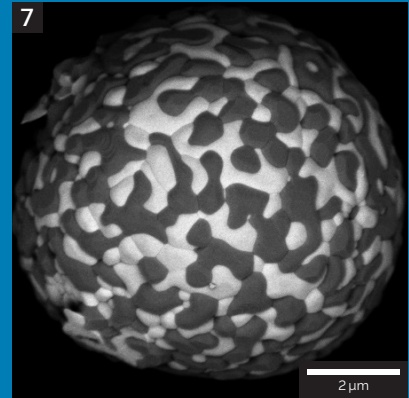
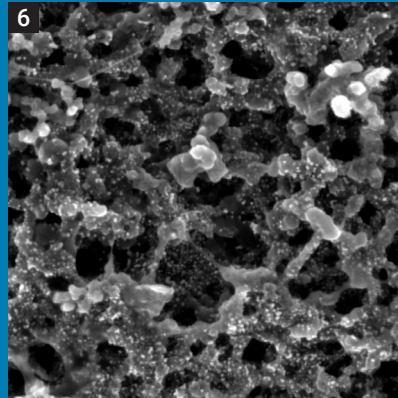
▲ Fig. 3, 4, 5: The beam deceleration mode further improves the performance of the electron beam at low and ultra-low landing energies. Example of the advantages of beam deceleration and detection system: surface features in an Al flake that remained hidden at a landing energy of 1 keV (left), became only well-visible at a landing energy of 500 eV (center). The lower the landing energy, the higher sensitivity in surface characterization. The detection system in Triglav™ makes it possible to distinguish SE (center) and BSE (right) signals providing topographic and material contrast respectively.

# Applications

The TESCAN S9000 is the ideal choice for imaging non-conductive and beam-sensitive samples including biological samples. The TESCAN S9000 enables highly sensitive surface analysis making it suitable for imaging samples with high topography. It is the SEM system of choice for keeping up with the increasing demand in all fields of science and technology for high-quality imaging at low beam energies.

## Materials Science

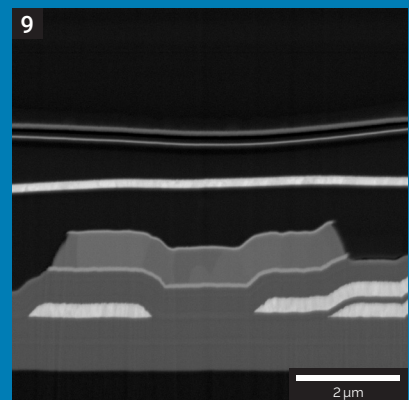
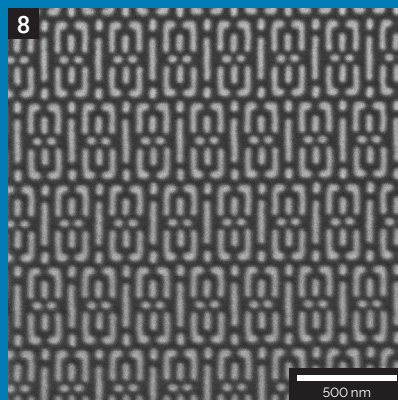
The TESCAN S9000 represents a significant advance in the characterization of nanomaterials. It is also suitable for observation of beam-sensitive and non-conductive samples (e.g. ceramics, polymers, glass, fabrics, etc.).



▲ Fig. 6: Image of an anode surface doped with Pt nanoparticles.  
Fig. 7: YAG crystals sensitive for charging and beam damage.

## Semiconductors, optoelectronics and photovoltaics

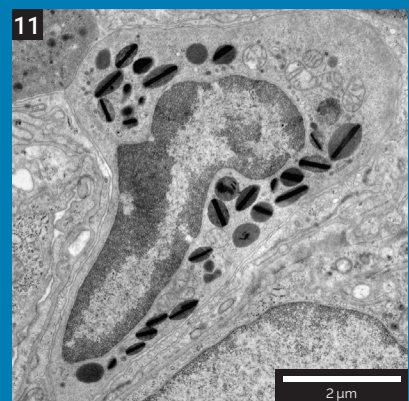
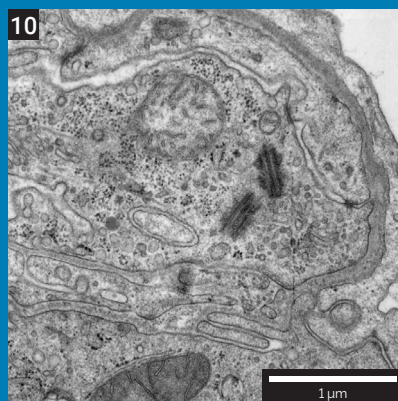
The TESCAN S9000 can be effectively used for failure analysis tasks in the semiconductor industry that include inspection of integrated circuits, observation of ultra-thin semiconductor sections, solar cells, nano-sensors, etc.



▲ Fig. 8: 2 keV In-Beam SE Image of the contact layer of a 10 nm node technology-based chip.  
Fig. 9: Detailed image of an OLED display showing the Al contacts and SiO<sub>2</sub>/SiN<sub>x</sub> layer structure imaged at 2 keV Mid-Angle BSE detector.

## Life Sciences

The excellent performance of the TESCAN S9000 at low beam energies makes it the ideal microscope to study uncoated biological specimens. The robust detection system that includes three BSE detectors, enables the possibility to explore different contrasts due to the angle- and energy-selective electron collection capabilities of the detection system. Thin specimens can be analyzed *in-situ* with the TESCAN STEM detector that enables simultaneous acquisition of BF, DF and HADF signals providing information of the ultrastructure of biological specimens. The low-vacuum mode (UniVac) enables chamber pressures up to 500 Pa that helps eliminate charge artefacts, when imaging non-conductive samples including biological samples.



▲ Fig. 10, 11: STEM-DF images of granulocytes in lungs.

## Technical Specifications

### Electron Optics:

<b>Electron Gun:</b>	High brightness Schottky emitter	
<b>Electron Optics:</b>	Triglav™ column equipped with the three-lens compound TriLens™ objective	
<b>Resolution:</b>	<b>Standard mode:</b>	<b>Beam Deceleration mode (option):</b>
	<b>In-Beam SE</b>	<b>SE (BDM)</b>
	0.7 nm at 15 keV	1.0 nm at 1 keV
	1.4 nm at 1 keV	1.2 nm at 200 eV
	<b>In-Beam f-BSE (option)</b>	<b>STEM mode (option):</b>
	1.6 nm at 15 keV	0.6 nm at 30 keV
	<b>Low Vacuum Mode*:</b>	
	<b>BSE (UH RESOLUTION)</b>	
	2.0 nm at 30 keV	
	<b>LVSTD (ANALYSIS)</b>	
	3.0 nm at 30 keV	
<b>Maximum Field of View:</b>	4.3 mm at WD <sub>Analytical</sub> 5 mm 7.0 mm at WD 30 mm	
<b>Electron Beam Energy:</b>	200 eV to 30 keV / down to 50 eV with the BDT option	
<b>Probe Current:</b>	2 pA to 400 nA	

### Detectors:

<b>Detectors (standard):</b>	SE In-Beam SE Mid-Angle BSE Retractable BSE** pA meter Chamber view camera
<b>Optional Detectors***:</b>	Beam Deceleration Technology (BDT), In-Beam f-BSE (for energy-filtering BSE signal collection), LE-BSE, Water-cooled BSE, 4Q BSE, Al-coated BSE, HADF R-STEM, EDX, WDX, EBSD, CL, Raman Spectroscopy (RISE)
<b>Accessories***:</b>	<b>Standard:</b> Decontaminator/plasma cleaner. <b>Optional:</b> Nanomanipulators, Load Lock (Manual/Automatic), Optical Stage Navigation, Control Panel, Peltier Cooling Stage, Beam Blanker, Cradle Stage
<b>LM Chamber:</b>	Internal dimensions: Ø 230 mm Door width: 148 mm Number of ports: 11+ Integrated active vibration isolation
<b>Stage:</b>	Compucentric, fully motorized <b>Movements:</b> X = 80 mm (-40 mm to +40 mm) Y = 60 mm (-30 mm to +30 mm) Z = 44 mm Rotation: 360° continuous Tilt: -80° to +80°
<b>GM Chamber:</b>	Internal Dimensions: 340 mm (width) × 315 mm (depth) Door: 340 mm (width) × 320 mm (height) Number of ports: 20+ Integrated active vibration isolation
<b>Stage:</b>	Compucentric, fully motorized <b>Movements:</b> X = 130 mm (-65 mm to +65 mm) Y = 130 mm (-65 mm to +65 mm) Z = 90 mm Rotation: 360° continuous Tilt: -60° to +90°

\*For systems with UniVac. \*\*Standard for variable pressure (UniVac) systems, optional for high vacuum systems. \*\*\*Availability of some items may depend on chamber configuration. +Configuration and number of ports can be modified according to customer's needs.