TESCAN

FOR LIFE SCIENCES

TESCAN VEGA

Practical SEM for a variety of biological applications designed with usability in mind

- Single Beam (SEM)
- Tungsten Electron Source
- Variable Pressure (MultiVac)
- Integrated EDS (Essence™ EDS)

Key features

TESCAN's 4th generation VEGA Scanning Electron Microscope (SEM) with tungsten filament electron source combines great imaging capabilities with a user-friendly environment to characterise samples in high resolution, with minimal effort. The special optical design enables researchers to effortlessly investigate even the largest specimens, allowing them to reveal the morphological details easily across a whole range of magnifications. The modular Essence™ software and multiple safety features allow both novice and skilled users to work efficiently. TESCAN VEGA is a research instrument suitable for various biological applications, where user comfort, easy setup of imaging conditions and high-resolution go hand in hand.

Easy to learn and maintain, TESCAN VEGA expands the possibilities of your lab with functionality like: high resolution imaging coupled with the ability to set up imaging conditions optimised for your specific sample with various detectors that deliver information on your sample's topography, material contrast and/or chemical composition.

See more with TESCAN's unmatched field of view

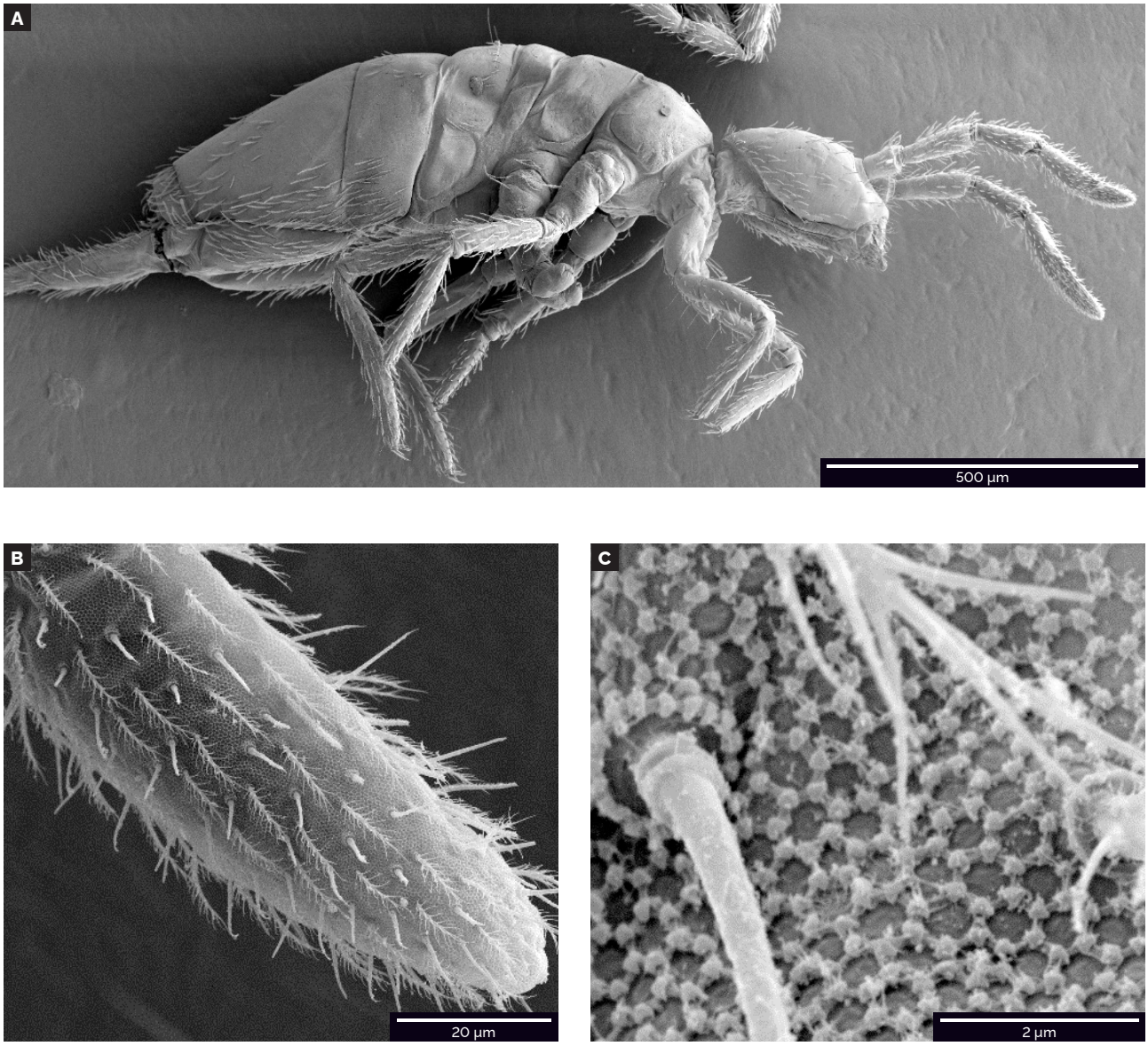
Even extremely large specimens, such as whole skulls, can be observed in the live scanning window, at magnifications as low as 2× without panoramic stitching. Investigate your samples at fields of view reaching nearly ten centimetres (~4 inches) while maintaining high resolution and unprecedented depth of focus thanks to unique Wide Field Optics™ which uses a sophisticated method of scanning correction so that even large specimens can be observed without distortion.

▲ Mole jaws – the image was captured as one field with mixed SE and BE signals. Image courtesy: Dr. James Weaver, Wyss Institute for Biologically Inspired Engineering, Harvard University, Cambridge, USA.

▲ Snail shell *(Helix pomatia)* on the SEM stage captured with SE detector. Field of View is >8 cm (>3 inches).

Optimum imaging conditions assured with TESCAN's uniquely designed optics powered by In-Flight Beam Tracing™

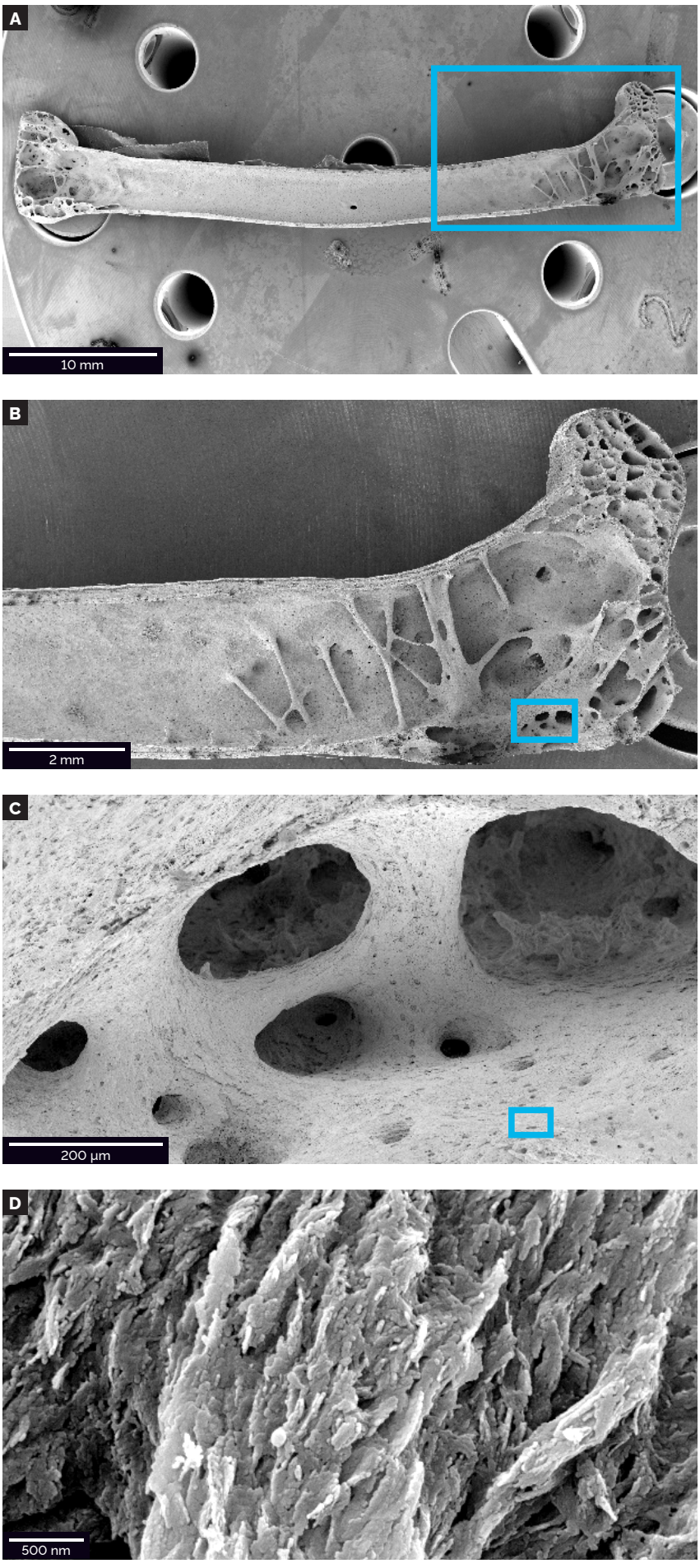
Biologic samples are often sensitive and require careful selection of imaging parameters, such as accelerating voltage and electron currents. TESCAN VEGA features an innovative optics design with a unique additional lens, the Intermediate Lens™, which is powered by TESCAN's In-Flight Beam Tracing™ algorithm. This combination not only allows users to continuously increase beam current to a value that optimizes signal to noise at the desired magnifications, it also guarantees immediate and seamless selection of the optimal imaging conditions for highest resolution imaging, without the need for mechanical realignment of any in-column elements. The most important benefit is that the user can switch between imaging and analytical conditions, which requires changing from low to high beam current, with a single click. Users don't need to interrupt their work every time they decide to switch conditions.



▲ Springtail *Coecobrya magyari,* overview image captured at 10 keV and higher current for fast imaging and high signal to noise **(A),** and detailed micrographs of antenna **(B)** and cuticle **(C)** after automatic beam optimisation for high resolution imaging. Sample courtesy: Dr. Danyi and Dr. Florian, Centre for Agricultural Research, Budapest, Hungary.

From macro to micro scale – a simple way to capture high resolution images:

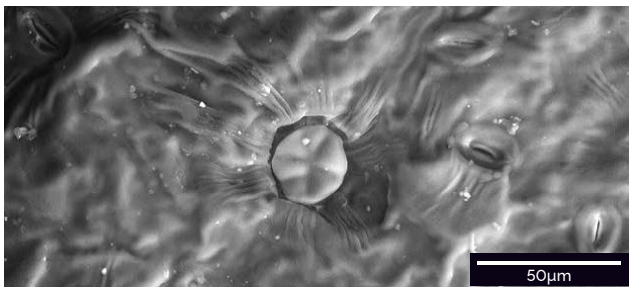
TESCAN's unique Wide Field Optics™ ensures precise navigation to the desired area of interest which provides the operator with a live SEM overview of the sample. Wide Field Optics™ provides a more intuitive navigation process with a view of the sample's actual topography. Users can begin an observation in the live SEM window using an overview that is several centimetres wide, then continuously magnify areas of interest and acquire a high-resolution image with minimal effort using TESCAN Essence™ software.



▶ Murine femur – series of micrographs with increasing magnification. No user interaction, except navigation and magnification, was required as focus, brightness and contrast were adjusted automatically. Sample courtesy: Dr. Natalie Butterfield, Imperial College London, UK.

Observe unprocessed samples quickly with apertureless SingleVac™

Observe plant tissue quickly and identify insects without any prior sample processing. SingleVac™ uses a factory-preset pressure value to make observation of charging samples possible without requiring a conductive surface coating. TESCAN VEGA is equipped with SingleVac™ mode as standard, and can be accompanied by optional MultiVac™ mode to allow continual adjustments to the chamber pressure.



▲ Tree leaf imaged with 4QBSE detector in SingleVac™ mode

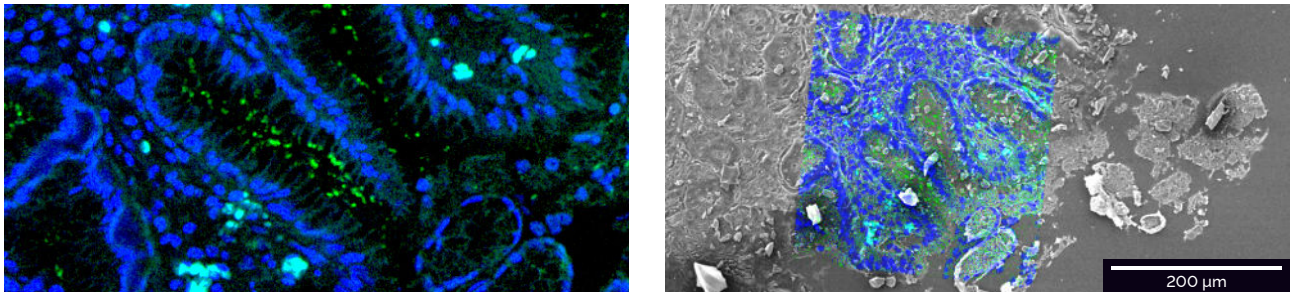
Achieve the finest topographic characterization of beam sensitive samples with MultiVac™ in low vacuum

Observe the finest surface morphological details by using a gaseous secondary electron detector (GSD) for the topographic characterization of uncoated and sensitive samples. TESCAN MultiVac™ supports imaging of unprocessed samples, such as plants, without surface coating, by enabling low vacuum and extended variable pressure up to 500 Pa. MultiVac includes a GSD for the most efficient topographical characterization of raw materials. Additionally, the GSD provides an H_2O atmosphere which maximizes signal collection efficiency and significantly increases contrast to deliver sharp, noise-free images even at low accelerating voltages, which are needed for surface sensitive imaging.

▲ Figure: Trichome of a plant **(left)** Scentless Mayweed (*Tripleurospermum inodorum*) bloom **(middle),** Detail of springtail cuticle and hair **(right)** captured in MultiVac mode using GSD detector.

Explore information from multiple modalities with correlative microscopy

Obtaining a single image is sometimes not enough as contextual information is vital for understanding biological systems. For example, it might be necessary to find the rare features in complex environments such as functionally different cells in a cell culture. Cells or structures of interest can be labelled with fluorescent labels so that researchers can easily find the ones of interest within a population. Basic correlative functions such as importing images from any light or fluorescent microscope, point and click calibration and SEM live image overlay are included in the TESCAN Essence™ software. For more demanding applications we offer a dedicated CORAL software module, with extended capabilities such as the ability to import a list of regions of interest from an optical microscope and export the overlay images.



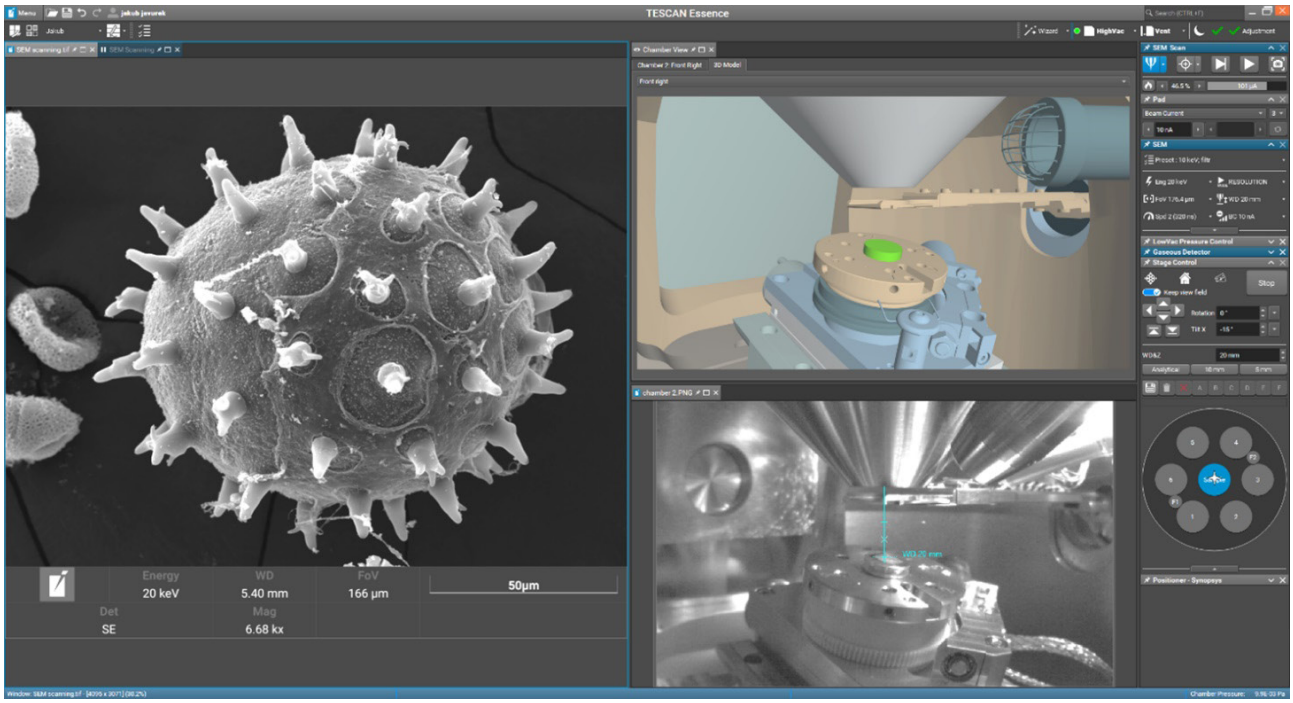
▲ Localization of *Helicobacter pylori* in gastric tissue using correlative approach. Gastric tissue with cell nuclei labelled by CLSM:DAPI (blue) and bacterial cells labelled by Alexa488-anti-HP (green) **(left).** SEM live window with fluorescent image overlaid allows easy navigation to bacterial cells **(right).**

Intuitive and modular Essence™ multi-user software interface designed for effortless operation regardless of a user's experience level

TESCAN VEGA is operated using the TESCAN Essence™ graphical user interface, which features several tools to streamline work. Essence™ is workflow oriented. All routine procedures and alignments are guided by software wizards for maximum simplicity. The instrument is highly automated with functions like Auto Focus, Auto Brightness/Contrast, and Auto Stigmation. Usability is further enhanced by functions like quick search and undo/redo commands. TESCAN Essence™ is designed to allow users to define workflows that match their level of experience and/or specific application needs. Users can not only adjust the layout of the user interface, but multiple layouts for various applications can be saved and shared between users to increase effectiveness. With different user level permissions, supervisors will benefit from the simple maintenance and easy alignment routine which can be shared with other users. Novice users can then log in to their own, already configured user environment. Supervisors' shared alignments and workflow layouts ensure high quality of results and repeatability between users, so users can focus on their work without worrying about misaligning the instrument for others.

Safe operation assured using smart collision prevention

The smart, real-time 3D collision model will prevent any possible collision inside the microscope chamber avoiding damage to an expensive tool so users can focus solely on their work. This provides peace of mind to novice users and their supervisors. The TESCAN Essence™ 3D collision model replicates the chamber interior virtually to create a live visualization of the hardware geometry, size and position of the stage, samples and chamber mounted equipment during operation. The software predicts the intended movements and interactions for a particular imaging or analytical routine to make it nearly impossible for samples to collide with any chamber mounted detectors*.



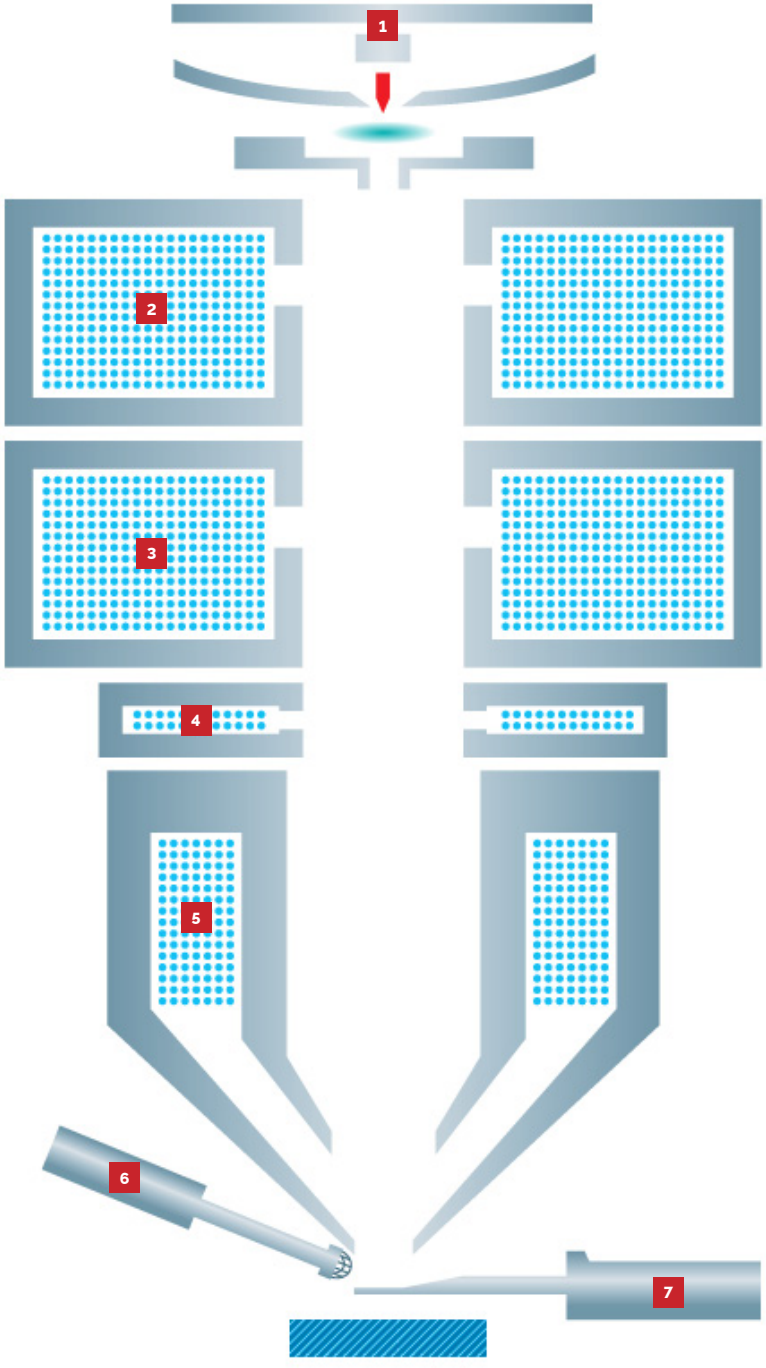
▲ TESCAN Essence™ graphical user interface showing real-time 3D collision model and chamber view

*Compatibility only applies to 3rd party options already integrated in the collision model.

Technology behind TESCAN VEGA

TESCAN VEGA is an analytical SEM with tungsten heated filament electron source. VEGA is equipped with two chamber mounted detectors: a secondary electron detector (SE) for topographical contrast and a backscattered electron detector (BSE) for material contrast. Choose the BSE detector from one of several options. The robust single crystal, YAG BSE detector delivers high material contrast even at the fastest scanning rates with unlimited lifetime. Another popular option is a four quadrant BSE detector (4Q BSE). This detector is appreciated by those whose investigations require take off angle-dependent signals. Each quadrant can be switched on or off according to the characterization requirements. This detector also provides access to predefined 4Q BSE observation modes such as COMPO for compositional observation and TOPO for topographical observation.

TESCAN VEGA also features an additional lens, the Intermediate Lens™ which provides access to unique observation modes. Wide-Field Optics ™ mode provides users with an exceptionally clear overview of the sample at any time to facilitate precise and fast navigation to the correct region of interest. Depth mode extends the depth of focus, so that samples with extreme topography are imaged with all features in focus.



1 Tungsten heated filament electron source

2 1st Condenser lens

3 2nd Condenser lens

4 Intermediate Lens™

5 Objective lens

6 SE Detector

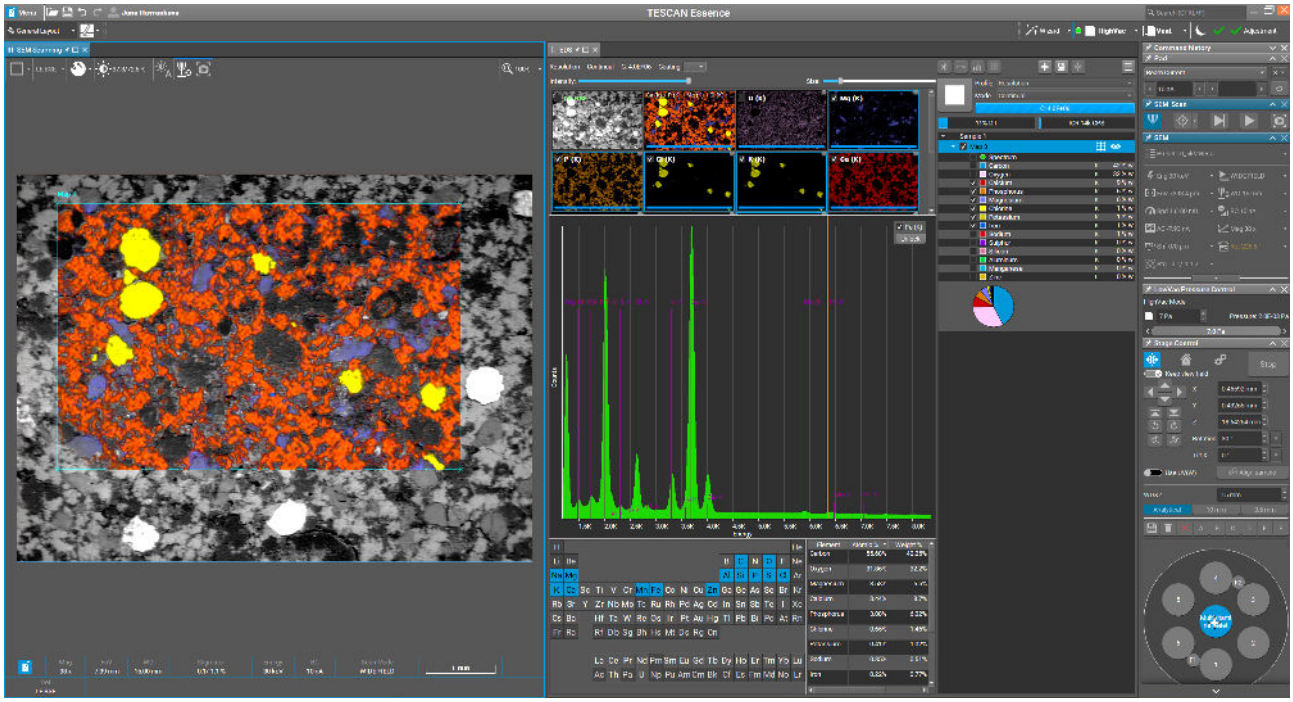
7 BSE Detector

Engineered for maximum ease of use and reduced time to data

All SEM operations are accomplished from a single, intuitive user interface. Navigation and imaging are entirely software-driven, allowing users to obtain crisp images with minimal effort. TESCAN Wide Field Optics™, In-Flight Beam Tracing™ and optional fully integrated Essence EDS™ all work together in a single, live view window of the SEM software to improve imaging results, speed analytical work and reduce time to data.

Use Wide Field Optics™ to navigate to the desired region of interest with a single click, then zoom in to individual features of interest while maintaining a clear and accurate image of the sample. Any features that appear transparent at high beam voltage can be resolved by simply reducing the beam voltage — without requiring mechanical aperture changes. TESCAN's optics design utilizes two condenser lenses and a unique Intermediate Lens™ that supports both wide field imaging and optimized imaging conditions based on TESCAN's In-Flight Beam Tracing™ simulations and calculations that improve low keV performance. Finally, with the optional fully integrated Essence™ EDS, users are a click away from their elemental analysis results.

TESCAN VEGA can reach these optimum imaging conditions quickly and effortlessly with a single click in the software GUI. TESCAN In-Flight Beam Tracing™ assures optimal imaging conditions for maximum contrast from your sample throughout the entire range of acceleration voltages. Speed your time to analytical data thanks to the optional integrated Essence™ EDS, which delivers the advantage of combining SEM imaging and elemental composition acquisition in a single live view window of the Essence™ microscope control software.



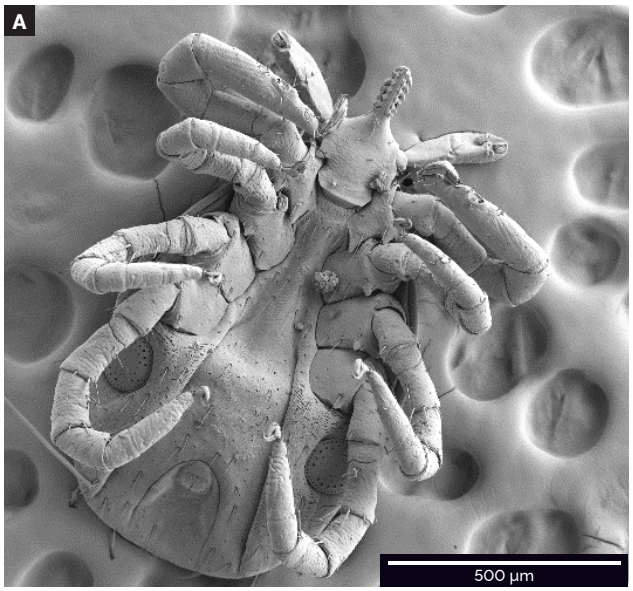
▲ EDS elemental map and spectrum captured with Essence™ EDS directly in a live window over the BSE image of cross-sectioned pharmaceutical tablet.

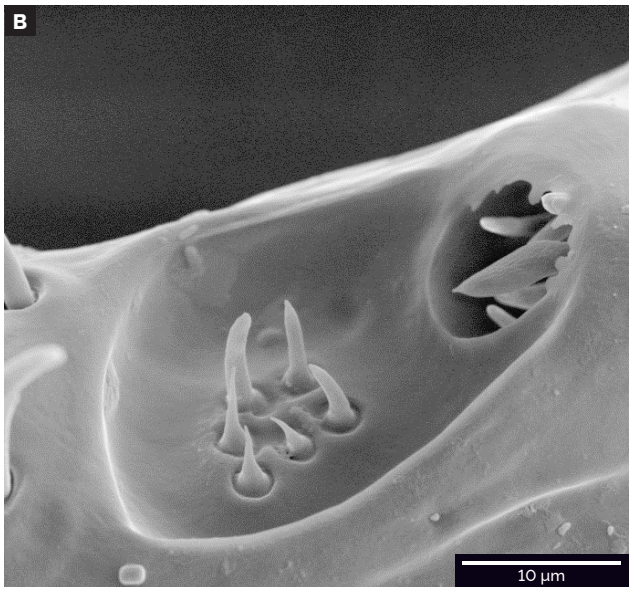
Application examples:

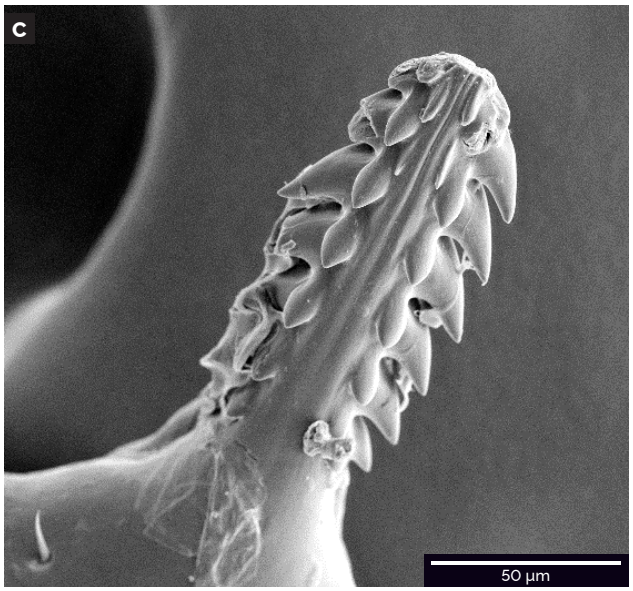
Taxonomic determination of small organisms

Some arthropods, such as ticks or mosquitoes, are important vectors of severe viral, bacterial, or protozoan human diseases. Due to climate change, non-native tick species are increasingly being spread and are adapting to new regions. The occurrence of these species needs to be monitored to predict potential new outbreaks of tick-borne infections.

Species determination of ticks is based on fine morphological structures on mouthparts, genitals, and the Haller's organ, some of which cannot be resolved by light microscopy. Moreover, there are no established molecular-biologic tools for reliable species determination of many arthropod taxa including ticks. Therefore, it is crucial for researchers investigating the taxonomy of arthropods to focus on morphology. TESCAN VEGA provides the resolving power to reveal the finest morphological features in an easy and convenient way, thanks to the intuitive user interface and automated beam optimisation. In addition, the multi-user Essence™ environment ensures that even students can perform these routine investigations without supervision.



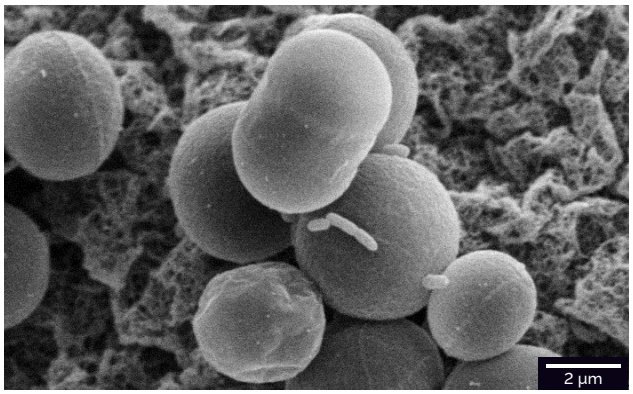


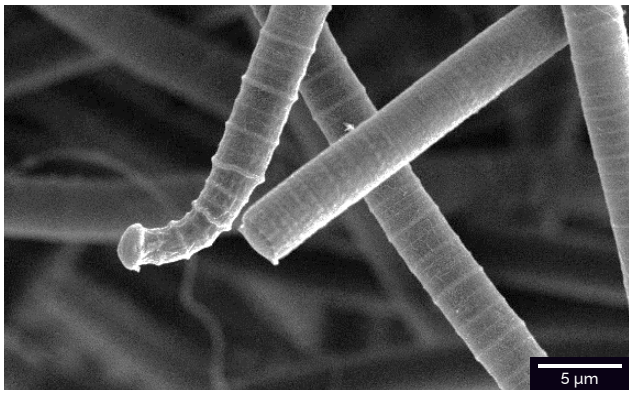


Castor bean tick *(Ixodes ricinus)* body ventral view **(A),** Haller's organ **(B)** and hypostome **(C)** captured at 7 keV using SE detector. Sample courtesy: Dr. Markéta Nováková, Department of Botany and Zoology, Masaryk University, Brno, Czech Republic

Characterisation of microbial isolate – Morphology and purity

To identify and describe a new genus or strain, microbial isolates are characterised using a multi-modal approach. In addition to the genetic and metabolomic methods, microbes are characterised by their morphological properties. TESCAN VEGA provides information that is invaluable for the taxonomical evaluation of microbial morphology, especially in the case of morphologically very similar species, where a light microscope does not provide enough detail. Scanning electron microscopy is a powerful tool used for a detailed study of, for example, cyanobacterial isolates. In addition to the shape, dimension, and surface characterisation, it is possible to visually detect any foreign species contamination.



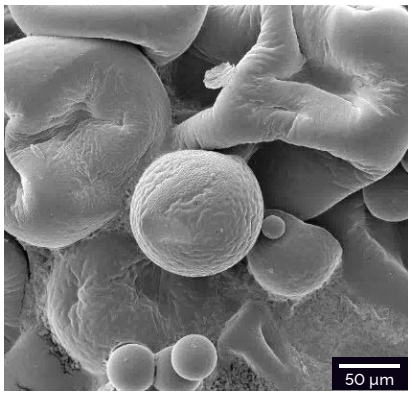


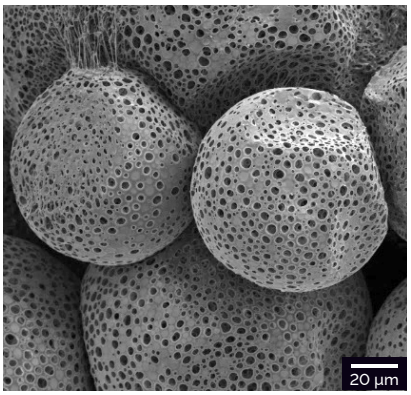
▲ *Chroococcus spp.* – dividing cells and bacterial contamination **(left),** *Microcolues spp.* with a characteristic calyptra at the end of its filament **(right).** Both images captured at 5 keV using SE detector. Sample courtesy: Dr. Luděk Sehnal, RECETOX, Masaryk University, Brno, Czech Republic

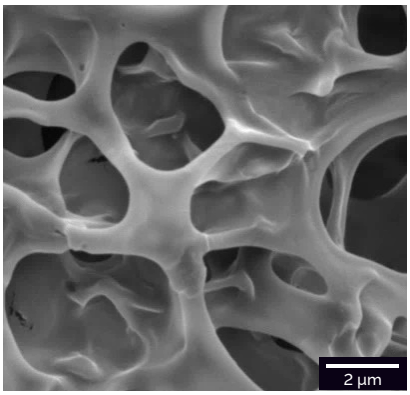
Investigation of drug encapsulation

Microcapsules are widely used in pharmacotherapy for their therapeutic benefits such as controlled drug release. The microcapsules are evaluated based on their morphology; surface texture, compactness of the prepared microcapsules, presence of pores, cracks and irregularities are all monitored. The TESCAN VEGA is an excellent tool for investigating the structure of the encapsulating material. TESCAN's unique Wide Field Optics™ provides the user with a DEPTH mode, where the microcapsules can be observed in high resolution, while simultaneously keeping whole particles in focus. The compactness and porosity of the encapsulating material, prepared under various conditions, could be easily compared, and evaluated.

Using the TESCAN VEGA, it has been possible to reveal that the microcapsules, prepared under various experimental conditions, differ in size and porosity which can affect drug release in an organism. Wide Field Optics™ provides a variety of working and display modes, imaging with high resolution, great depth of focus and unmatched field of view.



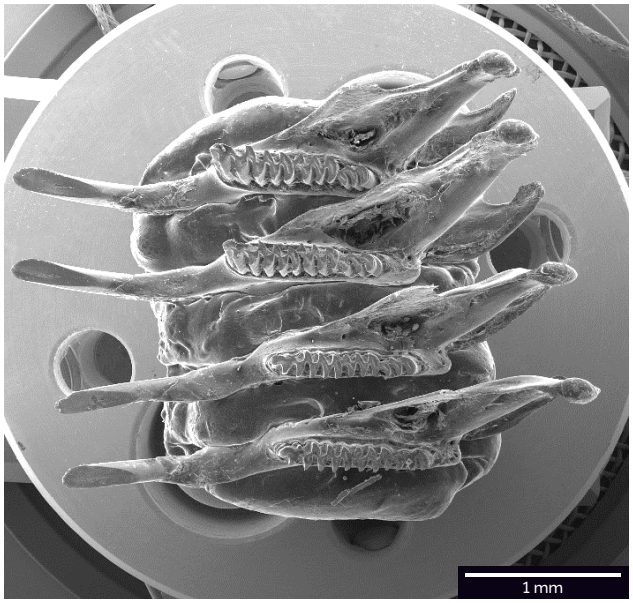


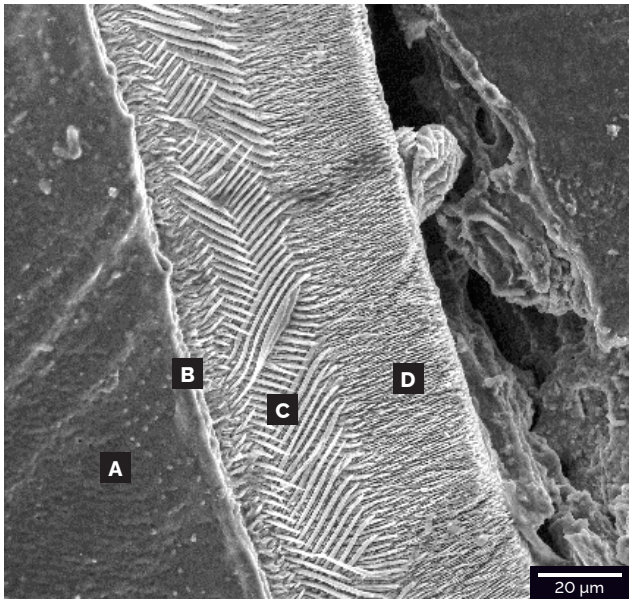


▲ Nonporous encapsulation **(left),** porous encapsulation **(middle)** and detail of porous encapsulation **(right).** Whole microcapsules are in focus because DEPTH scanning mode was used, which is available thanks to the special Wide Field Optics™ design. Sample courtesy: Dr. Martina Bajerová and Dr. Kateřina Dvořáčková, University of Veterinary and Pharmaceutical Sciences, Brno, Czech Republic

Dental histology

Scanning electron microscopy is the classic method for studying the schmelzmuster, three-dimensional arrangement of enamel types in a tooth. The cheek tooth enamel that forms the cutting edges of prisms has undergone dimensional and structural changes during the evolution of the dental system and can be used as a parameter for characterizing the evolutionary level of taxa. The schmelzmuster in rodents is described by three main types of enamel: radial, lamellar (uniserial HSB), and tangential. Initial observations of the enamel microstructures were done by light microscopes. However, analysis with SEM revealed much more detail and provided higher confidence. With its reliability and simple operation, TESCAN VEGA allows many samples to be analyzed per day. To further increase the throughput, the user can easily navigate across all samples thanks to Wide Field Optics™, providing an unmatched field of view to see all samples on the stage directly in the live SEM scanning window.





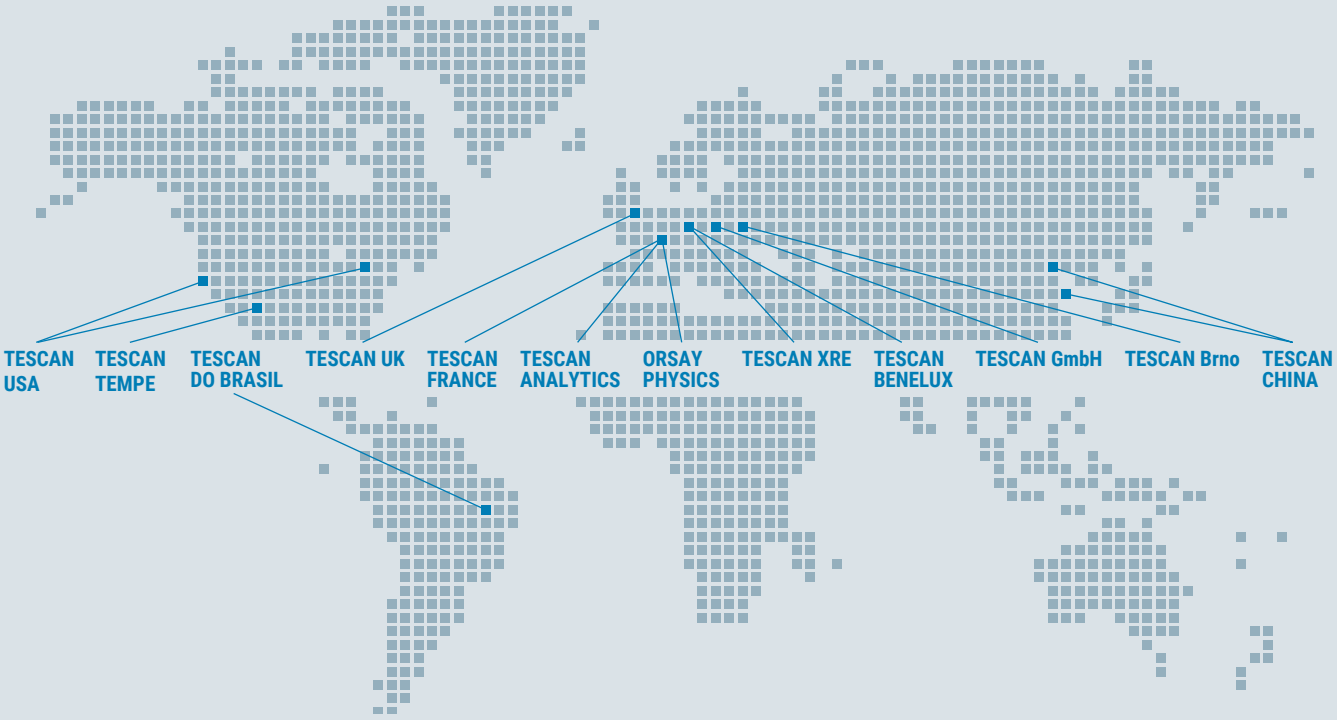
▲ Stage with multiple samples as seen in Wide Field mode **(left),** Enamel types in occlusal view on the leading edges of triangles of *Craseomys rex* first lower molar **(right).**
(A) Dentine, **(B)** Enamel dentine junction, **(C)** Lamellar enamel, **(D)** Radial enamel

Image courtesy: Dr. Sergey Zykov, Laboratory of Phylogenetics and Biochronology, Institute of Plant and Animal Ecology, Ekaterinburg, Russia

Technical specifications / Electron Optics:

Electron gun:	Heated tungsten filament cathode	
Electron Optics:	Wide Field Optics™ Technology with Intermediate Lens™ and In-Flight Beam Tracing™	
Resolution:	**High Vacuum Mode:**	**Low Vacuum Mode:**
	3 nm at 30 keV with SE detector	3.5 nm @ 30 keV with BSE*
	8 nm at 3 keV with SE detector	3.4 nm @ 30 keV with GSD*
		* optional detectors
Maximum Field of View:	>50 mm at max WD	

TESCAN Family Around the World



Is your sample compatible with SEM analysis?

Do you need assistance with sample preparation?

Do you have further questions?

We would be happy to help.

Contact us on lifesciences@tescan.com

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