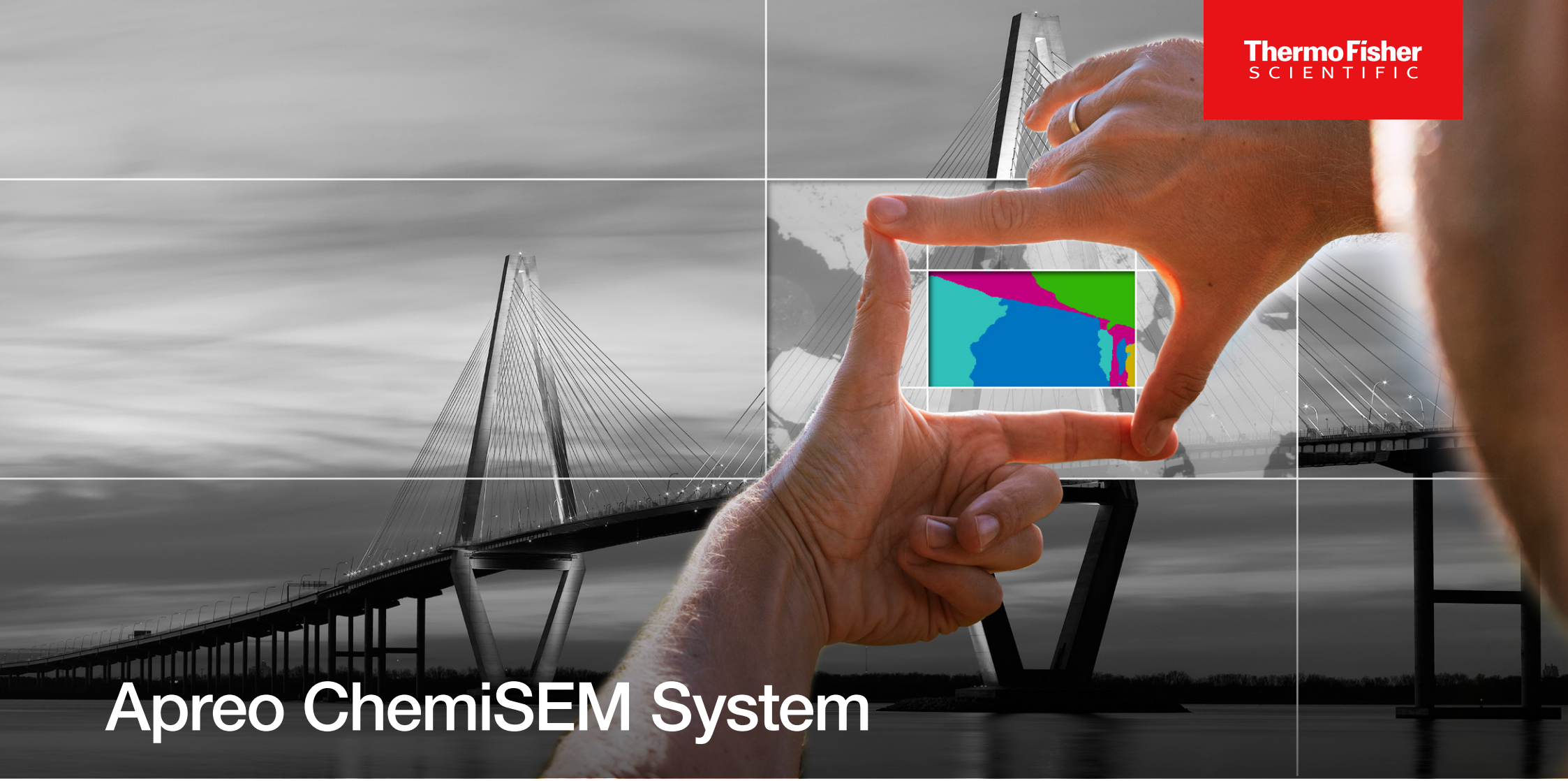


Apreo ChemiSEM System

High-performance imaging with integrated chemical analysis and structural characterization

thermo scientific

Apreo ChemiSEM

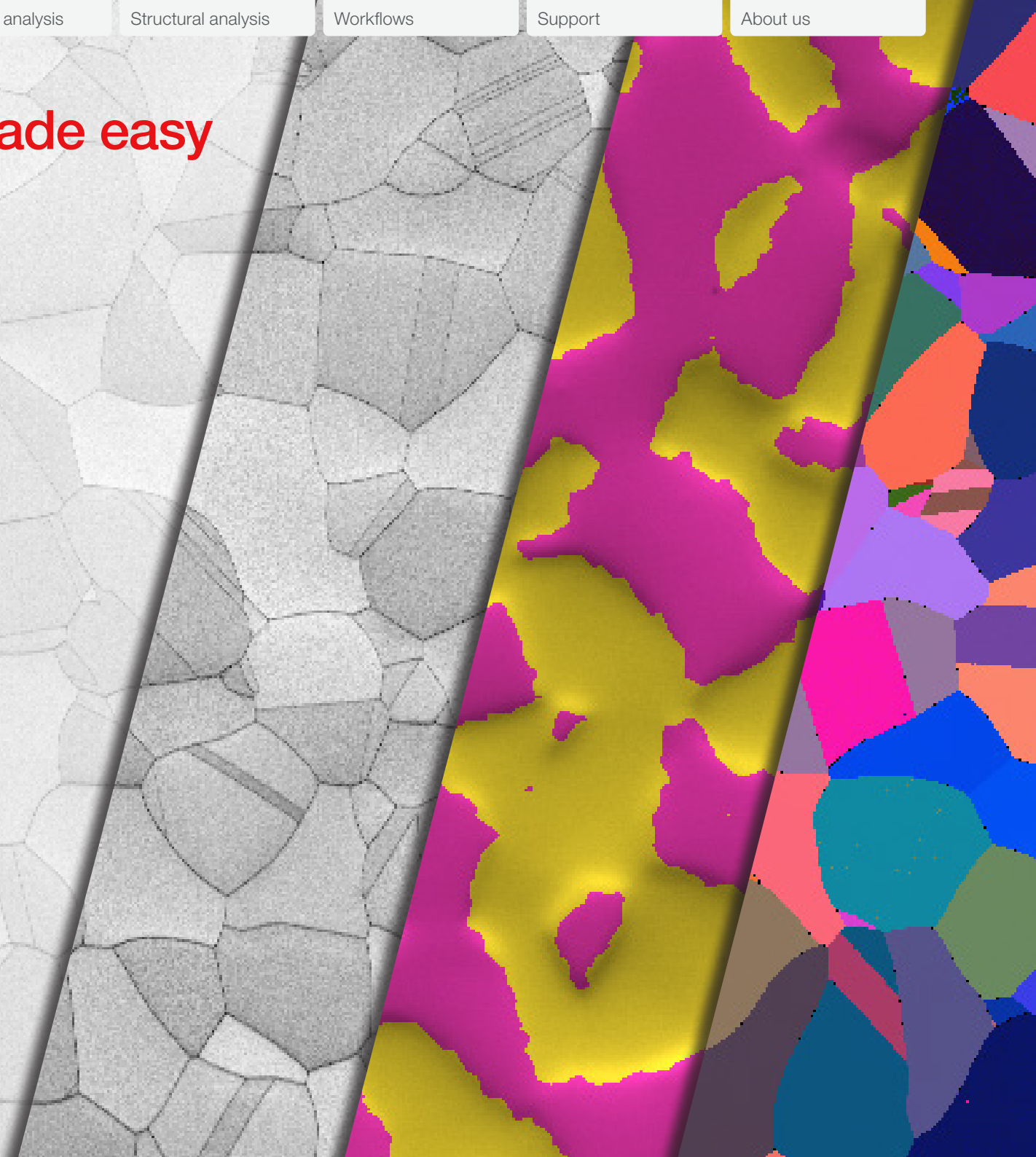
Working with advanced materials requires a keen understanding of your sample's surface, structure, and chemical composition. Whether you are researching your next innovation or focusing on product development and manufacturing, these attributes can help you certify the origin and purity of raw materials, assess failures, and ensure the quality of finished products.

The Thermo Scientific™ Apreo™ ChemiSEM™ System revolutionizes and simplifies these analyses. By fully integrating hardware and software for high-resolution imaging, elemental analysis, and structural analysis, it offers a seamless workflow that keeps up with fast-paced labs and delivers high-performance analysis for a wide range of samples.

Materials science made easy

From research and manufacturing to quality control and recycling, the Apreo ChemiSEM System is designed to quickly and easily analyze a wide variety of materials and help you:

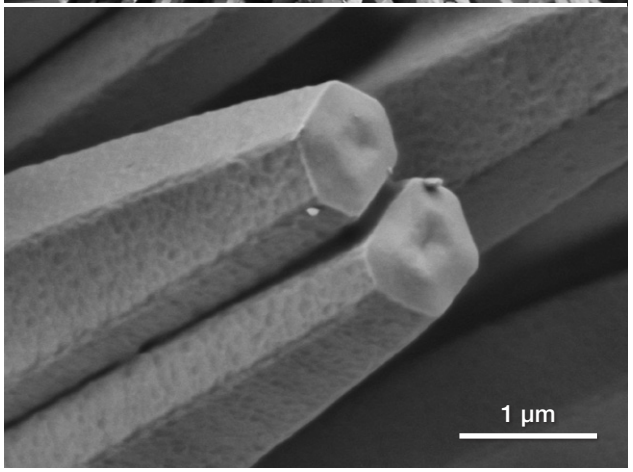
- Maximize efficiency with advanced automation, high-quality imaging, and dedicated support
- Access complete elemental information with minimal training, regardless of previous experience, through a simplified user interface
- Acquire data faster and streamline reporting with novel data segmentation, ultrafast signal processing, and tight SEM-EDS integration
- Ensure data integrity and eliminate user bias with intuitive operation and advanced automations
- Accurately qualify and quantify samples over a wide range of operating conditions, including beam energy, sample size, and working distance
- Improve productivity with proven workflows and advanced software
- Maximize uptime with robust hardware, routine upgrades, and preventative maintenance



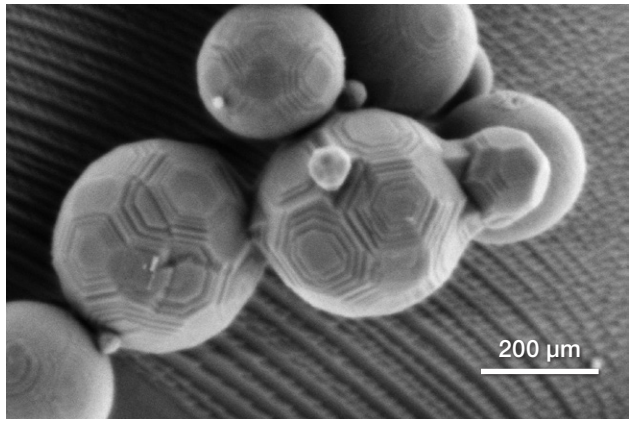
Obtain exceptional image results from any material

In-depth and comprehensive characterization has always played a crucial role in developing materials and driving innovation.

While many across industries, research and development, and quality control once saw scanning electron microscopes as complex tools that require extensive knowledge to operate, they now recognize that these systems can be the key to understanding the microstructure, composition, and surface characteristics of different materials.

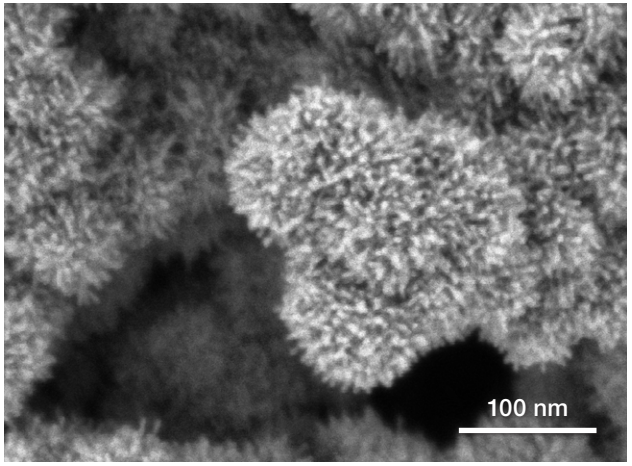


The Apreo ChemiSEM System keeps evolving to deliver high performance for many different materials that would usually require extensive electron microscopy knowledge for proper imaging. Thanks to its electrostatic final lens, the Apreo ChemiSEM System provides simultaneous in-column detection and excellent imaging results. When higher resolution is needed, the electrostatic final lens can be combined with magnetic immersion to form a compound lens that further improves image quality and helps you address the most challenging applications, including nanomaterials and composites.



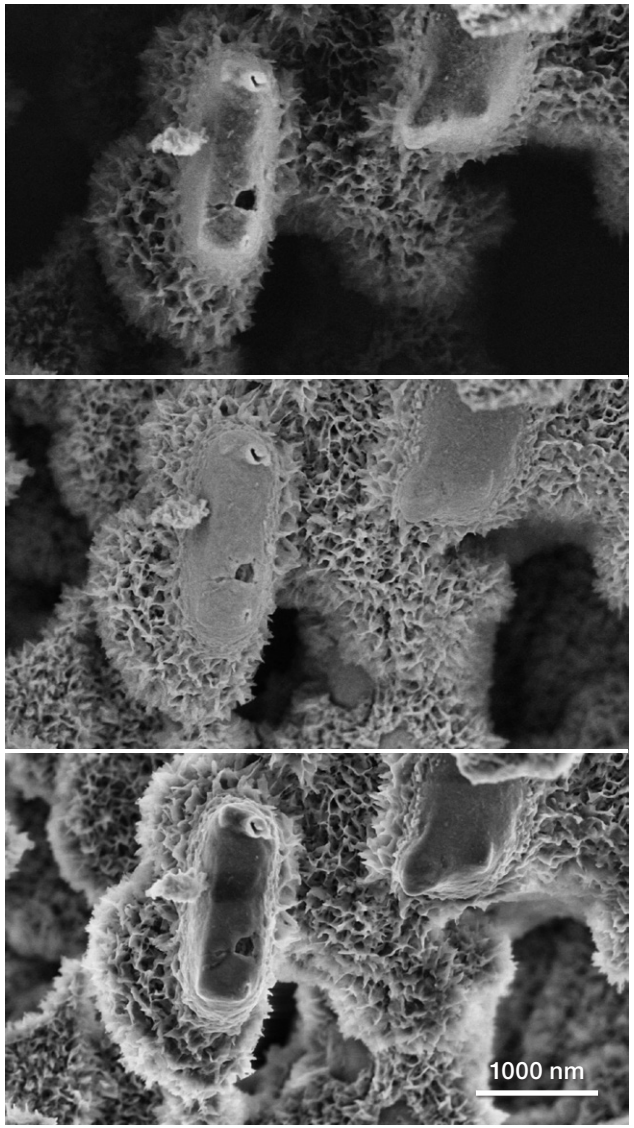
Aluminium oxide nanoparticles imaged at 1 keV and 13 pA with beam deceleration. Captured with the T1 and T2 detectors.

ETD images of $CoPO_4$ particles. Cobalt phosphates are employed in various applications, such as catalysts for chemical reactions, pigments in ceramics and paints, and as components in specialty glasses and ceramics. Accelerating voltage: 2 keV. Beam current: 6.3 pA.

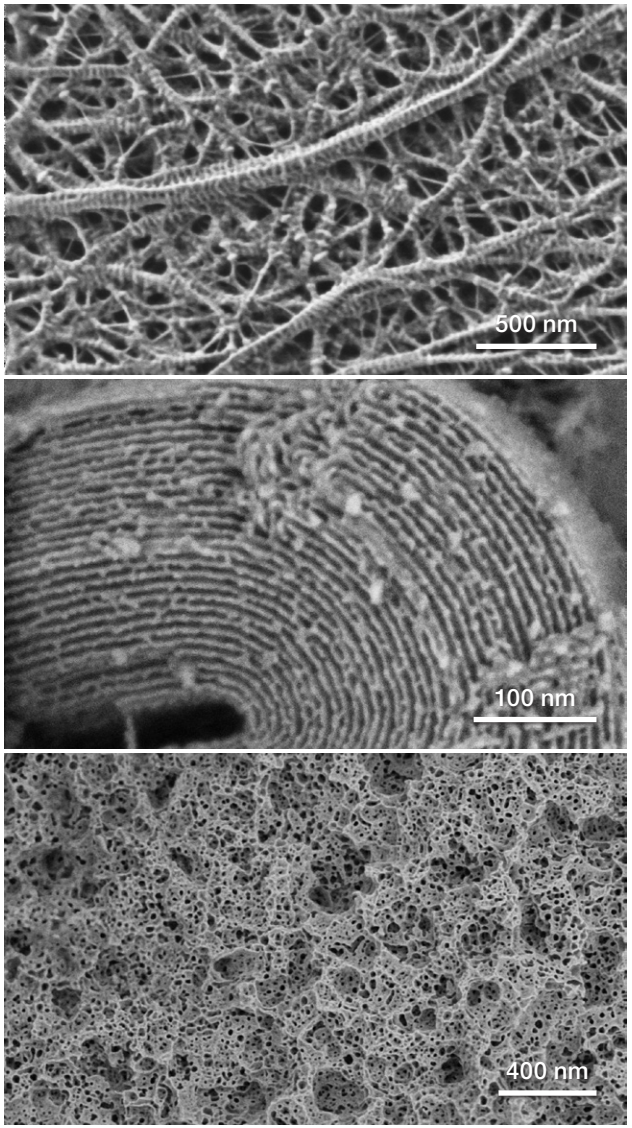


Au-Pt gas diffusion electrode for enhanced electrocatalysts with nanostructures imaged using the T2 detector. The compound lens filter is particularly suitable to characterizing nanosized features for high-resolution results. Accelerating voltage: 2 keV. Beam current: 6.3 pA.

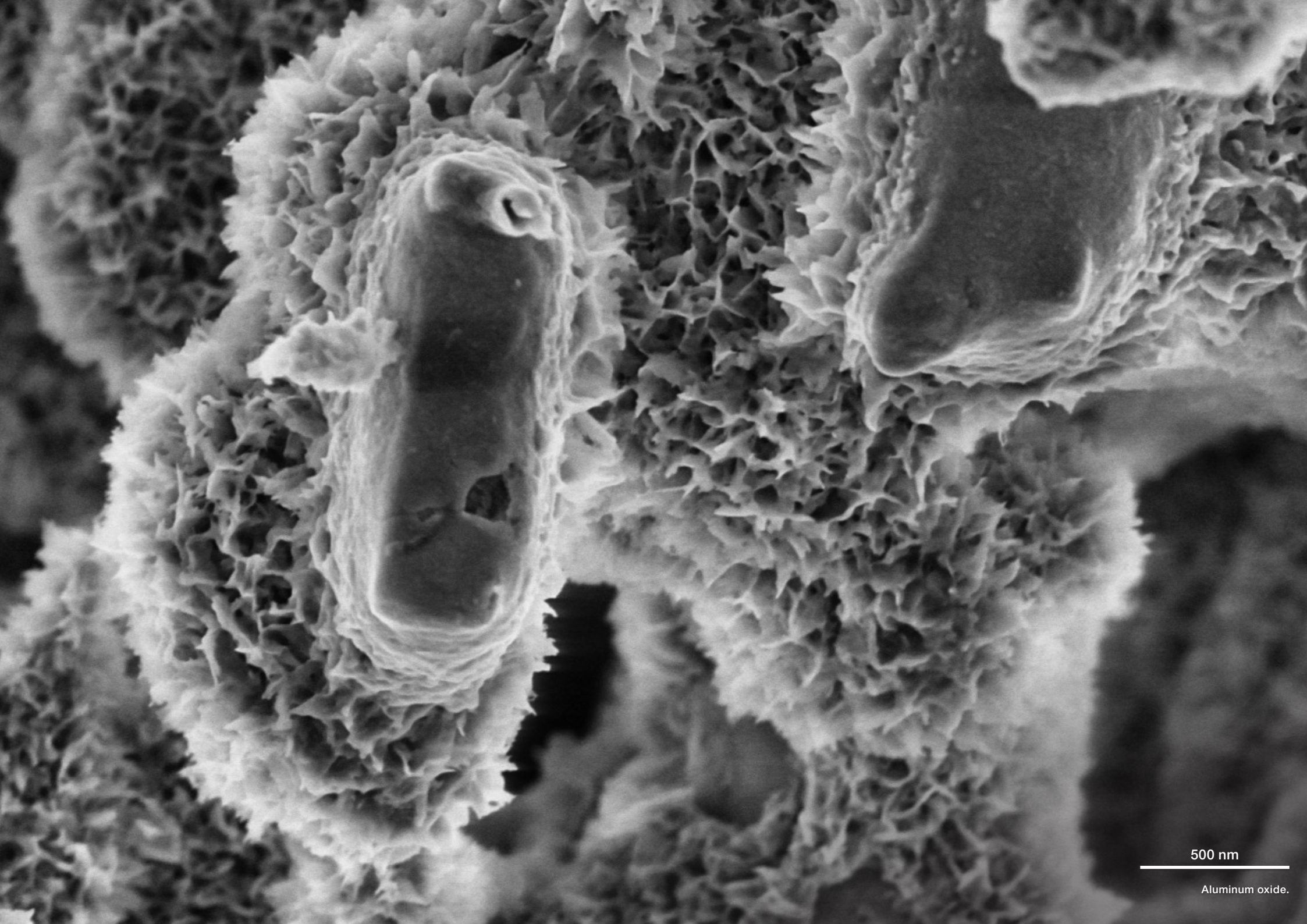
The Apreo ChemiSEM System's imaging capabilities can help you collect quality images in applications that traditionally demand conditions and settings that are difficult to assess. Thanks to its outstanding performance at low acceleration voltages, the Apreo ChemiSEM System supports characterization of beam-sensitive and charging materials, allowing you to achieve ideal imaging conditions for dedicated and complex applications.



The immersion mode provides excellent down-hole visibility using three different detectors to collect information from different depths. The aluminium oxide shown here is used as coating for biomedical applications. Thanks to its chemical properties, hardness, biocompatibility, and bio-inertness, alumina is a suitable candidate for various medical applications.



Top: Polymer battery separator imaged at 200 V and 3.1 pA with beam deceleration (T2 detector). Middle and bottom: SBA15 and alumina imaged at 500 V and 6.3 pA with beam deceleration (T2 and T3 detectors, respectively).

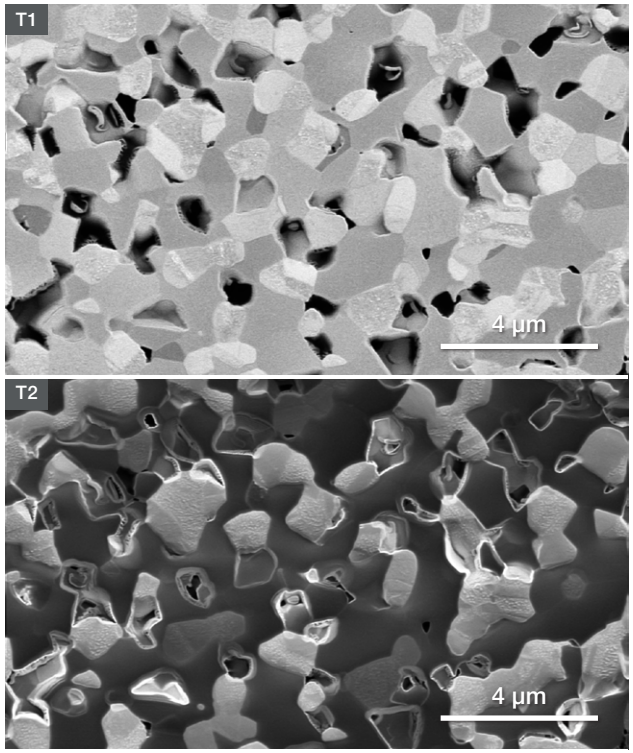


Aluminum oxide.

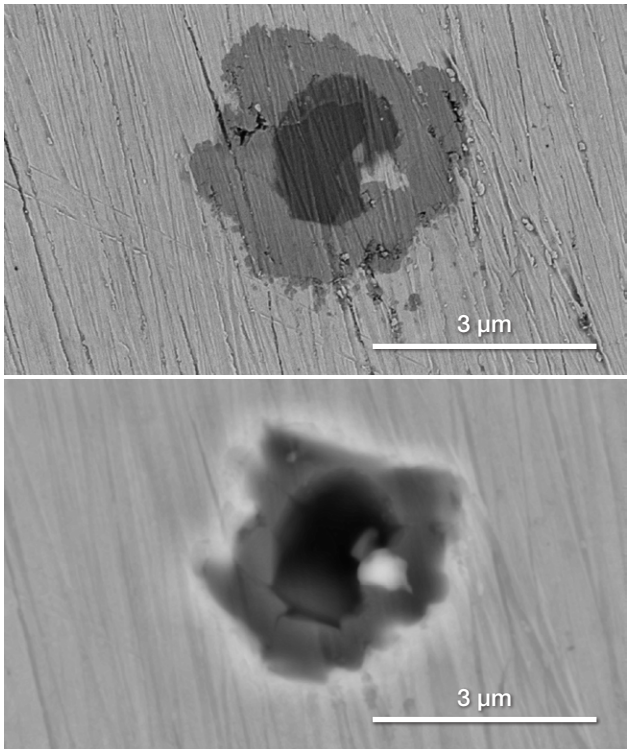
Easily obtain exceptional images with dedicated imaging strategies

In today's fast-paced industrial environments, ease of use and time to results have become more and more important in daily job planning. The productivity of researchers and engineers heavily relies on efficient electron microscopy solutions that can deliver accurate and complete results, with no need for extensive prior knowledge.

The Apreo ChemiSEM System provides high-resolution performance and excellent image quality at the analytical working distance (WD), allowing for non-expert users to easily achieve high-resolution results with no need to worry about possible collisions, especially when tilting a sample or working with multiple mounted samples. Imaging at the analytical WD offers straight access to all the Apreo ChemiSEM System's analytical capabilities, including EDS and EBSD characterization.



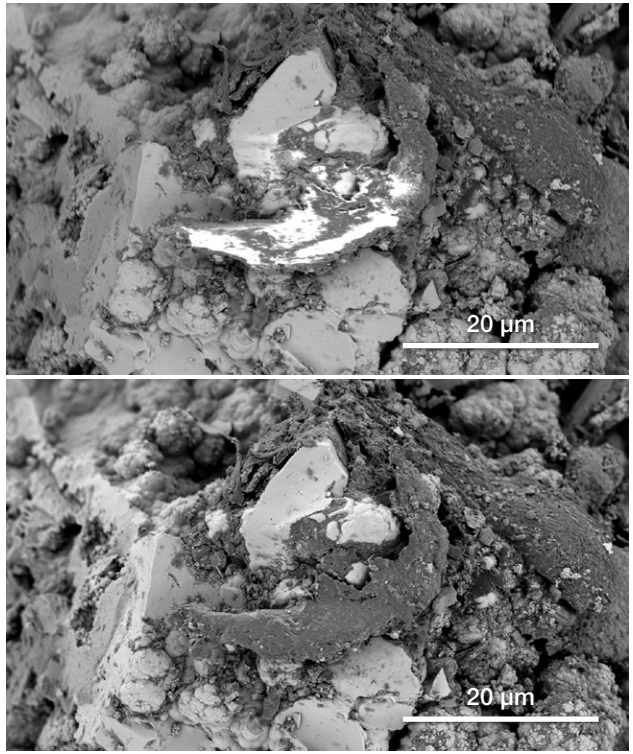
Low-kV characterization of a solid oxide fuel cell (SOFC) consisting of a matrix of yttrium stabilized zirconia (YSZ) and nickel. Nickel particles create a network that acts as an electronic pathway; however, some nickel particles may not be connected to the matrix. Those are usually called dead-nickel; it is important to characterize their presence and quantity within the sample. Using a low accelerating voltage made it possible to identify the dead-nickel by the charge contrast. The unique Trinity Detection System was used to identify the three phases (YSZ, nickel, and pores) with the T1 detector providing Z contrast, which was then used to distinguish dead-nickel from percolating nickel in the T2 detector image, which provided SE contrast. During the assessment of the method, it has been shown that the contrast between percolating and non-percolating nickel decreases with increasing voltage.



Complex inclusions in steel. The use of low acceleration voltage enhances the sample topography and compositional contrast from the immediate surface, highlighting the different materials within the inclusion. Accelerating voltage: 2 keV (top) and 20 keV (bottom). Beam current 25 pA (top) and 1.6 nA (bottom).

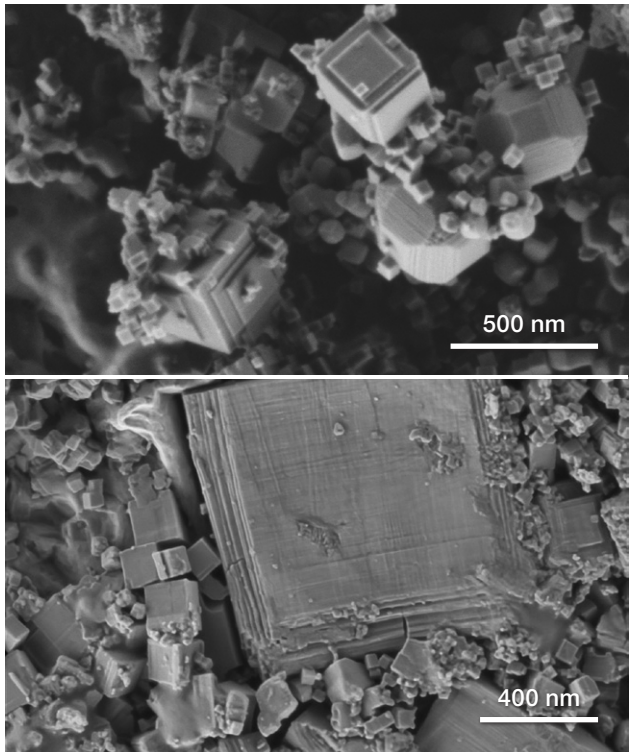
The Apreo ChemiSEM System can image any kind of material thanks to a full set of strategies and approaches that allow for charge mitigation, charge filtering, and contrast and topography enhancement, depending on the imaging conditions and specific application.

The compound lens, for example, brings better resolution performance and allows for charge filtering and contrast enhancement. For beam-sensitive materials, the Apreo ChemiSEM System offers a variety of imaging strategies to help you find the right approach for any kind of material.



Glass-fiber reinforced polymer. Non-conductive and beam-sensitive materials are the most challenging to image. Low acceleration voltages are not always enough to allow for the best image quality (as shown in the top image). The compound lens filter removes the charge and provides enhanced topographical details (bottom image). Accelerating voltage: 2 keV. Beam current: 6.3 pA.

Beam deceleration also helps mitigate charging effects. It reduces the flatness of features induced by charging and provides enhanced topography of the particle surface.

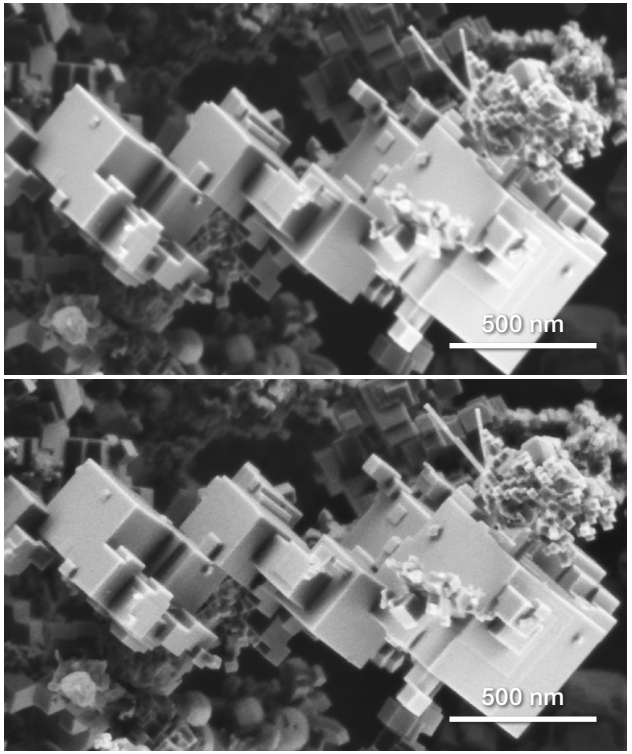


Magnesium oxide. Beam-sensitive materials are not easy to image, even when low acceleration voltages are used. Beam deceleration improves topographical details and reduces charging artifacts. Accelerating voltage: 1 kV (top) and 500 V (bottom). Beam current: 25 pA. Bottom image: BD on (-4keV).

By providing easy access to high-resolution imaging performance and a wide range of settings for the widest range of materials, the Apreo ChemiSEM System can help you obtain accurate results with minimal effort and expertise.

Enhance image quality with Smart Frame Integration

Smart Frame Integration (SFI) uses advanced digital enhancement and precise detector models to significantly enhance image quality compared to traditional frame integration techniques. Unlike previous methods, SFI operates in real time during scanning and dynamically adjusts detector settings to optimize quality and ensure acquisition of the highest-quality images. It also uses an HDR-like algorithm to fuse images captured at different detector settings, which enhances contrast while minimizing noise and blur. SFI eliminates the challenge of manually setting image processing parameters, helping you achieve superior image quality with minimal effort.



Top: Image acquired without SFI shows elongated magnesium oxide particles. Bottom: Image acquired with SFI eliminates artifacts. Accelerating voltage: 1 keV. Beam current: 50 pA. Captured with the T1 detector.

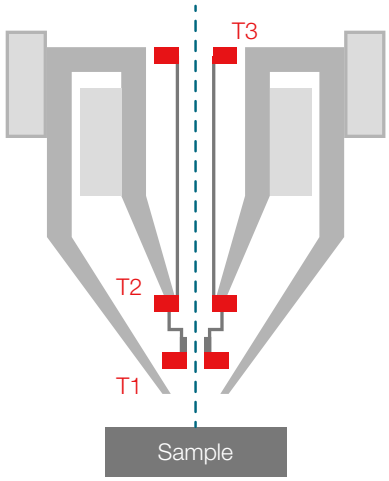
Study composition and morphology with the Trinity Detection System

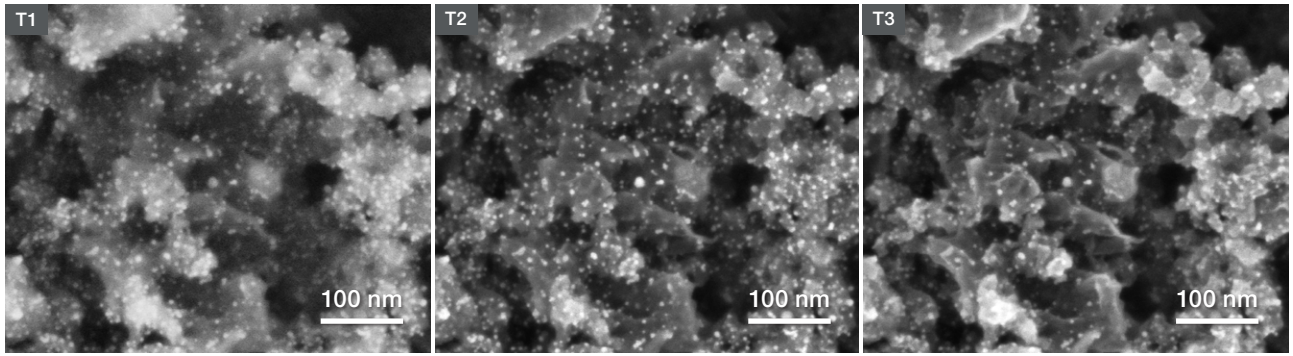
The Apreo ChemiSEM System features the unique Trinity Detection System, which delivers precise in-column detection for detailed insights into sample composition, morphology, and surface features.

The Trinity Detection System provides accurate results for a wide range of samples, even under difficult imaging conditions, thanks to the positioning, speed, and capabilities of its two in-lens (T1, T2) detectors and one in-column (T3) detector. The T1 detector is positioned inside the tip of the final lens and close to the sample to collect the maximum amount of signal.

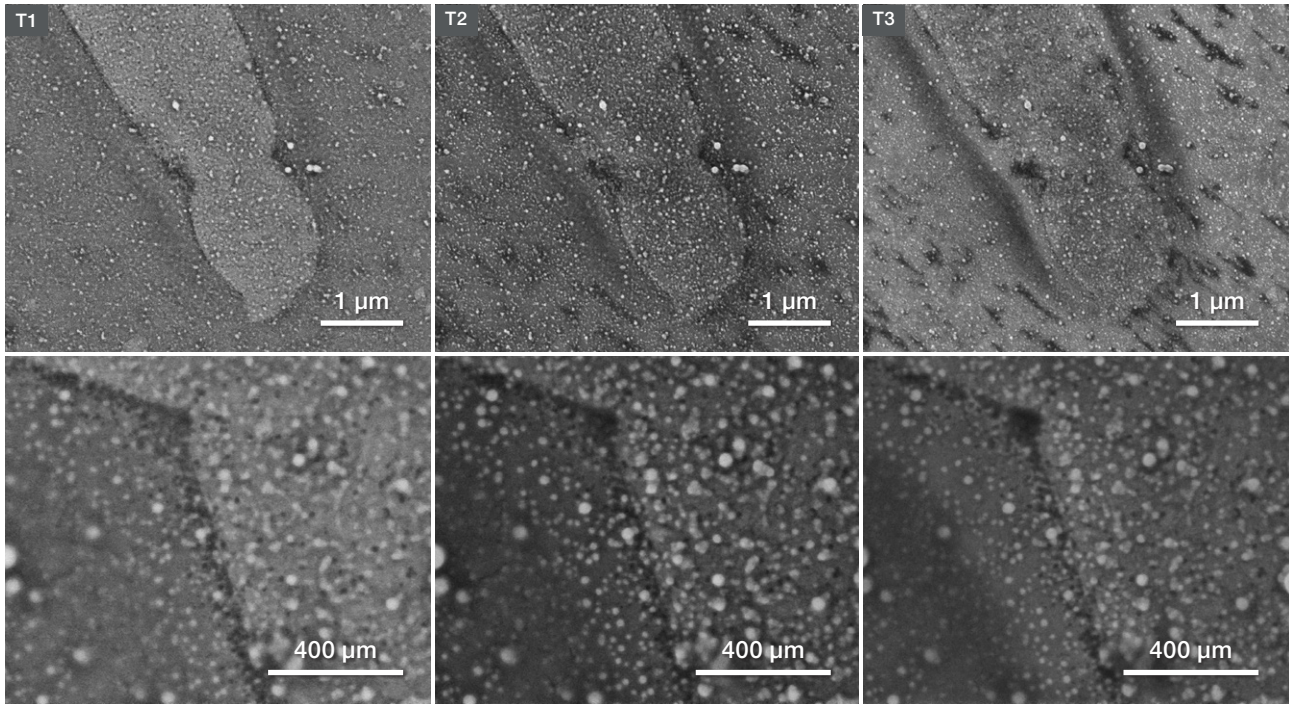
The T1 detector also provides:

- Material contrast at short or long working distances and at tilt
- High speed
- High sensitivity, with currents as low as 3 to 6 pA
- Imaging of charging and sensitive materials





Characterization of a Pt catalyst coated membrane (CCM) for polymer electrolyte membrane (PEM) cells showing T1, T2, T3 detector images that respectively provide pure material contrast (showing all the platinum particles available inside and outside of the polymer matrix), topographical information (showing only the platinum particles on the surface of the material) and surface information. Accelerating voltage: 2 keV. Beam current: 13 pA.



Lower- and higher-magnification images of a cross section of Al2024 aluminum alloy. The combined acquisition of T1, T2, and T3 detector images offer a complete view of compositional information (i.e., whether the dispersoids and precipitates are in the field of view with the same composition), topographical details (i.e., if objects are extruded from the base alloy or not), and surface information (i.e., carbon contamination). Accelerating voltage: 2 keV. Beam current: 6.3 pA.

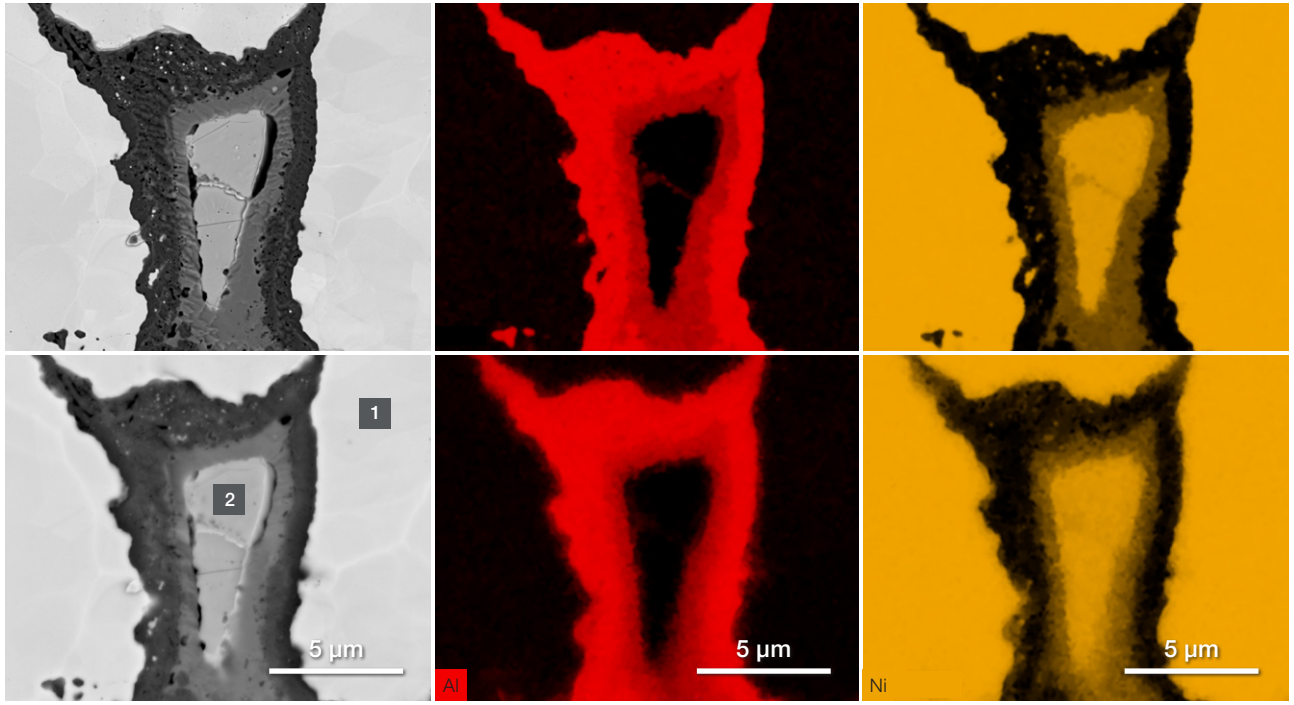
$CoPO_4$ particles.

Identify chemical composition with ChemiSEM Technology

Thermo Scientific™ ChemiSEM™ Technology seamlessly integrates scanning electron microscopy and energy dispersive X-ray spectroscopy (EDS) functions into a single platform.

Built on live quantification and decades of EDS analysis expertise, it offers a variety of features that help you more quickly and accurately analyze samples:

- Always-on data collection eliminates the need to switch between SEM imaging and EDS analysis for each sample
- Novel data segmentation approaches and tight SEM-EDS integration accelerate data acquisition and ensure accurate qualification and quantification
- Comprehensive view of micro-scale elemental composition enhances efficiency and facilitates multi-data viewing for complete sample characterization
- Seamless workflow, intuitive interface, and multiple analysis modes make elemental information available to a wider range of users



	Area 1		Area 2	
Element	**Atomic % at 5 keV**	**Atomic % at 15 keV**	**Atomic % at 5 keV**	**Atomic % at 15 keV**
Ni	91.5	92.5	51.7	51.5
Al	2	1.5	-	-
O	6.5	6	48.3	48.5

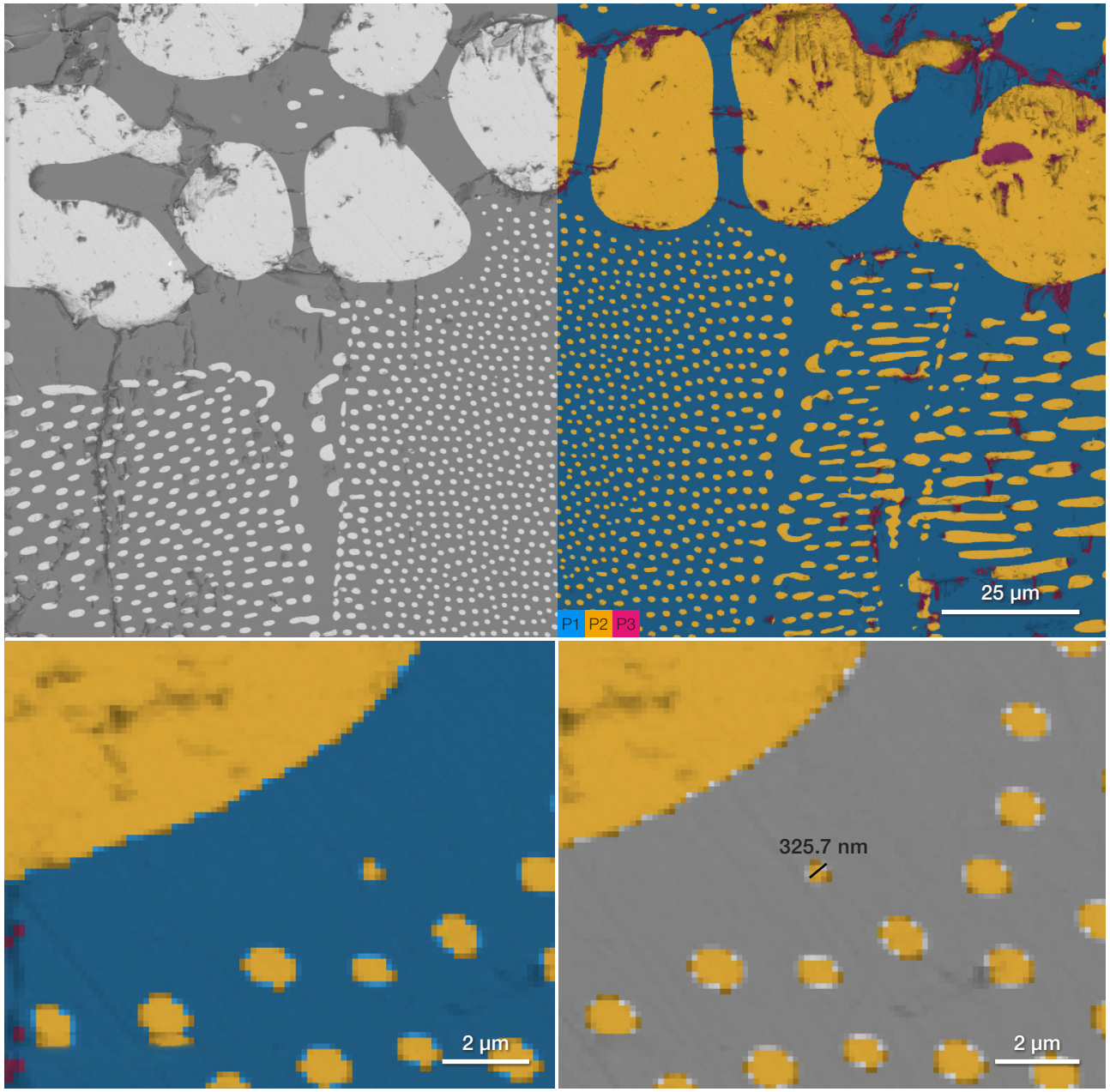
ChemiSEM Technology obtains high-resolution quantitative maps and reliable quantitative results at low kV, reducing the interaction volume and improving the spatial resolution of results. The comparison between the upper and lower images highlights how the use of low acceleration voltage shows more details in the aluminum and nickel quantitative maps. The quantification shown in the table confirms ChemiSEM Technology's reliability at low kVs. Accelerating voltage: 5 keV (top) and 15 keV (bottom). Beam current: 1.6 nA. Captured with the T1 detector.

ChemiSEM Technology includes ChemiPhase, a comprehensive feature that delivers real-time material insight. It's built around an advanced statistical engine to determine all chemically unique regions within the specimen.

ChemiPhase can help you:

- Reduce user bias by running the fully automated process with no prior identification of elements
- Locate minor and trace elements without extensive experience
- Unambiguously identify major and minor components down to a single pixel with complete and comprehensive analysis
- Locate unique components where peak overlaps obscure significant elements
- Analyze during acquisition and start phase determination with as few as 10 counts per pixel
- Complete most acquisitions in less than a minute, even for complex samples

The Apreo ChemiSEM System includes a fully integrated TrueSight EDS Detector with an optimized solid angle for high-throughput analysis, particularly when analyzing at low beam currents. TrueSight Detectors come in different sizes and include a shutter and automated slide as standard, supporting accurate and robust analysis under the widest range of operating conditions.



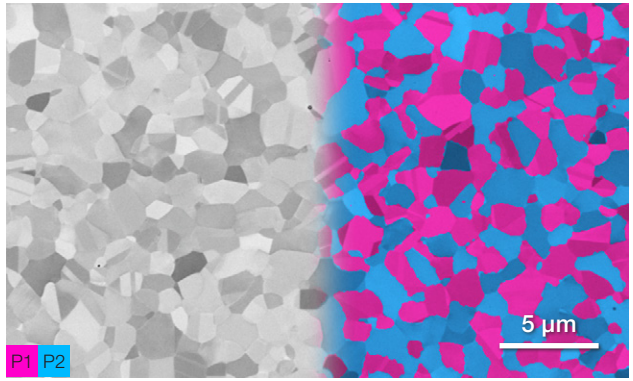
Phase maps of a zirconia mullite created with ChemiPhase. The high resolution makes it possible to identify and assign a phase down to 3 pixels. Accelerating voltage: 5 keV. Beam current: 0.8 nA.

Challenging materials

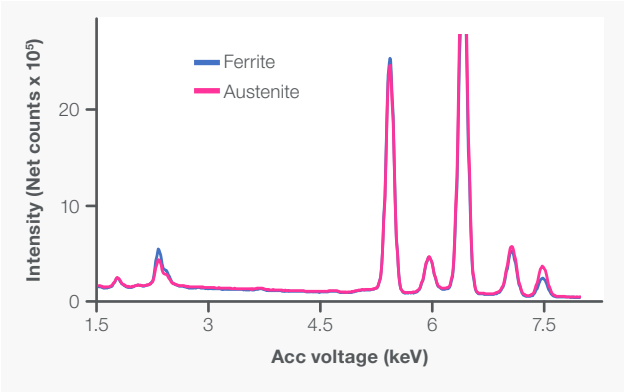
The example here shows a ChemiPhase characterization of a 2205 duplex steel. Duplex steels — a family of stainless steels — get their name from their microstructure, which consists of two phases, austenite and ferrite.

The chemical differences between the austenite and ferrite phases highlight the main challenge of this sample: identifying the distribution of the two phases across the polished surface. Austenite and ferrite, in fact, have little chemical difference, making them difficult to find.

With just the acquisition of the datacube, ChemiPhase automatically identifies the phases in one click and generates their distribution, spectra, and related composition, including their area percentage within the analyzed field of view.



CBS image of the surface of duplex steel (left) and corresponding ChemiPhase map (right) showing the presence of the two main phases, austenite and ferrite. Acceleration voltage: 20 kV. Beam current: 17 nA.



Element	Cr	Mo	Ni	Si	Mn	Fe
Austenite	24	3	8	0.5	1	bal.
Ferrite	27	5	5	0.5	1	bal.

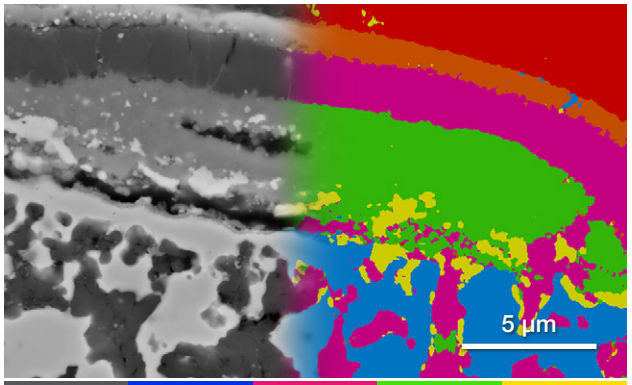
Spectra and quantification of austenite and ferrite extracted from the dataset provided by ChemiPhase. Both the overlay of the spectra and quantification show the small chemical difference between the two phases.

ChemiPhase for industrial applications: A customer use case explained

Superalloys are typically used in turbine blades mounted on jet engines. They must withstand extreme working conditions, especially in terms of temperature, stress, and oxidative environments.

The image on the right shows how the surface changed after being exposed to oxidation; however, because the chemistry of the alloy is extremely complex, both SEM imaging and EDS analysis could not give a complete overview of how the service conditions affected the initial alloy.

ChemiPhase provided a comprehensive analysis of all the different materials and oxides present, along with their composition and distribution across the field of view. With a single analysis, no prior knowledge of the material's chemistry, and no user intervention during elemental selection or data processing, ChemiPhase obtained a complete set of information.



Element	at.% Ni-Co-Cr	at.% Al-O	at.% Cr-Al-O	at.% Cr-Al-Ta-O
O	19.0	55.1	57.5	52.8
Al	14.9	36.6	8.6	9.9
Cr	5.8	2.8	30.2	20.5
Co	7.7	0.8		1.0
Ni	46.6	4.3	2.3	6.0
Ta	1.4	0.4	1.3	9.9
W + Re	3.2			

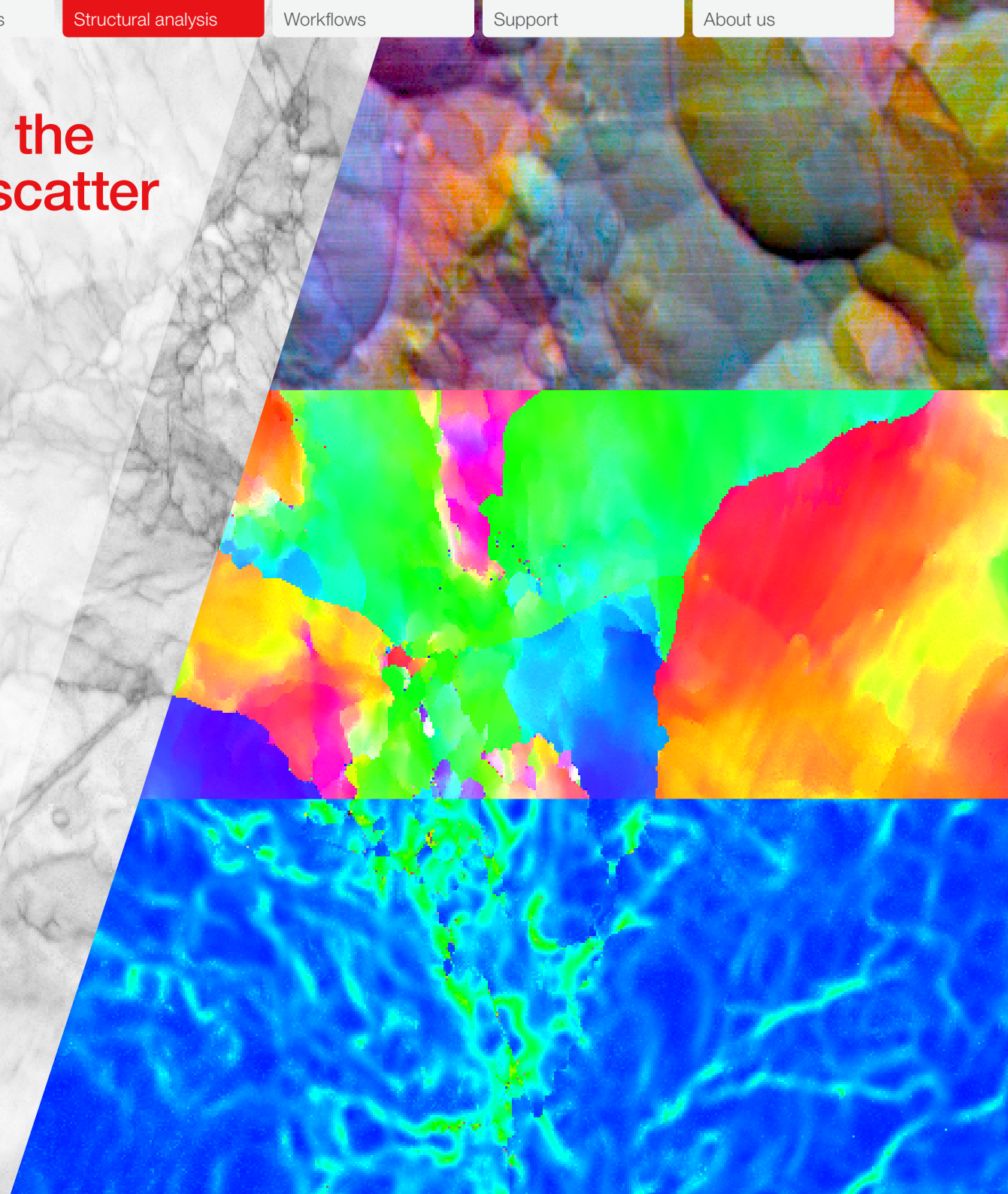
T1 detector image (left) and ChemiPhase characterization (right) of a superalloy's oxidized surface. ChemiPhase also provided quantification of all the phases identified in the area to allow for a complete understanding of how the oxidative environments affected the material.

Uncover structure with the TruePix Electron Backscatter Diffraction Detector

The Apreo ChemiSEM System has an optional high-performance TruePix Electron Backscatter Diffraction (EBSD) Detector that provides a complete understanding of specimen structure.

It gathers a wealth of crystallographic information, including texture, grain distribution, size, shape, boundaries, phase, and strain. The TruePix EBSD Detector delivers high-speed direct electron detection for outstanding low beam energy performance and single particle counting.

Our advanced software enhances EBSD analysis with a range of features. It provides easy analysis, fast time to data, reliable indexing, and a comprehensive set of post processing features.



EBSD characterization of deformed copper. Accelerating voltage: 20 keV. Beam current: 16 nA. Dwell time: 2 ms. Acquisition time: approximately 45 minutes.

Customize your workflow

Powered by Python-based scripting, Thermo Scientific AutoScript Software provides deep control of your instrument that allows you to customize image acquisition and data processing for your specific application.

Whether you are performing quality control, statistical characterization, or complex experiments that combine multiple techniques, AutoScript Software unlocks new possibilities for automated acquisition, analysis, interfacing, imaging, patterning, and data display that can help you improve reproducibility and accuracy. AutoScript Software offers full control over parameters including ChemiSEM EDS for direct insights and repeatable analysis that are critical for industrial quality control and detailed material characterization in research and development.

Download AutoScript Software datasheet

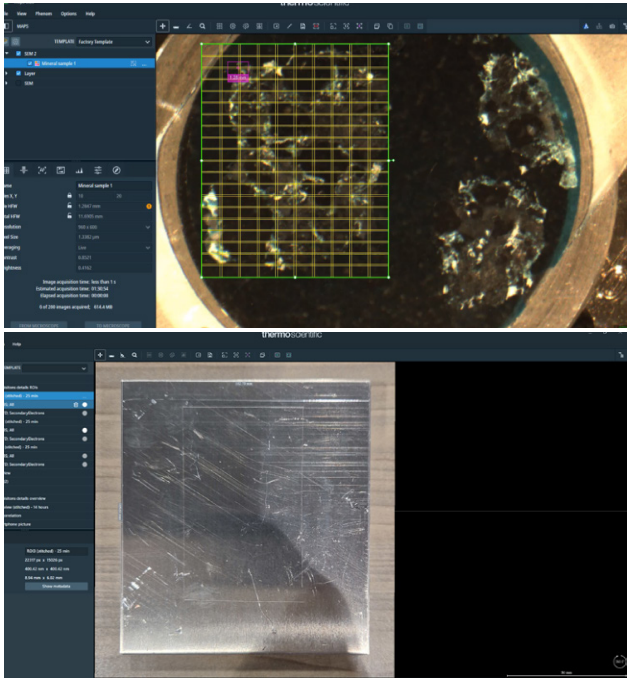
Correlate multi-modal data

Thermo Scientific Maps Software is a comprehensive solution for materials characterization across multiple scales. It allows you to import, align, and visualize images from a variety of formats—including TEM, FIB-SEM, Raman, and infrared—to see a more complete picture of your sample in a single view. Automated image acquisition simplifies creation of 2D mosaic datasets, enabling automatic capture of high-resolution data at specific regions of interest with minimal user intervention. It facilitates detailed inspections by correlating data from multiple sources and scales, enhancing the understanding of complex material behaviors.

Integrated with ChemiSEM Technology, Maps Software offers enhanced chemical imaging capabilities with:

- Efficient data management: Automate the collection of overview mosaics and locate areas of interest quickly, maximizing microscope productivity
- Enhanced data exploration: Review, annotate, and share full-resolution data remotely
- Multi-modal integration: Easily import, align, and visualize data across a wide array of image formats

Maps Software not only automates and simplifies acquisition of complex datasets but also enriches the analysis and sharing of scientific data. You can collaborate effortlessly, sharing insights and building on the digital archives created by Maps Software, all from the comfort of your own devices. This ease of access combined with powerful analytical tools propels research productivity and expedites discovery.



Maps Software user interface.

Download Maps Software brochure

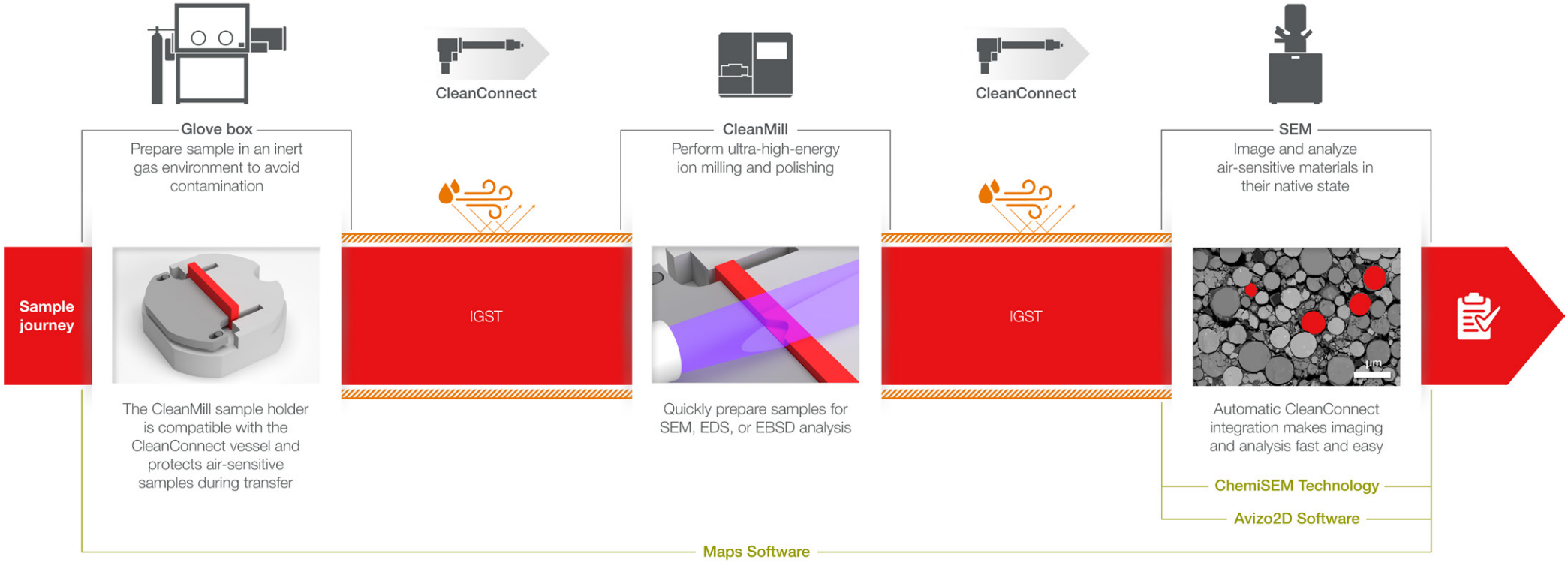
Safely prepare and transfer sensitive samples

The Thermo Scientific™ CleanMill™ Broad Ion Beam System delivers high-quality sample preparation for SEM applications. From rapid milling with the ultra-high-energy ion source to ultra-fine polishing with the low-energy source, the CleanMill System achieves artifact-free surfaces that are essential for accurate material characterization. With automated parameter setting, real-time monitoring, and optional accessories for specialized applications, the CleanMill System sets a new standard in sample preparation for SEM imaging and characterization.

Plus, it is fully compatible with the Thermo Scientific™ CleanConnect™ Sample Transfer System, which protects air-sensitive samples and allows for seamless transfer to the Apreo ChemiSEM System and other Thermo Scientific instruments.

Download CleanMill System application note

Download CleanMill System datasheet



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NanoPorts

Thermo Fisher Scientific supports you at the early stage with demonstrations and application support. The teams at our five NanoPorts can define solutions tailored to your application and provide dedicated on-site or remote demonstrations. In addition to acting as research collaboration centers, our NanoPorts give full support to our R&D, factory, and field service teams, helping to optimize outcomes and improve solutions.

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Our global service logistics network includes warehouses, regional hubs, and local stock locations to ensure that you receive the best customer service. From installation services to on-site and remote maintenance, our team of experts is here to support you at every step.

Learn more

My Microscope tool

With the My Microscope tool, we can quickly respond to issues with your instrument throughout its entire lifespan. Plus, the tool automatically updates the user interface to help you get the most out of your investment.

Learn more

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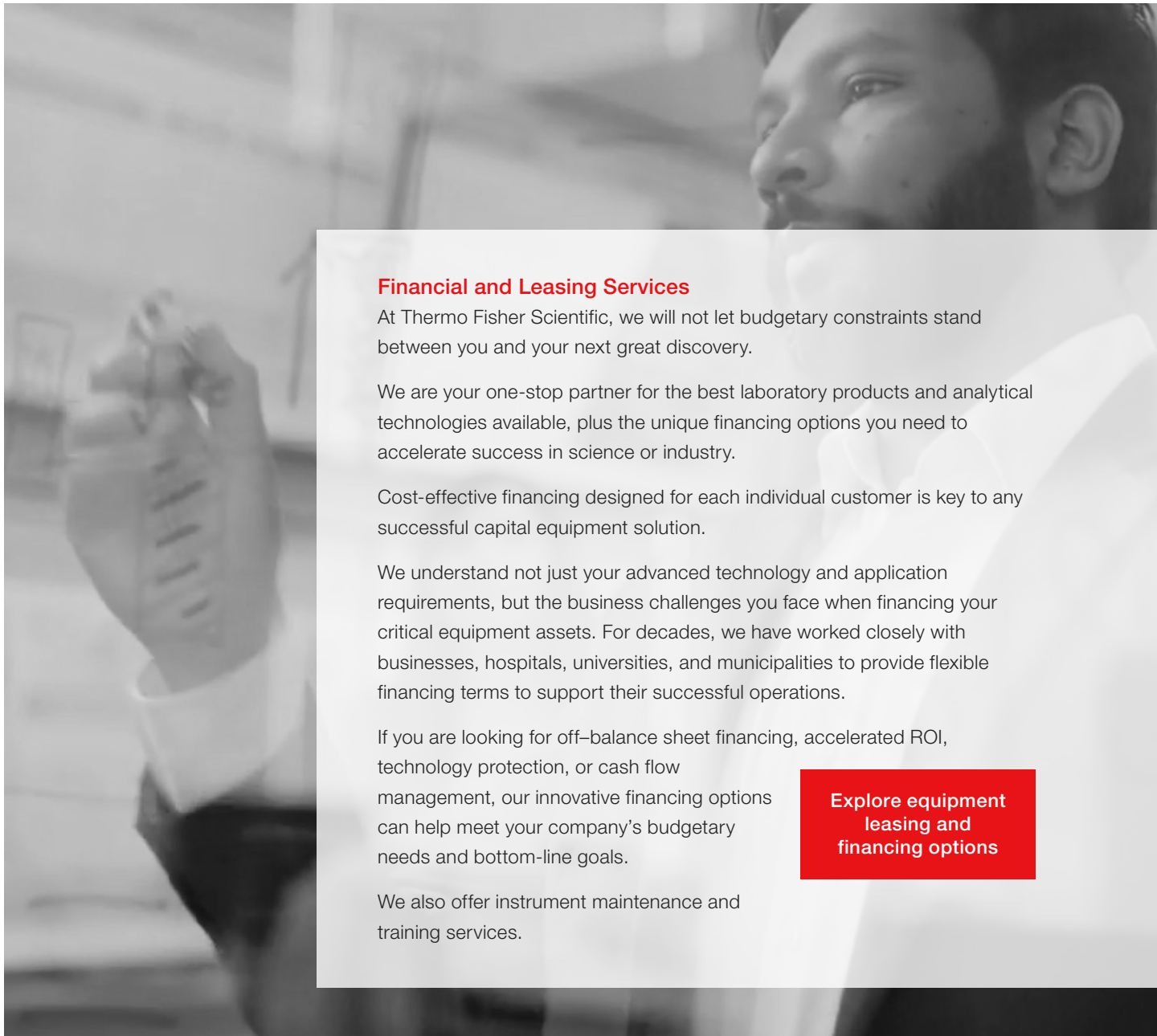
About Thermo Fisher Scientific

We are the world leader in serving science. Our Mission is to enable our customers to make the world healthier, cleaner and safer.

Step ahead. Step beyond. Duration 1.33

Our innovative solutions for electron microscopy, surface analysis, and microanalysis help materials science researchers advance their sample characterization to gain deeper insight into the physical and chemical properties of materials from the macroscale to the nanoscale. Our multiscale, multimodal solutions cover a broad range of applications across dozens of industries and research fields, serving customers in academia, government, and industry. Our TEMs, DualBeam™ FIB-SEMs, comprehensive portfolio of SEMs, XPS, and microanalysis solutions, combined with software suites, take customers from questions to usable data by combining high-resolution imaging with physical, chemical, elemental, mechanical, and electrical analysis across scales and modes.



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At Thermo Fisher Scientific, we will not let budgetary constraints stand between you and your next great discovery.

We are your one-stop partner for the best laboratory products and analytical technologies available, plus the unique financing options you need to accelerate success in science or industry.

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