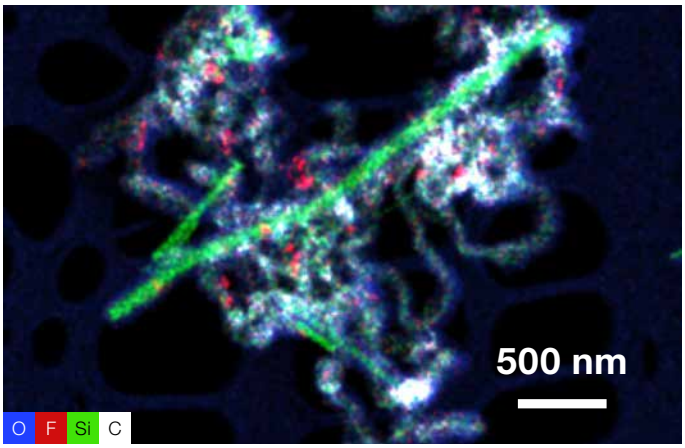
Talos F200X G2 (S)TEM for Battery Applications

Guiding design of battery materials with fast and clean chemical analysis

The Talos F200X G2 Scanning Transmission Electron Microscope ((S)TEM) delivers fast, precise, and quantitative high-resolution characterization of battery materials for composition and chemical state. With innovative features designed to increase throughput, precision, and ease of use, the Talos F200X G2 (S)TEM is ideal for advanced research and analysis across academic, government, and industrial research environments.

High-resolution imaging for better-quality data

The Thermo Scientific™ Talos™ F200X G2 (S)TEM combines outstanding high-resolution (S)TEM and TEM imaging with industry-leading energy dispersive X-ray spectroscopy (EDS) signal detection (Super-X G2), and 3D chemical characterization with compositional mapping. Its standard X-TWIN pole piece gap, which provides the highest flexibility in applications, combined with a reproducibly performing electron column opens opportunities for high-resolution 2D and 3D characterization, *in situ* dynamic observations, and diffraction applications. The Talos F200X G2 (S)TEM is equipped with the 4k × 4k Thermo Scientific Ceta™ 16M Camera, which provides a large field of view and fast imaging with high sensitivity on a 64-bit platform.



2D EDS map of solid electrolyte interface (SEI).
Sample courtesy of Dr. Chongmin Wang, PNNL.

Key Benefits

Available with two types of high-resolution field emission guns (FEG). Choose high-brightness X-FEG or ultra-high-brightness X-CFEG. X-CFEG combines the best STEM imaging with the best energy resolution.

High-quality (S)TEM images and accurate Thermo Scientific Super-X™ G2 EDS. Acquire high-quality (S)TEM images with the innovative and intuitive Thermo Scientific Velox™ Software user interface in very a simple way. Super-X G2 EDS provides the cleanest spectra with the highest peak to background (Fiori) number. Unique EDS absorption correction in Velox Software enables the most accurate quantification.

Best all-round *in situ* capabilities. Add tomography or in situ sample holders. Fast cameras, smart software, and our wide X-TWIN objective lens gap enable 3D imaging and in situ data acquisition with minimal compromise to resolution and analytical capabilities.

Increased productivity. Ultra-stable column and remote operation with SmartCam and constant-power objective lenses for swift mode and HT switches. Fast and easy switching for multi-user environments. Add Maps Software or the Automated Particle Workflow (APW) package to acquire and analyze large areas at high resolution; run it overnight to get the maximum out of your system time.

Most repeatable data. All daily TEM tunings, such as focus, eucentric height, beam shift, condenser aperture, beam tilt pivot points, and rotation center, are automated in the Align Genie Automation software, ensuring you always start from optimum imaging conditions. Experiments can be repeated reproducibly, allowing for more focus on research instead of on the tool.

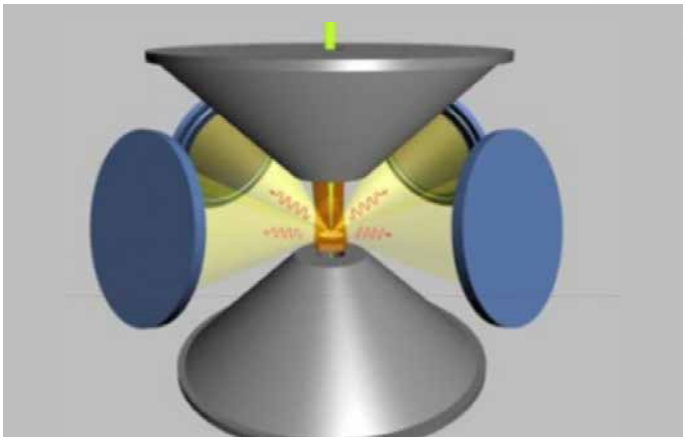
Large field-of-view imaging at high speed. The 4k × 4k Ceta CMOS Camera with its large field of view enables live digital zooming with high sensitivity and high speed over the entire high-tension range.

Smart Enclosure with touch screen for easy on-system access and sample loading instructions

The X-FEG high brightness electron source delivers a high total current—up to five times the beam current of a standard Schottky FEG—while keeping the convergence angle small. You gain an improved signal-to-noise ratio and exceptional image resolution for STEM, EDS, and high-resolutionTEM applications. Select the ultra-high-brightness cold FEG (X-CFEG) source for the ultimate imaging and analytical performance.

Accelerate nanoanalysis for faster answers

The Talos F200X G2 (S)TEM includes the patented Super-X G2 integrated EDS system with four individual, independent silicon drift detectors (SDDs) for superior sensitivity (highest Fiori peak to background number) and mapping capabilities of up to 10^5 spectra/sec. Integration with the X-TWIN objective lens maximizes collection efficiency while delivering outstanding output count rates for a given beam current—even for low-intensity EDS signals. Super-X G2 EDS is fully embedded in Velox Software to enable unique absorption correction for the most accurate quantification at all tilts. Super-X also enables automated EDS tomography.



Symmetrical Super-X G2 EDS.

Make research easier

The Talos (S)TEM makes imaging and analysis workflows accessible to a broader audience, with a friendly digital user interface and class-leading ergonomics.

More productivity

Image quality is sometimes reduced by drift, vibrations, or other instabilities during acquisition. These prevent you from obtaining the best-quality (S)TEM images, since only short exposure times can be chosen or beam damage occurs. Drift-corrected frame integration (DCFI) allows imaging with high contrast and high signal-to-noise ratio. Add integrated Differential Phase Contrast

(iDPC) to more reliably and accurately image light and heavy elements simultaneously, even at low dose. To further enhance productivity, especially in multi-user, multi-material environments, the constant-power objective lenses and low-hysteresis design allow for straightforward reproducible mode and high-tension switches. The Talos F200X (S)TEM also features educational, online help. Simply pressing F1 with the mouse hovering over a control panel quickly opens relevant information. The system is equipped with a touch screen that gives you quick and easy access to relevant parameters, and it also provides holder loading and uploading instructions on-the-fly while loading or retracting the sample holder.

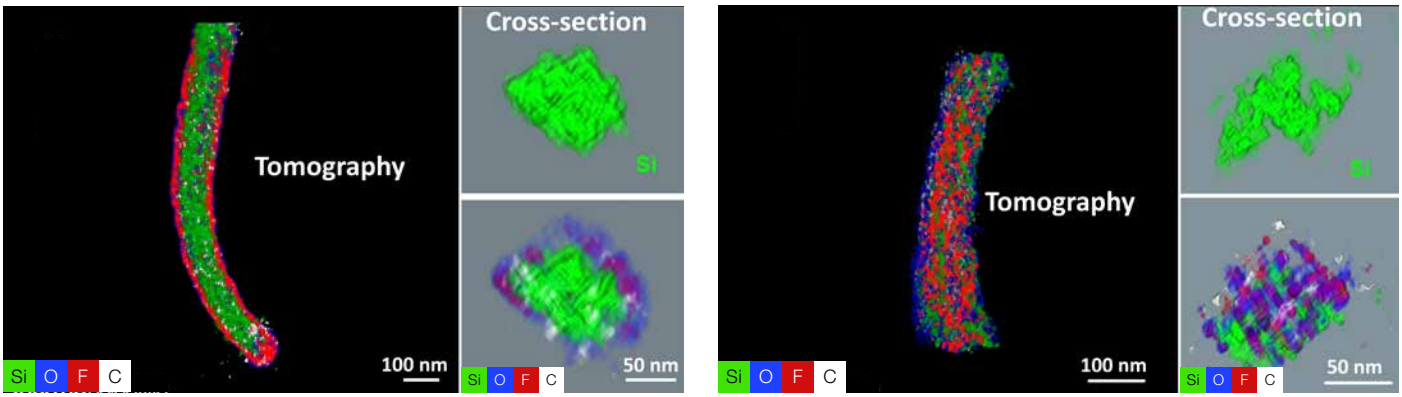
More battery science

Our high-brightness X-FEG or ultra-high brightness X-CFEG combined with the high-speed Super-X G2 EDS detectors enables accurate chemical analysis at lower doses on a wider range of samples, including beam-sensitive materials.

Resolving the SEI's composition and structure is essential for understanding how lithium ions move in and out of the electrode, providing information on how the capacity retention drops over battery cycling. Acquisition of elemental information can be expanded to three dimensions as shown in the image to the right where 3D-EDS reveals inward growth of SEI facilitated by the internal structure deterioration of nanosized silicon with cycling.

After 1st charging cycle

After 100th charging cycle



3D EDS tomogram of SEI after cycling. ***Sample courtesy of Dr. Chongmin Wang, PNNL.***

Features

- Class-leading optical performance: Constant-power X-TWIN objective lens
- Maximized ease-of-use: Fast, easy operation switching, fits for multi-user environments
- Ultra-stable platform: Constant power objective lens, piezo stage, robust system enclosure, and remote operation ensure maximum stability
- SmartCam camera: Digital search-and-view camera improves the handling of all applications and allows daylight operation
- Fully integrated fast detector: Ceta 16M pixel CMOS Camera provides a large field of view and high read-out speed (25 fps @ 512 × 512)
- Full remote operation: Motorized aperture system in combination with the Ceta and SmartCam Camera supports full remote operation

Installations requirements

Refer to preinstall guide for detailed data.

Talos F200X G2 (S)TEM	
Brightness X-FEG/X-CFEG	1.8/2.4 × 10^9 A/cm² srad (@200kV)
Super-X EDS system	4 SDD symmetric design, windowless, shutter-protected
EELS resolution	0.8 eV (X-FEG) / 0.3 eV (X-CFEG)

X-Twin	
STEM HAADF resolution	0.16 nm (X-FEG) / 0.14 nm (XCFEG)
EDX solid angle	0.9 srad
TEM Information limit	0.12 nm (X-FEG) / 0.11 nm (XCFEG)
Maximum diffraction angle	24°
Maximum tilt angle with double tilt holder	±35° alpha tilt / ±30° beta tilt
Maximum goniometer (stage) tilt angle	±90°

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Notes

Learn more at **thermofisher.com/talos**

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