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DATASHEET

Spectra 300 S/TEM for Advanced Semiconductor Analysis

Ultra-high performance for a comprehensive range of semiconductor applications

The Spectra 300 S/TEM is the Thermo Scientific highest resolution imaging and spectroscopy platform. With its wide-gap pole piece and an accelerating voltage range of 30–300 kV, it enables the widest range of material and device characterization for advanced R&D and failure analysis applications.

More than high resolution

The Thermo Scientific™ Spectra 300 S/TEM combines:

- Redesigned, high-stability base
- New ultra-high resolution (X-FEG UltiMono) source or a ultra-high brightness (X-CFEG) source
- Image and 5th order probe aberration correction (S-CORR)
- Single electron sensitive STEM detection
- Sensitive energy dispersive X-ray spectroscopy (EDS) detectors
- Improved spatial resolution without sacrificing EDS efficiency

By synchronizing these technologies through our advanced software and automation modules, the Spectra 300 S/TEM makes accessing the highest-resolution atomic-scale information more efficient, easy and repeatable than ever.

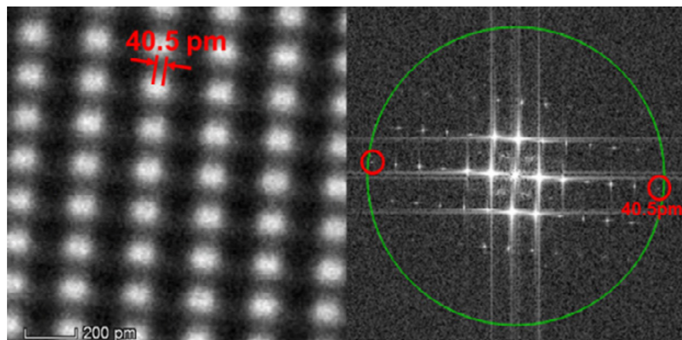

Figure 1. HAADF (DCFI) STEM image of GaN [212] at 300 kV showing 40.5 pm resolution on a wide gap (S-TWIN) pole piece.

Key Benefits

Best atomic characterization. Optimized electron optical performance and ultra-sensitive detection enables the best combination of atomic imaging and analysis in 2D and 3D.

Most repeatable data. Sophisticated software automation routines such as OptiSTEM+ and OptiMono+ optimize the system to its peak performance, resulting in more repeatable and quantifiable data.

Optimum EDS performance. Guaranteed by a portfolio of symmetric detector geometries, which contributes to our unique quantification capability, in combination with an ultra-high brightness X-CFEG to provide rapid EDS mapping across the widest range of materials.

Best *in situ* and dynamic experiments. Fast cameras, chemical detectors, smart software and our wide-gap S-TWIN lens enable *in situ* data acquisition with no compromise on resolution and analytical capabilities.

Best environmental stability. The redesigned enclosure and ultra-stable Spectra 300 S/TEM base with passive and (optional) active vibration isolation (with iVIS) minimize external environmental influences and ensure the highest-quality data from long-term and short-term experiments.

Widest range of semiconductor characterization in one platform. The best combination of optics, ultra-sensitive detection and wide-gap pole piece, ensures that even the lightest, most sensitive materials can be characterized at the atomic scale.

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With the combination of its large-gap objective lens (the Thermo Scientific S-TWIN/X-TWIN), superior optics and analytics, the Spectra 300 S/TEM delivers both performance and flexibility in one tool. S-CORR probe correction enables the highest commercially available STEM resolution specification at 300 kV (50 pm) and at 60 kV (96 pm). It also provides in situ, dynamic and 3D EDS tomography capability without the need for non-standard holders/sample types and switching of the asymmetrically located EDS detector. When equipped with an extreme field emission gun (X-FEG) Mono/UltiMono, the same fully flexible system can achieve ultra-high-energy resolution in the <200 meV/<30 meV regime.

Our powerful and advanced software allows specialized techniques like integrated differential phase contrast (iDPC) imaging for the study of magnetic and electrical properties, for optimized Z-contrast imaging from hydrogen to uranium and for low-dose high-contrast STEM imaging of beam-sensitive semiconductor structures.

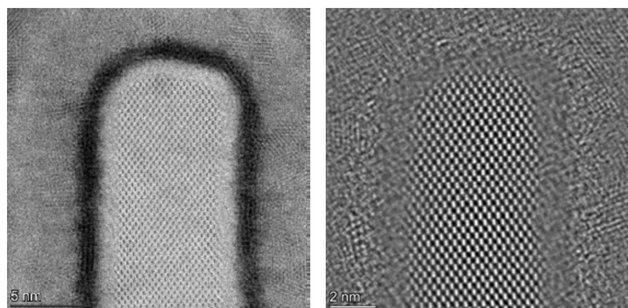

Figure 2. High-resolution ABF STEM image (left) and iDPC image (right) of a semiconductor FinFET at 200 kV.

Best characterization, down to the atomic level

The new S-CORR by Thermo Fisher Scientific provides specified sub-Angstrom imaging resolution from 60 to 300 kV and an order of magnitude improvement in the stability and lifetime of the corrected state, compared to previous generation DCOR technology. The S-CORR is capable of correcting A5 for all accelerating voltages. When combined with the new Auto S-CORR alignment software and OptiSTEM, the S-CORR can not only tune all aberrations up to 5th order (which is particularly important when high spatial resolution is required at accelerating voltages <120 kV) but can also achieve daily optimization automatically. The probe profile can be tuned to suit the experiment required (i.e. optimized for ultra-high-resolution STEM imaging or high-throughput spectroscopy).

The highest-quality atomic-level chemistry and bonding-state research is enabled by EDS and electron energy loss spectroscopy (EELS), with speeds up to a few thousands spectra per second.

More reliable data and higher productivity

Fully automated, single-click access to the highest-resolution STEM (<50 pm) and energy-resolution EELS (<30 meV) experiments are enabled for all users with new Thermo Scientific OptiSTEM+ and OptiMono+ software automation packages on the Spectra 300 S/TEM.

Additionally, drift corrected frame integration (DCFI) ensures that the most repeatable, high-quality, atomic-resolution images are possible and that recursive mapping capabilities guarantee the best chemical analysis. Our “look back” functionality, available within our acquisition software, guarantees that you never miss anything, since results can be stored and analyzed later.

An integrated Faraday cup provides an accurate calibration of the beam current measurement, which is pivotal for quantitative and reliable imaging and analysis. The Faraday cup measurement guarantees experimental repeatability between different Thermo Scientific tools.

The Spectra 300 S/TEM can be configured with either the Thermo Scientific Super-X or Dual-X integrated EDS system. Both have multiple silicon drift detectors (SDD) (for superior sensitivity) and both have proven to be successful in semiconductor applications, with mapping capability of up to 100,000 spectra/sec. Integration with the wide-gap pole piece maximizes collection efficiency while delivering outstanding output count rate for a given beam current – even for low intensity EDS signals. The efficiency of the Dual-X EDS system enables the highest resolution (4k x 4k pixels) EDS maps.

The highly stable Spectra 300 base makes high-tension switching even easier than before. As low-dose, lower kV becomes more important for analyzing beam sensitive semiconductor structures, the ability to change acceleration voltages and acquire your first image in a matter of minutes offers significant productivity benefits.

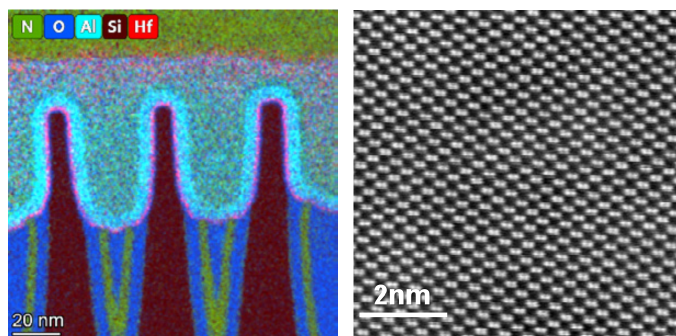

Figure 3. X-ray mapping of a device and Si HRSTEM image at 60 kV.

Panther: the next generation in low dose STEM imaging

Spectra 300 S/TEM is equipped with Panther - an entirely new, segmented STEM detection and data infrastructure unit. The new detector geometry offers access to advanced STEM imaging capability combined with the sensitivity and detectability to measure single electrons.

The entire signal chain has been optimized and tuned to provide unprecedented signal-to-noise-ratio-imaging capability with extremely low probe currents (<1 pA). When combined with sensitive STEM imaging techniques such as iDPC, new possibilities are enabled for imaging dose-sensitive samples which have typically been very difficult to characterize with a TEM.

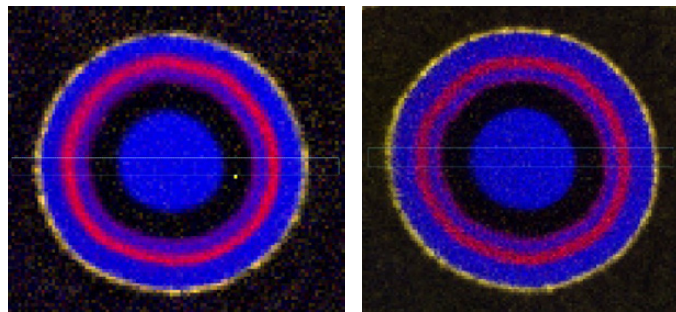

Figure 4. EELS (left) and EDS (right) spectrum imaging of 3D NAND. Oxygen - blue, nitrogen – red, titanium – yellow.

Spectra 300 S/TEM resolution specifications*	Energy resolution	Information limit	STEM resolution
Uncorrected	0.8 eV	100 pm	136 pm
Image corrected	0.8 eV	70 pm	136 pm
Probe corrected	0.8 eV	100 pm	50 pm
Double-corrected (X-FEG+Mono/UltiMono)	0.2–0.3 eV**/ 0.03 eV	60 pm	50 pm
Double-corrected (X-CFEG)	0.4 eV	100 pm	50 pm

* At 300kV and for X-FEG unless otherwise specified

** Depending on energy filter option.

Technical highlights

- Configurable electron source options: X-FEG+ monochromator; X-FEG+ UltiMono and X-CFEG
- New S-CORR probe corrector corrects six-fold astigmatism at all accelerating voltages
- New Auto S-CORR auto-alignment software up to high order aberrations correction
- Thermo Scientific ConstantPower™ lens and corrector design for ultimate thermal stability in mode switches, minimizes image drift
- Piezo stage with 20 pm step for fine specimen centering and specimen drift compensation
- Live TEM image rotation aligning device features and synchronized with the stage movement
- Super-X and Dual-X EDS system options
- Symmetrical EDS detector design allows 3D EDS study of devices
- OptiMono and OptiSTEM, automation packages to optimize energy resolution and STEM image, respectively
- Digital search-and-view camera, the SmartCam, improves the handling of all applications and allows daylight operation
- Fully digital system with remote control operation
- Fast, easy operation and mode switching improves productivity

Installation requirements

Please refer to the pre-install guide for details

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Notes

Find out more at **thermofisher.com/EM-Sales**

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