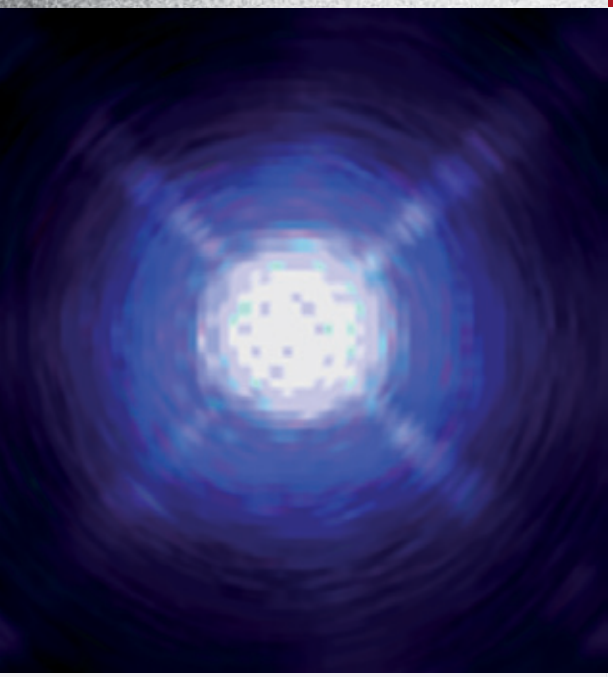


X-FEG module for Titan™

The X-FEG is a unique high brightness module that enables dramatically improved imaging and spectroscopy performance without adding operating complexity

Achieving ultimate performance in S/TEM imaging strongly depends on the properties and characteristics of the electron source. The brightness, temporal and spatial coherence and the total current of the electron source play a vital role in atomic resolution S/TEM applications.

The novel X-FEG module combines the benefits of the Schottky FEG emitter (S-FEG) such as high total current, stability and a long lifetime with a considerably increased brightness. Its brightness equals that of C-FEG emission (cold field emission gun), but still provides a symmetric energy distribution with and without monochromator technology for EELS applications, and a significantly higher total current, which ensures good illumination intensities at midrange magnifications. The X-FEG module delivers not only high currents into Ångström probes that were previously only achievable with C_s corrector technology, but also allows for minimizing of the beam convergence angle for analytical applications. Small convergence angles improve the lateral resolution in analytical applications, because a smaller 3D volume is excited in the specimen. The X-FEG makes use of optimized Schottky field emission technology, known for its robustness and reliability for more than 20 years. This makes it an easy to use module with a long life time, which is designed for a higher throughput. The illumination current is ultra-stable over time and the emission tip does not require flashing or resetting. These are key benefits for experiments that are very sensitive to any emission fluctuations, such as tomography, focus series reconstruction, EFTEM or chemical mapping applications.

The X-FEG module supports the Titan™ philosophy of not compromising TEM or STEM, but maximizing the performance in each mode of operation. In STEM, high brightness is a mandatory requirement for ultimate results in atomic resolution applications. In TEM, a higher spatial coherence results in an improved information transfer or higher resolving power.

Key Benefits

- Maximize analytical probe currents to improve lateral resolution in chemical analysis
- Enhance time to result and signal to noise ratio in S/TEM imaging and chemical analysis
- Improve spatial coherence for holography and HR-TEM applications
- Benefit from the excellent stability of the emission in automated experiments
- The ease of use coupled with the long life time and robustness of Schottky emitter technology maximizes your throughput
- Explore the frontiers in electron microscopy with the combination of an X-FEG with corrector and monochromator technology
- Upgrade your Titan S/TEM with the new X-FEG to boost your performance

Essential Specifications

- Operating voltage: 80 to 300 kV
- Energy resolution (300 kV): ≤ 0.8 eV
  with monochromator (300 kV): ≤ 0.2 eV
- Brightness: ≥ 7 x 107 A /m2 sr V
- Current in STEM at 300 kV 0.2 nm* (10 mrad): ≥ 250 pA
- Probe CS corrected current in STEM: ≥ 2000 pA
  at 300 kV 0.2 nm* (30 mrad)
- Total current: ≥ 50 nA**
- Emission stability (long and short term): ≤ 1 %
- Guaranteed emitter life time: ≥ 1 year

* *proven by the transfer of the 0.2 nm frequency in the Fourier transformed of an HAADF STEM image*
** *≥ 20 nA in combination with monochromator*

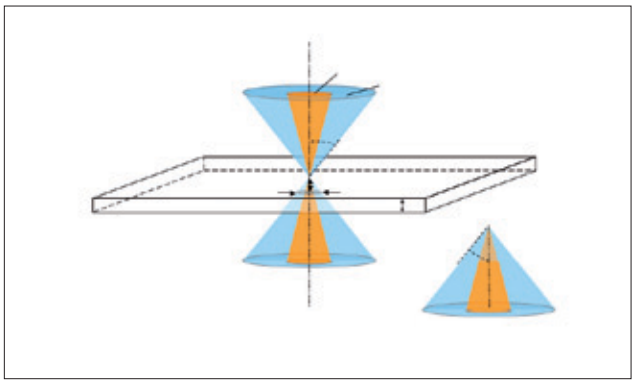
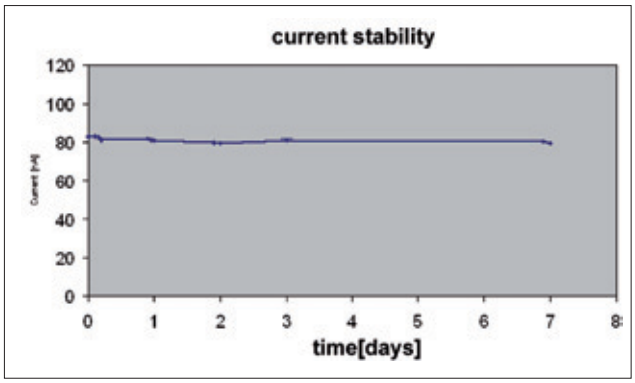
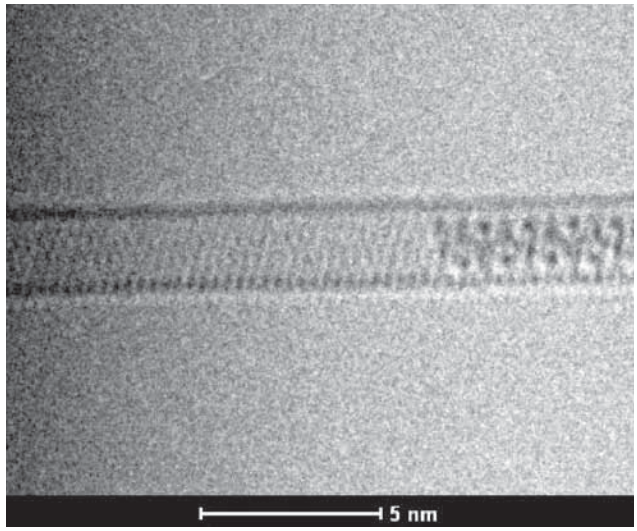


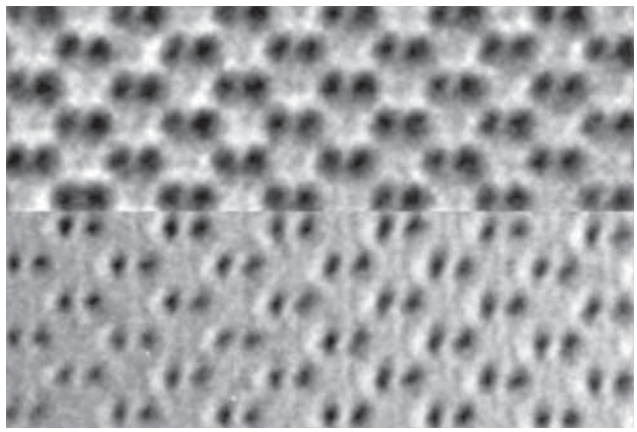
Diagram of the excited 3D volume in a sample with thickness t using two beams with different convergence angles. At a thickness of 10 nm the excited volume increases significantly, because the blurring b on the back of the sample is 2t* = 2*10 nm*0.03 = 0.6 nm for 30 mrad while the blur is only 0.2 nm for α = 10 mrad. Thus smaller opening angles α (10 mrad) with higher brightness electron sources improve the lateral resolution in chemical analysis.



Long term measurement of the emission stability over a period of 7 days. The emission current variation of the X-FEG is better than 1% per day. The X-FEG enables reliable data to be obtained and is suitable for high throughput applications.



HR-TEM image of partially filled single wall carbon nanotube at 80 kV acceleration voltage using a monochromator gun with X-FEG on a Titan with image Cs corrector (1 s). The high brightness of the X-FEG allows for atomic resolution imaging at 80 kV with short exposure times. Courtesy of Prof. N. Kiselev, Institute of Crystallography, Moscow, Russia.



HR-TEM image of germanium in the <110> direction at 300 kV. The upper image has been acquired with S-FEG gun, the lower with monochromator X-FEG on a Titan with image Cs corrector. The signal to noise ratio has not changed, while the resolution is significantly improved by the use of the monochromator X-FEG combination.

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