

FEI Titan G3 50-300 PICO

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Abstract: The FEI Titan G3 50-300 PICO is a unique fourth generation transmission electron microscope which has been specifically designed for the investigation of a wide range of solid state phenomena taking place on the atomic scale and thus necessitating true atomic resolution analysis capabilities. For these purposes, the FEI Titan G3 50-300 PICO is equipped with a Schottky type high-brightness electron gun (FEI X-FEG), a monochromator unit, and a Cs probe corrector (CEOS DCOR), a Cs-Cc achro-aplanat image corrector (CEOS CCOR+), a double biprism, a post-column energy filter system (Gatan Quantum 966 ERS) as well as a 16 megapixel CCD system (Gatan UltraScan 4000 UHS). Characterised by a TEM and STEM resolution well below 50 pm at 200 kV, the instrument is one of the few chromatically-corrected high resolution transmission electron microscopes in the world. Typical examples of use and technical specifications for the instrument are given below.

1 System Overview



Figure 1: FEI Titan G3 50-300 PICO transmission electron microscope (photograph by courtesy of Christian Lüning (www.arbeitsblende.de)).

2 Typical Applications and Limitations of Use

The configuration of the FEI Titan G3 50-300 PICO allows a variety of advanced transmission electron microscopy techniques to be applied to wide bunch of solid state materials. These techniques include electron energy loss spectroscopy (EELS), energy filtered transmission electron microscopy (EFTEM), high resolution transmission electron microscopy (HRTEM), high resolution scanning transmission electron microscopy (HRSTEM) with annular detectors for bright-field, annular dark-field, and high-angle annular dark field imaging, off axis electron holography (OAEH), electron tomography (ET), and combinations of the previous techniques.

The FEI Titan G3 50-300 PICO is not intended for the investigation of aqueous, contaminated, ferromagnetic or organic samples without further discussions with both of the instruments officers and the ER-C general management.

3 Sample Environment

Apart from the special case of the utilization of dedicated cooling or heating stages, the FEI Titan G3 50-300 PICO will allow samples to be investigated either under room temperature or liquid nitrogen cooling conditions at a vacuum level of about 10^{-8} mbar. Besides this standard setup, the sample

environment can be adapted to various conditions, e.g. the thermal treatment or the application of external electric or magnetic fields to samples, making use of a wide portfolio of *in situ* TEM holders available through the ER-C user services.

4 Technical Specifications

- electron acceleration voltage 50 kV ... 300 kV
- electron beam current < 140 nA
- information limit (TEM) @ 300 kV < 55 pm
- information limit (TEM) @ 200 kV < 50 pm
- information limit (TEM) @ 80 kV < 70 pm
- information limit (TEM) @ 50 kV < 90 pm
- total system drift (TEM) < 300 pm min⁻¹ (rms)
- resolution (STEM) @ 300 kV < 50 pm
- resolution (STEM) @ 200 kV < 80 pm
- combined electron probe and sample drift < 200 pm min⁻¹ (rms)
- system energy resolution @ 300 kV & 200 pA < 0.20 eV
- system energy resolution @ 200 kV & 30 pA < 0.12 eV
- system energy resolution @ 80 kV & 40 pA < 0.10 eV

5 Detectors

- Peltier cooled Gatan Ultrascan 4000 UHS charge coupled device camera (CCD) with a readout speed of 4 M pixel sec⁻¹ and a format of 4096 x 4096 pixels of 15 microns in size.
- Gatan Quantum 966 ERS image filter (GIF) with fully 2nd and 3rd order and partially 4th order corrected prisms and a maximum field of view of 17 µm for imaging and 120 mR for diffraction analyses, with additional STEM detectors implemented.
- Fischione Model 3000 HAADF detector.

6 Specimen Stages

- double tilt low background holder $\pm 40^\circ$
- high field of view single tilt tomography holder $\pm 70^\circ$
- dual-axis tomography holder $\pm 50^\circ$
- on axis rotation tomography holder 360°
- further *in situ* specimen stages available

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