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FEI Titan 80-300 STEM

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Abstract: The FEI Titan 80-300 STEM is a scanning transmission electron microscope equipped with a field emission electron gun, a three-condenser lens system, a monochromator unit, and a Cs probe corrector (CEOS), a post-column energy filter system (Gatan Tridiem 865 ER) as well as a Gatan 2k slow scan CCD system. Characterised by a STEM resolution of 80 pm at 300 kV, the instrument was one of the first of a small number of sub-ångström resolution scanning transmission electron microscopes in the world when commissioned in 2006.

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1 System Overview

Figure 1: FEI Titan STEM 80-300 scanning transmission electron microscope (photograph by courtesy of Ralf-Uwe Limbach (Forschungszentrum Jülich)).

2 Typical Applications and Limitations of Use

The FEI Titan 80-300 STEM allows a variety of advanced scanning transmission electron microscopy investigations to a wide range of materials. Techniques like electron energy loss spectroscopy (EELS), energy filtered transmission electron microscopy (EFTEM), high resolution scanning transmission electron microscopy (HRSTEM) with detectors for bright-field, annular dark-field, and high-angle annular dark field (HAADF) imaging, electron tomography (ET), and combinations of the previous techniques. The FEI Titan 80-300 STEM 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 utilisation of dedicated cooling or heating stages, the FEI Titan 80-300 STEM 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. thermal treatment under vacuum or under gas atmosphere up to 1 bar using a MEMS-based closed-cell holder, or the application of external electric or magnetic fields to samples, making use of a wide portfolio of in situ TEM holders available at the ER-C.

4 Technical Specifications

- electron acceleration voltage 200 kV ... 300 kV
- electron beam current < 140 nA
- resolution (STEM) @ 300 kV < 80 pm
- information limit (TEM) @ 80 kV < 200 pm
- system energy resolution @ 300 kV & 40pA < 0.12 eV

5 Detectors

- Peltier-cooled Gatan Ultrascan 2k charge coupled device (CCD) camera.
- Gatan Tridiem 865 ER image filter (GIF) with fully 2nd and 3rd order and partially 4th 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 ± 40 °
- high field of view single tilt tomography holder ± 70 °
- dual-axis tomography holder ± 50 °
- on axis rotation tomography holder 360 °
- further *in situ* specimen stages available

References

Cui, C., Gan, L., Heggen, M., Rudi, S., & Strasser, P. (2013). Compositional segregation in shaped Pt alloy nanoparticles and their structural behaviour during electrocatalysis. *Nature Materials*, *12*(8), 765-771. http://dx.doi.org/10.1038/nmat3668

Heggen, M., Houben, L., & Feuerbacher, M. (2010). Plastic-deformation mechanism in complex solids. *Nature Materials*, *9*(4), 332-336. http://dx.doi.org/10.1038/nmat2713

Heidelmann, M., Barthel, J., & Houben, L. (2009). StripeSTEM, a technique for the isochronous acquisition of high angle annular dark-field images and monolayer resolved electron energy loss spectra. *Ultramicroscopy*, *109*(12), 1447-1452. http://dx.doi.org/10.1016/j.ultramic.2009.07.007

Luysberg, M., Heidelmann, M., Houben, L., Boese, M., Heeg, T., Schubert, J., & Roeckerath, M. (2009). Intermixing and charge neutrality at DyScO3/SrTiO3 interfaces. *Acta Materialia*, *57*(11), 3192-3198. http://dx.doi.org/10.1016/j.actamat.2009.03.031