| | |
|---|---|
| **Equipment Name:**<br>**Titan Transmission Electron Microscope [TEM]** | **Category:**<br><br>**B. Particle Labelling and/or**<br>**C. Particle Characterisation in and ex-situ**<br><br>**Institute: CRANN, Trinity College Dublin**<br><br>**Location: CRANN Advanced Microscopy Laboratory, Unit 27-29, Trinity Enterprise Centre, Grand Canal Quay, Dublin 2, Ireland**<br><br>**Contact Details of Technology Expert:**<br>**Name: Dr. Colm Faulkner**<br>**Phone: +353-1-896 4170**<br>**Fax,: +353-1-896 3037**<br>**E-mail: colm.faulkner@tcd.ie** |

**Short technology description/Overview:**

A field emission Transmission Electron Microscope (TEM) with accelerating voltages between 80kV and 300kV capable of sub-angstrom imaging. This TEM is ideally suited to materials qualification, nano-metrology, and ultra-high resolution characterisation of nano-particles. Very high quality materials characterisation and analysis can be performed before any in-vivo experiments, or functionalisation of the nano-materials. .

Nano-particles are imaged with angstrom resolution, and are characterised in terms of elemental composition and crystallographic orientation. The analytical capability of the Titan can chemically identify different atomic constituents of a material with nm resolution.

**Technical Specifications:**

• HRTEM (Including exit wave reconstruction)
• Atomic Resolution
• HRSTEM (Z-contrast imaging)
• Electron Diffraction
• Convergent Beam Electron Diffraction
• Dark field imaging of lattice defects
• Electron Spectroscopic imaging
• Electron Energy Loss Spectroscopy and a Gatan Tridiem energy filtering system
• Energy Dispersive X-Ray Spectroscopy

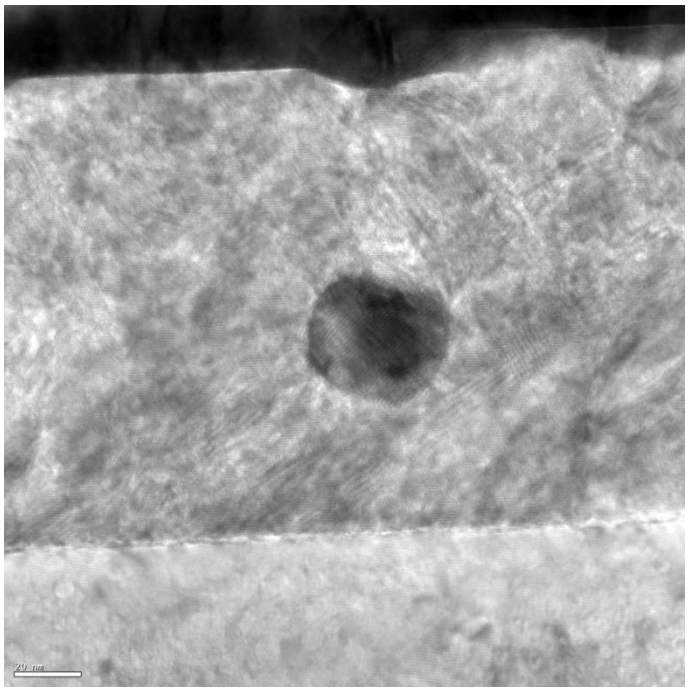
**Main Features (Equipment Capabilities):**

The Titan 80-300 TEM offers sub-Ångstrom resolution (<0.1 nm), enabling imaging with atomic resolution in both normal imaging mode (bright-field) and scanning TEM (STEM) mode. This extraordinary performance level, combined with automated experiments to assist operators during analysis, enables analytical and structural characterization of specimens at an atomic scale. Analytical capabilities include Energy Dispersive X-ray Spectroscopy (EDX) as well as Electron Energy Loss Spectroscopy (EELS). While EDX is suitable for precise compositional analysis, EELS delivers information on the electronic band structure of materials. Further analytic capability is afforded by the energy filtered imaging, and Plasmon based imagingChip based samples are prepared in-house by focused ion beam. This Titan TEM provides Q-Nano stakeholders with an incredibly powerful tool to

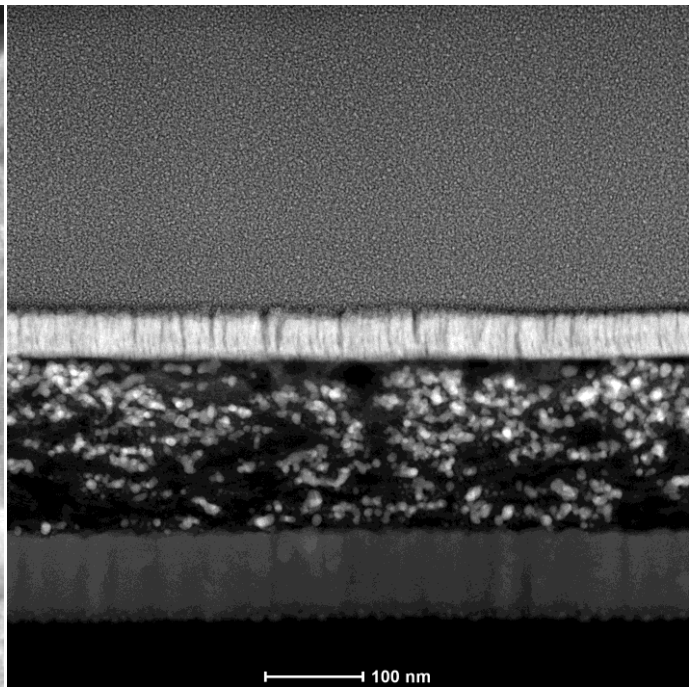
understand nano-particle systems. The microscope has alignments at 80 kV suited for the study of carbon based materials and polymers.

**Typical Samples & Images:**

A full range of nano-particles, and nano-materials are characterised. Nanowires, nano-particles, nanotubes, nano-composites, polymer based samples, grapheme and low dimensional materials are investigated. Samples are dispersed on lacey carbon grids, however nano-particles are also investigated by TEM when embedded in thin films or other host materials.



Bright field TEM image of an embedded iron nano-particle in $TiO_2$. [JMD Coey, TCD]




STEM image of nano-rods and nano-particles on a chip based sample. [KM Ryan, RD Gunning, UL]

*Any further Information*: