


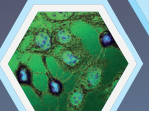

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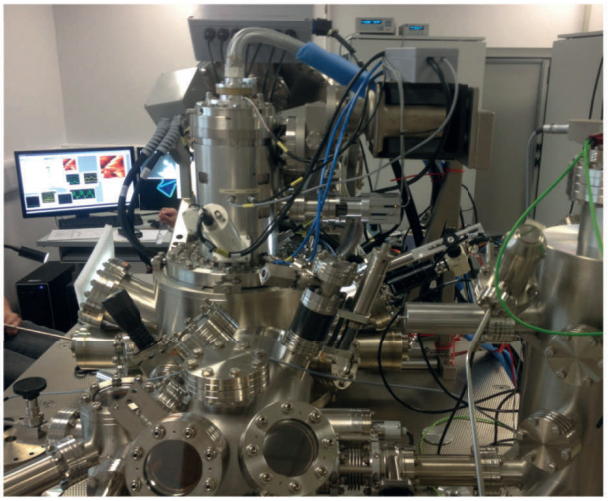
NANOPROBE



FEATURES

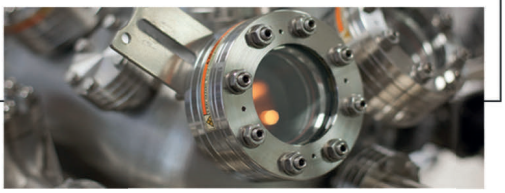
- Simultaneous AFM and STM with the Qplus probe.
- 4 independent STM probes (atomic resolution).
- Probe navigation with in-situ SEM (<15nm resolution).
- Qplus AFM with Kelvin probe functionality (non-contact atomic resolution).
- Auger analyser for SAM (<15nm resolution) and AES.
- Preparation chamber for sample annealing, ion bombardment or evaporation.
- Liquid Helium/Hydrogen cryostat that cools the sample and tips.
- Counter heating for measurements from 5K to room temperature.
- Independent control of sample stage bias.

The Omicron Low Temperature multi probe system is equipped with four tungsten probes that can be manipulated under the navigation of an in-situ SEM. This allows the probes to be positioned with nanometre precision making it possible to conduct electrical measurements on structures such as nanowires and nanotubes. The system is housed in an ultra-high vacuum (UHV) chamber which can be cooled to <5K to ensure environmental and thermal effects are reduced to a minimum.

The system is unique as it has dual functionality, allowing simultaneous Qplus Atomic Force Microscopy (AFM) and/or Scanning Tunnelling Microscopy (STM). The Qplus AFM uses a tuning fork design and tungsten probes similar to those of STM. These probes can be produced with atomic sharpness which makes it possible to achieve atomic resolution. The Kelvin probe function allows local measurements of surface potential which can be used for active electronic devices, functionalised surfaces or device characterisation.

These techniques are complemented by the Auger electron analyser that can perform elemental analysis with Scanning Auger Microscopy (SAM) and Auger Electron Spectroscopy (AES), which are based on highly surface sensitive effects.

A highly productive function of the system is the four probe functionality. The electrical probes are similar to an electronics probe-station which can test devices and perform local electrical measurements with the additional benefit of in-situ SEM to measure nanometre sized structures.



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Benefits

The LT Nanoprobe is a unique instrument that houses 4 techniques that together can perform electrical, compositional and surface analysis of a sample. This normally would require 3-4 independent systems.

- Reduce analysis time as techniques can be performed simultaneously and on the same sample non-destructively.
- Save costs by reducing expensive analytical work that may require collaboration with several institutions.
- Equipment not normally available to industry.
- Ability to identify precise sample locations and characterise the device/material failure.
- Improve the quality of products by identifying and characterising key properties of a material.
- Reduced device failure.

Case Study

At the Centre for NanoHealth, the Nanoprobe is used for studying the electrical properties of nanostructures such as nanowires. The image shows the 4 terminal measurement of a semiconductor ZnO nanowire. With the structural dimensions taken from the SEM image, the nanowire resistivity is measured. Using these techniques we have been able to show how the nanowire electrical properties are dominated by adsorbates on the nanowire surface.

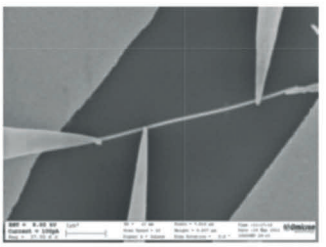


Figure 1: In situ SEM image from the Nanoprobe showing the 4 probe measurement of a ZnO nanowire

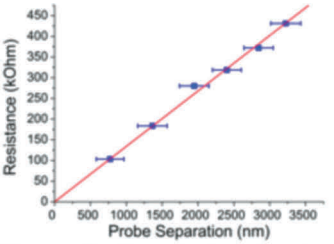


Figure 2: Graph showing how the resistance of a nanowire changes with the distance between the measurement probes

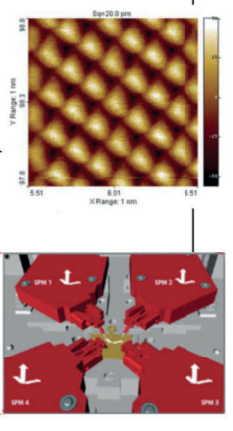
Examples of materials characterised by the various techniques:

- STM - Atomic resolution of gold on mica
- AFM - Atomic resolution on NaCl
- SAM - Silver nano-triangles scanned to ~15nm resolution
- 4-probe-measurement of individual NanoWires

Applications

The combination of the techniques makes the system highly appropriate for surface science, materials science and nanotechnology. These techniques are brought together in many fields, in particular, semiconductor devices such as laser heterostructures.

Technique	Applications
Scanning Auger Microscopy	• Semiconductor device failure analysis • Grain mapping in metals/semiconductors • Biologically derived structures or specimens • Interface compositional mapping
Qplus AFM	• Imaging of non-conducting surfaces/structures • Surface potential of material interfaces • Imaging and electrical measurement of biological structures • Device characterisation



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