

Laboratory of Scanning Probe Microscopy with high magnetic fields and low temperature



This laboratory offers the possibility of combining probe measurements with low temperatures and a high vector magnetic field.

The SPM with high magnetic fields and low temperature is especially designed for combination of local probe and magneto-transport measurements as, for example, scanning gate microscopy.

Therefore, it runs research lines oriented towards low temperature magnetism, transport through nanodevices, spintronics, and superconductivity.

The instrument is composed by a large liquid helium cryostat holding a vertical bore superconducting magnet reaching 8 T (one axis) / 2 T (2D vectorial) magnetic field and a variable temperature controller (2 K-300 K).

The equipment has a quick load facility, allowing an easy sample replacement. The system is also equipped with two different piezos in order to get the best features in resolution and stability, and a low noise voltage amplifier keeping the conditions to get the best signal/noise ratio.

What kind of information can be obtained with this instrument?

These features allow performing many of the STM/AFM related techniques:

- **Surface morphology.** Topography with resolution below 1 nm.
- **Electrical conductivity** (c-AFM). Quantitative local electrical resistance measurements.
- **Local electrical potential** (KPM). Qualitative measurements of local charge distribution.
- **Magnetic properties** (MFM). Magnetic properties analysis under magnetic fields.
- **Piezo-electric properties** (PFM). Using the tip as electrode and deformation sensor.
- **Thermal dependence.** Capacity to measure in the 2 to 500 K range.
- **Topography** based in low vacuum Scanning Tunnel Microscopy (STM).

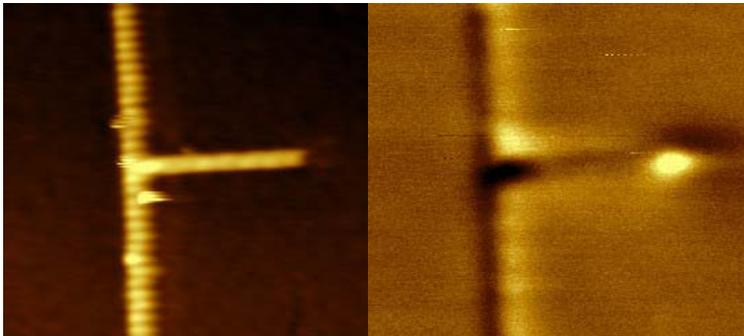
Sample requirements

- The sample should be immobilized onto a flat substrate
- The sample should exhibit a roughness lower than the range of the piezo scanner.
- The size of the sample should be small enough to fit inside of the microscope, around 1cm^2 and a maximum thickness of 0.5 cm.
- The sample should be compatible with low temperature and vacuum conditions.

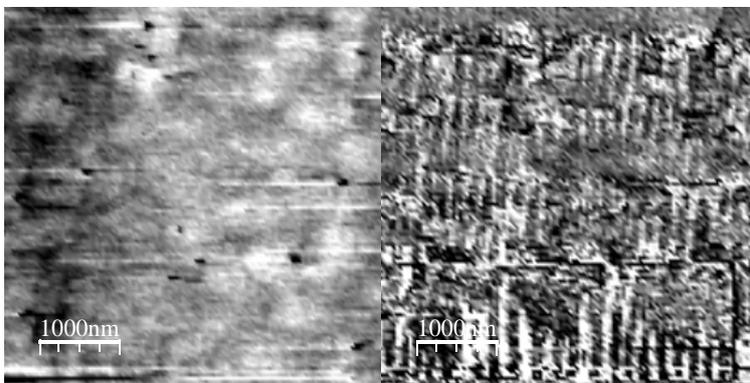
Technical Specifications

- AFM/MFM head with interferometric sensor.
- STM/Tuning Fork head.
- Variable temperature insert (1.5 K-300 K) cryostat.
- 8 T (vertical) and 2 T (in-plane) superconducting magnet, that combined with a rotating platform allows to apply vector fields in three dimensions.
- Compatible chip carrier with dual-beam and pulsed field facilities.

Images



Topography and magnetic signal from a permalloy nanowire



Topography and piezoresponse map from a piezoelectric material thin film.