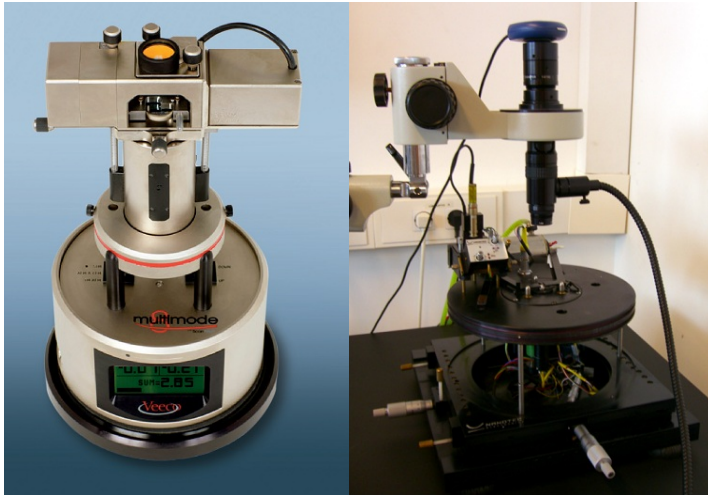


Scanning Probe Microscopies (SPM) in environmental conditions



Scanning Probe Microscopies are key enable techniques in Nanosciences and Nanotechnologies, supporting a wide range of multidisciplinary activities.

The LMA has a special room with outstanding vibration isolation stages dedicated to hold the SPM instruments in environmental conditions. In addition, a

highly specialized technical scientist is in charge of the support to external users, training of frequent and experienced users, and maintenance of the equipment.

Two environmental SPM microscopes are available for internal and external users at LMA:

1. **Cervantes Fullmode SPM from Nanotec Electrónica S.L.** AFM (Atomic Force Microscope) / MFM (Magnetic Force Microscope) / STM (Scanning Tunnelling Microscope) equipped with variable magnetic field and a liquid cell. The jumping mode is especially suitable to measure soft samples in liquid.
2. **Multimode 8 from Veeco-Bruker.** Scanning Probe Microscope equipped with KPM (Kelvin Probe Microscopy), c-AFM (conductive-AFM), liquid and electrochemistry cells, PicoForce module for force spectroscopy measurements, variable temperature controller, Torsion mode head and QNM (Quantitative Nanomechanical Property Mapping) Peak Force mode.

What kind of information can be obtained with these instruments?

The following information can be obtained with our SPM instruments:

- **Surface morphology.** Topography with resolution below 1 nm.
- **Electrical conductivity** (c-AFM). Quantitative local electrical resistance measurements.
- **Mechanical properties** (QNM Peakforce). Quantitative local measurement of the elastic modulus, adhesion, stiffness, energy dissipation and deformation on surfaces.
- **Local electrical potential** (KPM). Qualitative measurements of local charge distribution.

- **Magnetic properties** (MFM). Magnetic properties analysis under magnetic fields.
- **Nanomechanical studies** by using Single Molecule Force Spectroscopy. Pull-push experiments for inter and intra-molecular force measurements, with 1 pN resolution.
- **Electro-chemical properties** (EC-SPM). Study of chemical reactions on surfaces under controlled environments.
- **Piezo-electric properties** (PFM). Using the tip as electrode and deformation sensor.
- **Thermal dependence**. Capacity to measure in the 250 K to 500 K range.
- **Topography** based in ambient Scanning Tunnel Microscopy (STM).

Sample requirements

The sample should be immobilized onto a flat substrate (for instance, biomolecules should be immobilized onto a mica surface via adsorption or via a covalent procedure).

The sample should exhibit a lower roughness than the range of the piezo scanner.

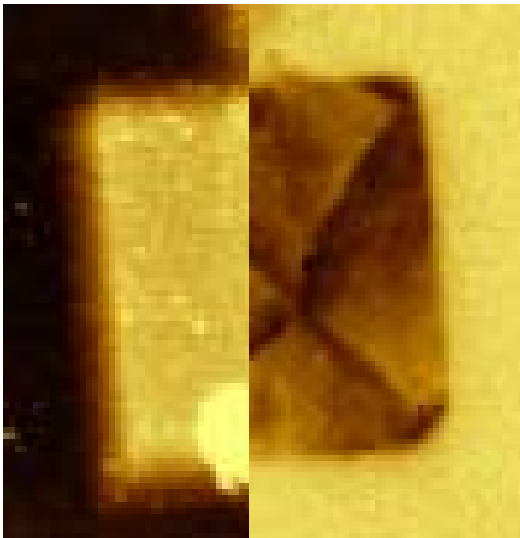
The size of the sample should be small enough to fit inside of the microscope, around 1 cm² in surface and 0.5 cm in thickness.

Types of samples that can be studied with the environmental SPMs include:

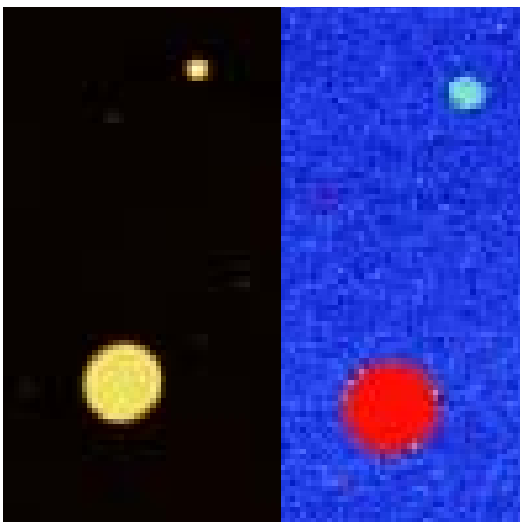
- Biological samples (DNA, proteins and peptides; cells, viruses and bacteria; biological tissues, etc.).
- Organic and inorganic thin films.
- Nanostructures.
- Nanoparticles.
- Gels and Polymers.

Technical Specifications

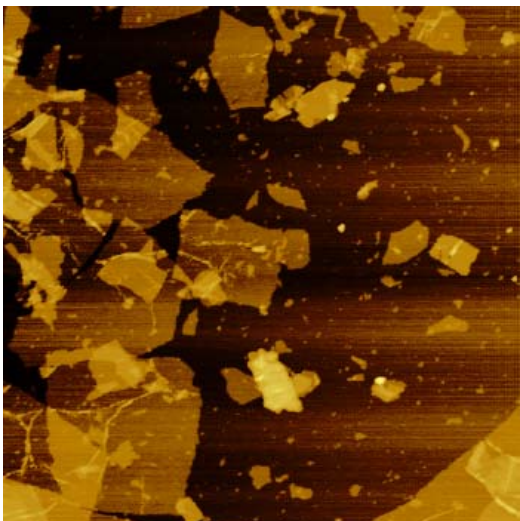
| | Bruker Multimode 8 | Nanotec Cervantes |
|---------------------|--|---|
| Environment | Air, liquid and electrochemical cell | Air and liquid |
| Temperature range | [-35, 200] °C | Room temperature |
| Piezoelectric range | 200 μm x 200 μm x 5 μm 12 μm x 12 μm x 3 μm | 10 μm x 10 μm x 3.5 μm |
| Magnetic field | No | Out of plane, pulsed (1 s max.) In plane continuous up to 0.15 T |



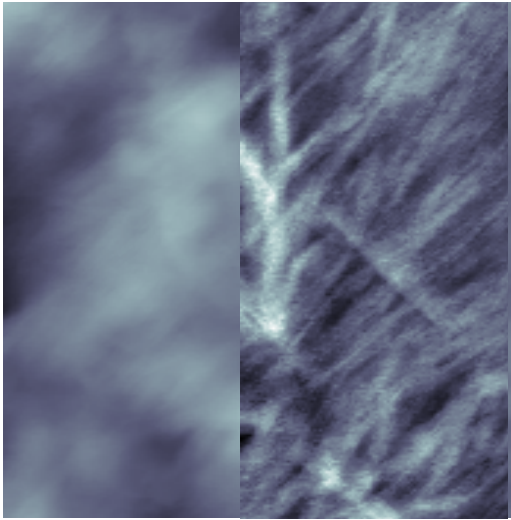
Topography and magnetic signal from a focus ion beam fabricated nanostructure.



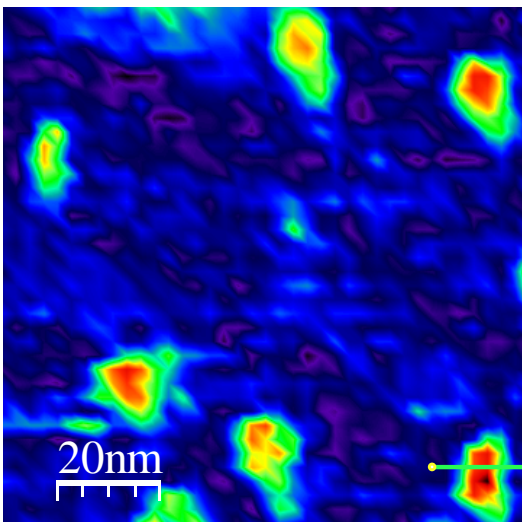
Topography and electrical conductivity from nanoelectrodes.



Graphene layers deposited on mica



Topography and elastic modulus map from a polymer



Liquid ambient topography from proteins deposited on mica