

UE Physical measurements at nanoscale by local probes



Level
Baccalaureate
+4



ECTS
3 credits



Component
UFR PhITEM
(physique,
ingénierie, terre,
environnement,
mécanique)



Semester
Printemps

- > **Teaching language(s):** English
- > **Open to exchange students:** Yes
- > **Code d'export Apogée:** PAX8NQAЕ

Presentation

Description

Goal: Introduction to local probes techniques in the field of nanosciences and nanotechnologies.

Content

1. Introduction to Scanning Probes Microscopy (1h30)

- Comparison between surface analysis techniques: SEM/TEM, SFA
- Presentation of the SPM sub-families: STM / SFM / SNOM via examples of applications

2. The Scanning Tunneling Microscope (7h)

- The tunneling effect
 - STM relevant parameters
 - Expression of the tunneling current
- The STM instrument
 - Tip fabrication methods
 - Electronic and instrumental chain to measure and control tunnelling current in the pico/nano-ampere range ADC/DAC, I/V converter, lock-in amplifier

- Source of noises and detection limit
- Vibration isolation (tutorial on transfer function and damping)
- Measurement at low temperature : how to operate an STM in a cryostat>
- Operating STM modes and associated measurements
 - Local density of states (LDOS) and I/V spectroscopy
 - Constant current mode versus constant height mode

3. The Atomic Force Microscope (12h)

- Why mechanical oscillators
 - Introduction and history
 - Mechanical susceptibility
 - Limits of sensitivity (readout noise and Brownian motion)
 - Working at resonance, decrease the size/mass
- How to build an AFM
 - Micro fabrication of cantilever and tips
 - Nano positioning (piezo material and issues with them as hysteresis...)
 - Precision position measurements (optical and capacitive)
 - Signal analysis (Homodyne detection, PLL and PID)
- Operating AFMs
 - Calibration process (cantilever stiffness, position detection)
 - What physical values are accessible (van der Waals, electrical, magnetic, friction forces)
 - Different modes of operation
- Maps analysis and image processing
 - Surface analysis parameters: rms, ra, skewness, kurtosis, etc
 - Artefacts, tip dilation effect
 - Tilt correction via polynomial subtraction and color scale
 - Tutorial on processing of the images and spectroscopy curves obtained in PW via Gwyddion software

Course parts

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| CM | Lectures (CM) | 22h |
| UE Physical measurements at nanoscale by local probes - TP | Practical work (TP) | 8h |

Period : Semester 8

Useful info

Campus

> Grenoble - University campus