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:** PAX8NQAE

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

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