UE Physical measurements at nanoscale by local probes

Niveau d'étude
Bac +4

ECTS
3 crédits

Composante
UFR Physique, Ingénierie, Terre, Environnement, Mécanique (PhITEM)

Période de l'année
Printemps (janv. à avril/mai)

Diplômes intégrant cet élément

- Master Nanosciences et nanotechnologies

Langue(s) d'enseignement: Anglais

Ouvert aux étudiants en échange: Oui

Code d'export Apogée: PAX8NQAB

Présentation

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

Informations non contractuelles.
Dernière mise à jour le 30 juin 2026

- 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

Heures d'enseignement

CMTD	Cours magistral - Travaux dirigés	20h
TP	TP	8h

Période : Semestre 8

Infos pratiques

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Campus

Grenoble - Domaine universitaire

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