Local Probe Microscopies

Code: 43441
ECTS Credits: 6

2024/2025

Degree	Type	Year
4314939 Advanced Nanoscience and Nanotechnology	OT	0

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

Basic knowledge in physics and chemistry.

Objectives and Contextualisation

Acquire the knowledge needed to understand the fundamentals and advances capabilities of the different Scanning Probe Microscopes (SPM) relevant for Nanoscience and Nanotechnology.

Competences

- Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
- Continue the learning process, to a large extent autonomously
- Identify the characterisation and analysis techniques typically adopted in nanotechnology and know the principles behind these, within one's specialisation.
- Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.

- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

Learning Outcomes

1. Assess the particularities of physical and chemical processes that take place on surfaces.
2. Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
3. Continue the learning process, to a large extent autonomously
4. Critically analyse the validity of results obtained using SPMs.
5. Know the appropriate local probe microscopy variant for the property to be studied.
6. Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.
7. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
8. Use the atomic force microscope in its basic modes.

Content

Contents:

1. Introduction to basic concepts in surface science: Crystallography, adsorption and diffusion, thin films, intermolecular interactions
2. Introduction to vacuum and cryogenic conditions.
3. Introduction to Atomic Force Microscopy. General concept of Scanning Probe Microscopy (SPM) and comparison of AFM with other SPM methods . Historical background of AFM.
4. Contact-Mode AFM. Basic principles. Imaging and Force curves. Friction contrast.
5. Dynamic-Mode AFM. Basic principles of Amplitude modulation and Frequency modulation. Imaging and amplitude curves. Interaction regimes and non-contact vs. intermittent contact operation. Phase shift and dissipation contrasts. Multifrequency AFM.
6. Long range forces with AFM. Electrostatic forces in AFM. Kelvin probe Force Microscopy. Magnetic Force Microscopy. Imaging
7. Other methods. Piezoresponse AFM. Current sensing AFM. Measurement of intermolecular forces. Adhesion forces and nanoindentation.
8. Practical Issues: Image artifacts, tip convolution and other effects. Piezoelectric scanner issues.
9. Introduction to Scanning Tunneling Microscopy: High resolution imaging
10. Spectroscopic measurements with STM, atomic manipulation.
11. Electrochemical STM.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory	6	0.24	4, 5, 7, 8
Lectures	32	1.28	1, 2, 3, 4, 5, 6, 7
Personal time used to study (2 hours per 1 hour of lecture)	64	2.56	3
Type: Supervised			

Bibliography research/reading articles	20	0.8	3
Oral presentation	8	0.32	1, 2, 3, 4, 5, 6, 7
Type: Autonomous			
Written report	20	0.8	2, 3, 6

Lectures, laboratory workshop, written report and oral presentation

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Oral presentations	50 %	0	0	2, 3, 6
Participation	10%	0	0	4, 5, 7, 8
Written report	40 %	0	0	1, 3, 5, 6, 7

At the end of the course the student must deliver a written report (10 pages) and do a 5 minutes oral presentation. Participation in lectures and laboratory workshop will be also taken into account for the final score.

Bibliography

Important books and articles will be mentioned during the lectures. All optional.

Software

use of editing software to present teaching notes and presentations

Language list

Name	Group	Language	Semester	Turn
(TEm) Theory (master)	1	English	first semester	morning-mixed