

**Local Probe Microscopies**

Code: 43441  
ECTS Credits: 6

Degree	Type	Year	Semester
4314939 Advanced Nanoscience and Nanotechnology	OT	0	1

**Contact**

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**External teachers**

Aitor Mugarza

Neus Domingo

**Use of languages**

Principal working language: english (eng)

**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.

**Skills**

- 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.

## Methodology

Lectures, laboratory workshop, written report and oral presentation

## Activities

Title	Hours	ECTS	Learning outcomes
<b>Type: Directed</b>			
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
<b>Type: Supervised</b>			
Bibliography research/reading articles	20	0.8	3
Oral presentation	8	0.32	1, 2, 3, 4, 5, 6, 7
<b>Type: Autonomous</b>			
Written report	20	0.8	2, 3, 6

## Evaluation

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.

### Evaluation 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

### Bibliography

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