

**Techniques for Characterising Materials**

Code: 43442  
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

Bachelor or Engineering in the fields of materials and nanomaterials, physics, chemistry or biosciences

This module presents a small overlap (approximately 35%) with the Nanoscience and Nanotechnology (N&N) degree at UAB and is therefore suitable for this degree.

## Objectives and Contextualisation

This module covers a significant part of the main techniques for characterization of materials and nanomaterials, but it is not aimed at comprising all the techniques currently used. Most of them are available at our research facilities (UAB-CIE Sphere). Several laboratory experiments and practical examples are planned as a key part of the course.

The local probe microscopy techniques and the X-ray absorption spectroscopies, not included in this module, are covered in modules "Local Probe Microscopies" and "Spectroscopies with Synchrotron Radiation", respectively.

## 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. Choose the most suitable technique for chemical/compositional characterisation: bulk, thin layer, superficial and interlayer.
2. Choose the techniques for identifying the functions of surfaces.
3. Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
4. Continue the learning process, to a large extent autonomously
5. Describe the bases of electron microscopy, image formation and the associated spectroscopic techniques.
6. Describe the fundamental physical process underlying vibrational spectroscopies, X-ray and photoelectron emission, etc.
7. Describe the structure of crystalline matter and the bases for X-ray diffraction.
8. Determine the crystalline phase of the material in different morphologies. dust, layer, heterostructure, particle, nanotube, etc.
9. Identify the techniques for establishing the range of sizes of particles of the material and the surface area.
10. Interpret the results from the most important techniques.
11. 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.
12. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

## Content

Part I. Structure of materials and X-Ray diffraction

Fundamentals of diffraction. Experimental diffraction methods for the characterization of the structure of materials and nanomaterials.

Part II. Structural characterization of materials. Microscopy.

Electron Microscopy, Scanning Electron Microscopy and Transmission Electron Microscopy.

Part III. Other characterization techniques.

IIIA) Thermal analysis techniques. Thermogravimetry Analysis (TGA) and Differential Scanning Calorimetry (DSC)

IIIB) Spectroscopic techniques. NMR Spectroscopies, Vibrational Spectroscopies, Terahertz spectroscopy and Mössbauer Spectroscopy.

Several practical sessions covering different aspects of parts I and II are planned.

## Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	29	1.16	1, 5, 6, 7
Practical sessions	12	0.48	1, 2, 8, 9, 10, 12
Type: Autonomous			
Deliveries: practical reports, exercises, other works	35	1.4	3, 11
Self-work	72	2.88	4

Lectures covering the fundamentals of the main topics of the course

Practical sessions that will take place preferently at the services of the UAB-CEI Sphere:

- Characterization of thin film samples by X-ray diffraction and electron microscopy (FESEM and EDX)
- Characterization of nanoparticles by TEM, HRTEM, EDX, electron diffraction and X-ray diffraction
- Observation and characterization of biological structures by TEM

Delivery of works and exercises related to the topics of the lectures and practices that could involve the use of specialized software

Reports of practical work

Tutoring for the supervision of the different teaching activities of the module.

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
Deliveries: practical reports, exercises, other works	30%-50%	0	0	3, 4, 10, 11
Exam	10%-40%	2	0.08	5, 6, 7, 10, 11

Student's behaviour and attitude during practical sessions will be also taken into account for the module evaluation.

The final mark will be weighted as indicated in the table.

## Bibliography

- "Fundamentals of materials science and engineering". W.D.Callister and D.G. Rethwisch, 4<sup>th</sup> ed. Ed. John Wiley, 2013.
- "Fundamentals of crystallography". C. Giacovazzo, H.L. Monaco, D. Viterbo, F. Scordari, G. Gilli, G. Zanotti & M. Catti. IUCr texts on crystallography, 2<sup>nd</sup> ed. Oxford University Press, 2002.
- "Thin Film Analysis by X-Ray Scattering". M. Birkholz. Wiley-VCH Verlag, 2006.
- Instituto de Química-Física Rocasolano (Crystallography Department)  
<http://www.xtal.iqfr.csic.es/Cristalografia/index2.html>
- International Union of Crystallography <http://www.iucr.org/>
- 2014 International Year of Crystallography <http://www.iycr2014.org/learn>
- "Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM". Ray F. Egerton. Kluwer Academic-Plenum Publishers, 2005. ISBN: 0-387-25800-0
- "Transmission Electron Microscopy". M D.B. Williams, C.B. Carter. Plenum Press, New York, 1996. ISBN: 0-306-45247-2.
- "Scanning electron microscopy and X-Ray microanalysis". J.I. Glodstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer, and J. Michael. 3<sup>rd</sup> ed. Kluwer Academic-Plenum Publishers, 2003. ISBN: 0-306-47292-9.
- "Principles of Thermal Analysis and Calorimetry". P.J. Haines, Royal Society of Chemistry, 2002.  
<http://ebook.rsc.org/?DOI=10.1039/9781847551764>

## Software

use of standard programs to enable presentation of teaching materials

## Language list

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