Universitat Autònoma de Barcelona

2021/2022

Techniques for Characterising Materials

Code: 43442
ECTS Credits: 6

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

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: english (eng)

Teachers

Jordi Hernando Campos

Konrad Eiler

Ignacio Ramón Mata Martínez

Lluís Casas Duocastella

Pau Solsona Mateos

External teachers

José Luis Garcia-Muñoz

José Santiso

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

Topic I. Structure of materials and X-Ray diffraction

Overview of the fundamentals of crystallography and X-ray diffraction. Experimental diffraction methods for the characterization of the structure of materials and nanomaterials.

Topic II. Structural characterization of materials. Microscopy.

Electron Microscopy, Scanning Electron Microscopy and Transmission Electron Microscopy.

Topic III. Other characterization techniques.

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

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

Several practical sessions covering different aspects of each topic are planned.

Methodology

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.

Activities

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

Assessment

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 follows:

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Deliveries: practical reports, exercises, other works	30%-50%	0	0	11, 10, 3, 4
Exam	20%-40%	2	0.08	6, 7, 5, 11, 10
Practical sessions	30%-40%	0	0	8, 1, 2, 9, 10, 12

Bibliography

- "Fundamentals of materials science and engineering". W.D.Callister and D.G. Rethwisch, 4th 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, 2nd 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 micronanalysis". J.I. Glodstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer, and J. Michael. 3rd 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