Estructura, Preparació i Caracterització de Materials i Nanomaterials

2012/2013

Code: 42261
ECTS Credits: 9

Degree	Syllabus	Type	Year	Semester
4313132 Nanotecnologia i Ciència de Materials / Nanotechnology and Materials Science	1096 Nanotecnologia i Ciència de Materials / Nanotechnology and Materials Science	O	1	0

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Use of languages

Principal working language: anglès (eng)

Prerequisites

A bachelor in Chemistry, Engineering or Physics is convenient.

Objectives and Contextualisation

This module introduces the concepts for working with materials and nanomaterials: classification, structure, preparation and synthesis; as well as the main characterization techniques employed.

Laboratory experiments and demonstrations will be a key part of the course activities.

Skills

- Analyse the basics of characterisation and analysis techniques that are specific to nanotechnology and materials
- Analyse the research results to obtain new products or processes evaluating their industrial and commercial viability for transfer to society.
- Apply characterisation and analysis methods according to the physical-chemical-biological properties under study
- Apply the principal physical and chemical methods of preparation and synthesis of materials and nanomaterials
- Demonstrate a mastery of scientific technology and develop skills for arguing the research results in the context of scientific production to understand and interact effectively with other professionals.
- Demonstrate knowledge of the basic structure of materials, nanomaterials and their properties
- Search for information in the scientific literature using the appropriate channels and integrate that information for proposing and contextualising a research topic
- Students must be capable of integrating knowledge and dealing with the complexity of formulating judgements on the basis of incomplete or limited information, including considerations of the social and ethical responsibilities associated to the application of their knowledge or judgements
- Students must know how to communicate their conclusions and final reasons sustaining the same to specialised and unspecialised audiences in a clear and unambiguous manner
- Students must possess learning abilities to enable them to continue studying in a way that will to a large extent have to be self-managed and autonomous
- Students should know how to apply the knowledge acquired and their capacity for resolution to problems in new or little known environments in broader (or multidisciplinary) contexts related with their field of study

Learning outcomes

1. Analyse the efficiency of a process of synthesis
2. Analyse the possible dangers of synthesising materials
3. Analyse the research results to obtain new products or processes evaluating their industrial and commercial viability for transfer to society.
4. Analyse the symmetry of molecules and crystals
5. Define the different types of analytical characterisation of materials
6. Define the different types of orders of materials
7. Demonstrate a mastery of scientific technology and develop skills for arguing the research results in the context of scientific production to understand and interact effectively with other professionals.
8. Describe the applications of spectroscopies in structural determinations and composition
9. Describe the capacities of large installations in determining the nanostructure of materials
10. Describe the packaging of molecular crystals
11. Describe the principal methods for the synthesis of different types of materials, identifying those that are most appropriate for each type of material
12. Explain the characteristics of materials with different compositions
13. Identify the most reactive chemical groups in materials
14. Recognise the importance of purity and describe methods of purification
15. Recognise the possibilities and limitations of optical, electronic and scanning microscopies
16. Search for information in the scientific literature using the appropriate channels and integrate that information for proposing and contextualising a research topic
17. Students must be capable of integrating knowledge and dealing with the complexity of formulating judgements on the basis of incomplete or limited information, including considerations of the social and ethical responsibilities associated to the application of their knowledge or judgements
18. Students must know how to communicate their conclusions and final reasons sustaining the same to specialised and unspecialised audiences in a clear and unambiguous manner
19. Students must possess learning abilities to enable them to continue studying in a way that will to a large extent have to be self-managed and autonomous
20. Students should know how to apply the knowledge acquired and their capacity for resolution to problems in new or little known environments in broader (or multidisciplinary) contexts related with their field of study

Content

Topic I. Materials Classification (6h)

Chemical bonding.

Topic II. **Structure of materials. X-ray diffraction (18h)**

Fundamentals of crystallography. X-ray diffraction. Experimental methods. Cooperative combination of X-ray diffraction and spectroscopic techniques.

Topic III - Preparation and Processing of Materials (26 h)

General methods for materials preparation. Preparation and Processing of Polymers. Types of nanomaterials and fabrication approaches. Synthesis and stabilization of nanoparticles. Synthesis and applications rods and wires. Carbon nanotubes. Preparation of thin films. Lithographic techniques for surface nanostructuration. Nanomaterials and Composite Materials.

Topic IV- Structural characterization of materials. Microscopy (18h)

Optical and Confocal Microscopy, Electron Microscopy, Scanning Electron Microscopy and Transmission Electron Microscopes.

Methodology

Lectures covering the fundamentals and main topics of the course.

Seminars related to application-oriented topics.

Practical works to improve the interaction between students and cooperation yields (work in groups) and to acquire the experimental skills in this field.

Homework to achieve the level required and to consolidate the scientific background.

Tutorials supervising learning activities.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures and seminars	46	1.84	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
Practical works	22	0.88	3, 5, 7, 9, 15, 16
Type: Supervised			
Tutorials	12	0.48	7, 17, 18, 19, 20
Type: Autonomous			
Student work	141	5.64	9, 16, 17, 18, 19, 20

Evaluation

The students must attend 90% of the total duration of the course to be able to pass the module and actively participate during the lectures.

In addition, students are expected to elaborate a series of exercises focused on the techniques studied in this module as well as a final exam, in which there will be some questions regarding the topics covered in this module.

The student is notified at the end of the course whether or not he/she has successfully completed the requirements of the course on the basis of attendance, class participation and evaluation of the exercises presented. The final mark will be weighted as follows:

40% - Exam

20% - Practice's report.

30% - Exercices and activities (10% for each topic).

10% - Attendance

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Attendence	10%	0	0	17, 18, 19, 20

Examen	40%	4	0.16	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
Exercices and activities	30%	0	0	7, 16, 17, 18, 19, 20
Practice report	20%	0	0	3, 5, 7, 15, 16

Bibliography

"General Chemistry. Principles and Modern Applications", R.H. Petrucci, W.S. Harwood, F.G. Herring, 8th ed., Prentice Hall, 2002.

"Inorganic Chemistry", P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, 4th ed., Oxford University Press, 2006.

"Nanoparticles and catalysis", ed. Didier Astruc, Wiley-VCH, 2008.

"Nanostructures and nanomaterials: synthesis, properties and applications", G. Cao, Imperial College Press, 2004.

"Materials Science and Engineering. An Introduction." W.D. Callister, John Wiley & Sons, 2007.

"Fundamentals of crystallography." GIACOVAZZO, C., MONACO, H.L., VITERBO, D., SCORDARI, F., GILLI, G., ZANOTTI, G. & CATTI, M. IUCR texts on crystallography 2

2a edició. Oxford University Press, 2002.

Instituto de Química-Física Rocasolano (Crystallography Department)

http://www.xtal.iqfr.csic.es/Cristalografia/index2.html

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http://www.iucr.org/

"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. 3ªEd. Kluwer Academic-Plenum Publishers (2003) ISBN: 0-306-47292-9