Universitat Autònoma de Barcelona

2023/2024

Nanochemistry: from Small Molecules to Nanoporous Materials

Code: 43436
ECTS Credits: 6

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

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Ramon Alibes Arques

Luis Escriche Martinez

Jordi Hernando Campos

Rosa Maria Sebastian Perez

External teachers

Mariona Coll

Rossella Zaffino

Prerequisites

The student should be familiar with basic chemical and supramolecular concepts.

Objectives and Contextualisation

This course aims at providing advanced knowledge in Nanochemistry, specially dealing with those subjects that have not been covered in the bachelor degree of Nanoscience & Nanotechnology. The most important of these topics are:

1) Advanced synthetic tools for the covalent assembly of building blocks in the preparation of new molecular systems relevant in Nanochemistry.

2) Molecular electronics, photonics and magnetism.

3) Polymers and polymeric nanostructures.

4) Nanoporous materials.

Competences

- Analyse the benefits of nanotechnology products, within one's specialisation, and understand their origins at a basic level
- Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
- Continue the learning process, to a large extent autonomously
- Design processes for nanomaterials with properties and functionalities default (specialty Nanomaterials).
- Identify and distinguish the synthesis/manufacture techniques for nanomaterials and nanodevices typically adopted in one's specialisation.
- Identify the characterisation and analysis techniques typically adopted in nanotechnology and know the principles behind these, within one's specialisation.
- Integrate knowledge and use it to make judgements in complex situations, with incomplete information, while keeping in mind social and ethical responsibilities.
- Seek out information in the scientific literature using appropriate channels, and use this information to formulate and contextualise a research topic.
- 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.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

Learning Outcomes

1. Choose the method of characterisation and analysis to demonstrate the formation and determine the properties of molecular devices and nanomaterials, polymer nanomaterials, nanocomposites and nanoporous materials.
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. Correlate the parameters of the synthesis of molecular nanomaterials, polymeric nanomaterials, nanocomposites and materials nanoporoosos structural characteristics desirable for
5. Describe the most common techniques for preparing molecular devices and nanomaterials, polymer nanomaterials, nanocomposites and nanoporous materials.
6. Identify the main applications of molecular devices and nanomaterials, polymer nanomaterials, nanocomposites and nanoporous materials.
7. Integrate knowledge and use it to make judgements in complex situations, with incomplete information, while keeping in mind social and ethical responsibilities.
8. Seek out information in the scientific literature using appropriate channels, and use this information to formulate and contextualise a research topic.
9. 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.
10. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
11. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

Content

1) Introduction to nanomaterials

Nanomaterials: definitions. Molecular nanomaterials: definitions and types. Hybrid nanomaterials: definitions. Nanocomposites: definitions.

2) Small molecules for molecular devices and materials

Advanced methods for the synthesis and assembly of small molecules: catalytic C-C bond formation; "click-chemistry". Building molecular materials: crystal engineering. Molecular devices and machines. Molecular electronics and photonics. Molecular magnetism. Molecular functional devices.

3) Macromolecules and polymeric nanomaterials

Polymers: composition, structure and synthesis. Dendrimers. Polymeric nano- and microparticles: synthesis and applications.

4) Nanoporous materials

Nanoporous materials: definitions. Main families: Silica polymorphs; zeolites, aluminosilicates and other metallosilicates; metallophosphates; non-oxide nanoporous solids. Synthesis and chemistry of nanoporous materials. Adsorption and diffusion. Applications in catalysis. Other applications. Engineering of functional materials with chemical coating methods.

Methodology

The course will consist on theory lectures (38 h), which will be combined with autonomous activities (bibliographic work, personal study, problem solving).

Theory lectures will be the main teaching activity developed in the classroom. In these sessions the lecturer will explain the contents of the course using blackboard and multimedia material, which will be made available to the students in the "Campus Virtual". At home the students will be required to solve problems, do autonoums study and prepare review works on scientific articles related to the course. During theoretical classes the participation of students on the discussion will be promoted.

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			
Theory lectures	38	1.52	9
Type: Autonomous			
Bibliographic Work	10	0.4	8, 9, 2
Personal Study	65	2.6	9
Problem Solving	15	0.6	9

Assessment

It is mandatory to attend all the face-to-face theorethical sessions. Only justified absences related to health reasons will be considered, with a maximun of 10% of the overall theoretical sessions and of the particular specific parts. If attendance is lower than 90% in any of the parts of the course, the mark for this part will be zero and no possibility of retaking will exist.

The overall grade will be broken down as follows:

- Introduction. Nanomaterials, molecular devices and molecular photonics (J. Hernando). Evaluation: exercices and/or works (13.2%)

- Advanced synthetic methods (R. Alibés). Evaluation: exercices and works (13.2%)

- Molecular electrònics, molecular magnetism and MOFs (R. Zaffino). Evaluation: Exercices and/or works (21,0%)

- Macromolecules and polymeric nanomaterials (R. Sebastián). Evaluation: final exam (21.05%)

- Nanoporous materials (Ll. Escriche). Evaluation: Exercices and/or works (21.05%)

- Engineering of functional materials with chemical coating methods (M. Coll). Evaluation: Exercices and/or works (10.5%)

In general the global evaluation will consist of final exams (21%) + Exercises and works (79%) = 100%.

Students will take a final exam in each of the parts where this type of assessment is applied. The date may be set by the coordination or may be agreed with the students. The grade obtained from the exams will account for 21% of the overall grade.

Thoughout the course, students will be required to hand out exercises and works, such as solved problems and reports or presentations on scientific articles. The average grade of all these items will account for 79% of the overall mark.

To pass the course, the weighted average grade of the students should be at least 5/10. If they do not meet this requirement, they will have the possibility to perform some retake exercices or exams for each individual part of the course where they have failed. To participate in these resit activities, the students should have obtained at least 3/10 in the previous evaluation tests and in the weighted average grade, and he/she should have attended at least 90% of the theroretical sessions of those parts.

The participation of the students in all the evaluation activities is mandatory to have the possibility to participate in the retake tests.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exercises and works	79%	20	0.8	8, 4, 5, 9, 1, 6, 7, 10, 2, 3, 11
Final Exam	21%	2	0.08	8, 4, 5, 9, 1, 6, 7, 10, 2, 3, 11

Bibliography

G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London, 2004

C. E. Carraher, Jr., Carraher's Polymer Chemistry, 10th Edition, CRC Press, 2017

C. I. C. Crucho, M. T. Barros, Polymeric Nanoparticles: A study on the preparation variables and characterization methods, *Materials Science and Engineering C*, 2017, *80*, 771-784.

D. R. Paul, L. M. Robeson, Polymeric Nanotechnology: Nanocomposites, *Polymer* 2008, *49*, 3187-3204.

Q. Xu, Nanoporous Materials: Synthesis and applications, CRC Press, Boca Raton, 2013.

Software

Software for slide presentations.