Universitat Autònoma de Barcelona

2017/2018

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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Use of languages

Principal working language: english (eng)

Teachers

Ramón Alibés Arqués

Luis Escriche Martínez

Dmitri Muraviev

Rosa Maria Sebastián Pérez

External teachers

Mariona Coll

Núria Aliaga

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.

Skills

- 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.

3) Macromolecules and polymeric nanomaterials

Polymers: composition, structure and synthesis. Dendrimers. Polymeric nano- and microparticles: synthesis and applications. Polymeric coatings: preparation and applications. Conjugated polymers: plastic electronics and opto-electronics. Polymeric nanocomposites.

4) Nanoporous materials

Nanoporous materials: definitions. Main families: Silica polymorphs; zeolites, aluminosilicates and other metallosilicates; metallophosphates; non-oxide nanoporous solids; metal-organic frameworks. 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 autonomous activities (bibliographic work, personal study, problem solving).

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Theory lectures	38	1.52	9
Type: Autonomous			
Bibliographic Work	10	0.4	2, 8, 9
Personal Study	65	2.6	9
Problem Solving	15	0.6	9

Evaluation

The overall grade will be broken down as follows:

Final exam (53%) + Exercises and works (47%) = 100%

A final exam will be taken by the students at the end of the course. Its grade will account for 53% of the overall mark.

Thoughout the course, students will be required to hand out exercises and works, such as solved problems and reports on scientific articles. The average grade of all these items will account for 47% of the overall mark.

To pass the subjects, the weighted average grade of the students should be at least 5/10.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Exercises and works	47%	20	0.8	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Final Exam	53%	2	0.08	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Bibliography

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