Nanoquímica 2012/2013

Code: 42267
ECTS Credits: 6

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	P	1	0

Contact

Name: Joan Pau Bayón Rueda

Email: Pau.Bayon@uab.cat

Use of languages

Principal working language: anglès (eng)

Prerequisites

Basic Chemical knowledge is required. Contents are suitable for Bachelors in Chemistry and Biochemistry. It is advisable to have some Organic and Inorganic synthesis background.

Further, basic knowledge in separation technology, of chromatographic separation procedures as well as basic analytical chemistry (equilibria, analytical procedure, chemometrics,...), and also some general knowledge in polymeric organic chemistry.

Objectives and Contextualisation

1.- To give a general scope on interdisciplinary aspects of Supramolecular Chemistry and Nanochemistry.

2.- The make students familiar with physical and chemical properties of important nanometric structures together with their manufacturing and engineering processes for nanotechnological solutions.

3.- To develop abilities related to schematization and organization of information and capability for communicating their knowledge and conclusions on Supramolecular Chemistry and Nanochemistry.

4.- To understand basic physical-chemical properties of nanomaterials including simple designs and operation of the resulting biosensing systems

5.- The students should be able to distinguish different kind of membrane separation systems (polymeric, inorganic, porous, non-porous,…), types of applications of each, and different possible applications in different specialties (pharmaceuticals, metal separation, organics separation, medical applications, in agro-food area, etc.). Also, different ways of membrane preparation and characterization should be known after attending the course.

Skills

- Analyse the research results to obtain new products or processes evaluating their industrial and commercial viability for transfer to society.
- 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
- Possess and comprehend knowledge that offers the basis and opportunity to be original in the development and/or application of ideas, frequently in a research context
- Search for information in the scientific literature using the appropriate channels and integrate that information for proposing and contextualising a research topic
- 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 research results to obtain new products or processes evaluating their industrial and commercial viability for transfer to society.
2. Define and describe molecular devices and machines
3. 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.
4. Describe the different chemical methods for the preparation and stabilisation of nanoscale materials
5. Describe the different types of membrane, their nature and their applications in separation processes
6. Describe the most important methods for the preparation of separation membranes
7. Describe the preparation of nanomaterials suitable for use in biomedicine and as nanosensors
8. Describe the types, nature and application of supramolecular interactions and the processes of molecular recognition
9. Identify the principles on which self-assembly processes are based
10. Identify the principles on which separation processes by membrane are based
11. List the chemical processes for the formation of supramolecular structures and molecular recognition
12. Possess and comprehend knowledge that offers the basis and opportunity to be original in the development and/or application of ideas, frequently in a research context
13. Recognise the structures that result from liquid interfaces (micelles, vesicles, monolayer, bilayer and liquid crystals)
14. Relate the nature of nanomaterials to their biomedical applications and as nanosensors
15. Search for information in the scientific literature using the appropriate channels and integrate that information for proposing and contextualising a research topic
16. 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
17. 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

Part 1: Supramolecular Chemistry:

***** Introduction to Supramolecular Chemistry. Preorganization and complementarity.

***** Intermolecular forces. Affinity and selectivity. Complementarity. Examples

***** Molecular recognition. Cation recognition. Anion recognition. Neutral Species recognition.

***** Study of supramolecular associations. Stoichometry. Association constants. Job's method. Molar relation method. Examples.

***** Template effect and selfassembly. Mechanical bond. Rotaxanes and catenanes. Selfreplication. Chelate and macrocycle effects.

***** Devices and molecular machines. Definition. Molecular machines in nature, Examples. Classification of molecular machines. Examples.

Part 2: Nanometric Structures:

***** Introduction to the concepts of nanoscience, nanotechnology and nanochemistry.

Physical and chemical reasons for the size dependent properties.

Surface effects: importance of the surface at the nanoscale. The surface/bulk relation. Surface energy and surface tension. Surface reactivity and catalysis. Self-Assembly. Adsorption. Charged interfaces: the electrical double layer. Surface reconstruction and relaxation.

Quantum phenomena: Tunnel and confinement effects.

***** Nanometric structures

Carbon based materials: synthesis, properties and applications of fullerenes, carbon nanotubes and graphene.

Colloids. Stabilization of colloids. Metallic and semiconducting nanoparticles: synthesis, properties and applications. Magnetic and silica particles.

Nanoparticles and nanocapsules based on lipids, polymer and proteins. Properties and applications. Stimulus responsive materials and auto-healing materials.

Part 3: Application of Nanostructured Materials:

***** Nanoparticles, quantum dots, carbon nanotubes, graphene.

***** General properties and their applications in nanobiosensors.

***** Biomedical, environmental and safety related applications.

Part 4: Separation Membranes:

***** General concepts and classification of the different types of membrane systems: polymeric, inorganic, porous, non-porous, etc.

***** Membrane preparation Techniques.

***** Membrane characterization techniques.

***** Differences between micro, nano and ultrafiltration processes.

***** Different applications in different specialties (pharmaceuticals, metal separation, organics separation, medical applications, in agro-food area, etc.).

***** Some examples of biological membranes systems.

Methodology

Students will attend at Lectures, seminars about particular subjects and finally some sessions will consist in presentations about different aspects of the course held by

students. For these presentations each student will be individually in charge of one presentation regarding one specific subject from one of the 4 parts in which the course is divided.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures	28	1.12	2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16
Seminars	2	0.08	4, 7, 12, 14, 16
Type: Autonomous			
Speech (presentation) preparation	30	1.2	1, 3, 9, 10, 12, 13, 14, 15, 16, 17
Study	82	3.28	1, 9, 10, 12, 13, 14, 15, 16, 17

Evaluation

Each student final mark will be calculated on the basis of a 60% contribution of their presentations and a 40% contribution of the exam at the end of the course. At the end of the course a 4 hours session will be held in order that each student will give a speech according to a specific subject assigned along the course. Finally, another 4 hours session will be taken as an exam including concepts related to the four different parts of the course.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Exam	40% of contribution to final mark	4	0.16	2, 3, 8, 9, 10, 12, 13, 17
Presentations	60% of contribution to final mark	4	0.16	1, 3, 12, 15, 16, 17

Bibliography

Core Concepts in Supramolecular Chemistry and Nanochemistry Steed, J. W.; Turner, D.R.; Wallace, K. John Willey & Sons, **2007**, ISBN-10: 0470858672

Supramolecular Chemistry Beer, P.; Gale, P.; Smith, D. (Coll. Oxford Chemistry Primers) Oxford University Press **1999**, ISBN-10: **0198504470**

Supramolecular Chemistry. J. W. Steed and J.L. Atwood. John Willey & Sons, **2009**, 2009 ISBN: 978-0-470-51234-0

Nanochemistry Ozin, G.A.; Arsenault, A.C. RSC Publications, Cambridge, **2005**. ISBN: 0-85404-664-X

Basic Principles of Membrane Technology. M. Mulder. Kluwer Academic Publishers **1996**, ISBN: 0-7923-0979-2

Biosensing using Nanomaterials, A.Merkoçi, Wiley Series in Nanoscience and

Nanotechnology, Arben Merkoçi, Series Editor, A John Wiley & Sons, Inc, Publication, **2009**, ISBN: 0470447729

Concepts of Nanochemistry Ludovico Cademartiri and Geoffrey A. Ozin Wiley-VCH Verlag, Weinheim, **2009**. ISBN: 978-3-527-32597-9.