COURSE DATA

Data Subject	
Code	M7-44423
Name	Use of supramolecular chemistry for the preparation of nanostructures and nanomaterials
Cycle	Master's degree
ECTS Credits	3.0

Study (s)

Degree	Center	Acad. year	Period
2208 - Master's Degree in Molecular Nanoscience and Nanotechnology	Faculty of Chemistry	1	Second term

Subject-matter

Degree	Subject-matter	Character
2208 - Master's Degree in Molecular Nanoscience and Nanotechnology	7 - Use of supramolecular chemistry for the preparation of nanostructures and nanomaterials	Obligatory

Coordination

Name	Department
MÍNGUEZ ESPALLARGAS, GUILLERMO	320 - Inorganic Chemistry- U. de València

SUMMARY

The aim is to introduce the students, through advanced lectures, into supramolecular chemistry and its utility to obtain nanostructures and nanomaterials of interest for chemical applications (catalysis, sensors), physical applications (magnetism, molecular electronics) and biomedical applications.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Previous knowledge of chemistry, physics or materials science as taught in the degrees indicated in the recommended entry profile to the master's degree is required. Previous knowledge of molecular nanoscience and nanotechnology as taught in the Introduction and Basic Modules is required.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

2208 - Master's Degree in Molecular Nanoscience and Nanotechnology

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- To possess the necessary knowledge and abilities to continue with future studies in the PhD program in Nanoscience and Nanotechnology.
- For students from field of knowledge (e.g. chemistry) to be able to scientifically communicate and interact with colleagues from another field (e.g. physics) in the resolution of problems laid out by the Molecular Nanoscience and Nanotechnology.
- To know the methodological approaches used in Nanoscience.
- To acquire supramolecular chemistry conceptual concepts necessary for the design of new nanomaterials and nanostructures.
- To know the main techniques for molecular systems nanofabrication.
- To acquire the conceptual knowledge about molecular systems self-assembly and self-organisation.
- To know the main biological and medical application in this area.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

We expect the students to gain knowledge on supramolecular chemistry and its utility to obtain nanostructures and nanomaterials of interest for chemical applications (catalysis, sensors), physical applications (magnetism, molecular electronics) and biomedical applications.

DESCRIPTION OF CONTENTS

1. Self-assembly

1.1. Hierarchical self-assembly and auto-organization: functional nanostructures and supra-molecular materials with interesting physical or chemical properties; design of bio-molecular architectures; design of functional molecules and nanomaterials with a high level of communication with biological systems and its biomedical applications.
1.2. Organización de estructuras supramoleculares en superficies: Supramolecular Organization in Thin Films, Chemical and physical vapor deposition, Solution and Thermal Evaporation on surfaces, The Layer-by-Layer Approach, LangmuirBlodgett (LB) films, Self-assembled monolayers (SAMs). Molecular machines: Machines on a molecular scale. Effects of scale on movement, Construction of machines on a molecular scale, topological entanglement or mechanical joints: catenanes and rotaxanes, isomerizable unsaturated bonds: Light-Driven monodirectional molecular rotors.
1.3. Use of self-assembled structures as templates for growing organic and inorganic nanostructures.
1.4. Self-assembly of nanoparticles.
1.5. Chirality in surfaces and its relevance in heterogeneous catalysis.
1.6. Supramolecular Polymers. Stimuli-Responsive Systems. Supramolecular Organization of -Conjugated Oligomers.

2. Crystal engineering

2.1. Crystal engineering.
2.2. Crystal structure prediction.
2.3. Supramolecular interactions: supramolecular synthons, secondary building units and structural databases.
2.4. Crystallization techniques.
2.5. Graph set analysis.
2.6. Crystallography: basics.
2.7. Powder diffraction.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	15,00	100
Seminars	5,00	100
Tutorials	4,00	100
Other activities	2,00	100
Preparation of evaluation activities	37,00	0
Preparing lectures	12,00	0
TOTAL	**75,00**	

TEACHING METHODOLOGY

Classes in this subject will be taught, together with the rest of the advanced module, intensively during 3 weeks in May and each year at a different university.

During the **theory classes**, professors will give an overview of the subject under study, emphasising new or particularly complex aspects. The necessary bibliographical sources will be indicated for students to study the subject in depth.

The **practical classes** of this subject will be devoted to the organisation of seminars in which problems related to the theoretical content will be posed and solved. Likewise, practical cases and other topics related to the subject will be discussed with the students.

During these hours of practical activities, as far as possible, visits to laboratories and facilities related to the contents of the theoretical classes will be organised. This includes visits to the controlled atmosphere and clean room device fabrication laboratories and to the electrical and optical device measurement equipment. In addition, simple practical exercises will be carried out with the main computer programmes used for the theoretical modelling of quantum transport in molecular electronic devices.

After the intensive face-to-face classes, the lecturers will ask students a series of **questions** about the contents of the course that the student will have to solve.

Professors will hold **tutorials** with the students to resolve any doubts and questions they may have. These tutorials will take place in person or remotely (email, videoconference, telephone, etc.) depending on whether the student and teacher are from the same or a different university.

Through all these activities, students will acquire the competences described in the corresponding section. The basic competences will be worked on above all during the seminars.

EVALUATION

The acquisition of the competences of the subject will be assessed by means of a written exam based on the questions posed to the students. The mark for this exam will represent 90% of the final mark for the subject.

Student participation during the training activities will represent 10% of the final grade.

In order to pass the course, it will be necessary to have attended 80% of the face-to-face training activities.

REFERENCES

Basic

- J.W. Steed, J.L. Atwood: Supramolecular Chemistry (2nd Ed.) Wiley, 2009.
V. Balzani, M. Ventura, A. Credi: Molecular Machines, Wiley-VCH, 2003.
P.J. Collings, Liquid Crystals: Natures delicate of Mater. 2ª Ed., Princenton University Press, 2002.
Ulman, An Introduction to Ultrathin Organic Films: from Langmuir-Blodgett to Self-Assembly, Academic Press, San Diego, 1991.
J.W. Steed, D.R. Turner, K.J. Wallace: Core Concepts in Supramolecular Chemistry and Nanochemistry. Wiley, 2007.
V. Balzani, A. Credi, M. Venturi, Molecular Devices and Machines: Concepts and Perspectives for the Nanoworld, Wiley, 2008.
K.J. Klabunde, Nanoscale Materials in Chemistry, Wiley, 2001.
Y.S. Lee, Self-Assembly in Nanotechnology, Wiley, 2008.
J.L. Atwood, J.W. Steed, Organic Nanostructures, Wiley, 2008.
Supramolecular Chemistry: From Molecules to Nanomaterials, ed. P. Gale and J. Steed, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2012

Additional

- Organic Nanomaterials: Synthesis, Characterization, and Device Applications, T. Torres, G. Bottari, Eds., John Wiley & Sons, Inc, Chichester 2013.
L. Brammer, Developments in Inorganic Crystal Engineering, Chem. Soc. Rev. 2004, 33, 476489
G. R. Desiraju, Crystal Engineering. The Design of Organic Solids; Elsevier: Amsterdam, 1989
M. C. Etter, Encoding and Decoding Hydrogen-Bond Patterns of Organic Compounds, Acc. Chem. Res. 1990, 23, 120-126
M. OKeeffe and O. M. Yaghi, Deconstructing the Crystal Structures of Metal-Organic Frameworks and Related Materials into Their Underlying Nets, Chem. Rev. 2012, 112, 675702
G. R. Desiraju, Supramolecular Synthons in Crystal EngineeringA New Organic Synthesis Angew. Chem. Int. Ed. 1995, 34, 2311

Supramolecular Polymers and Assemblies, Ed. Ulrich S. Schubert (Author), George R. Newkome (Author), Andreas Winter,1st. Edition.

Supramolecular Polymer Chemistry, Ed. Akira Harada. 1st. Edition.

Donald J. Cram, The design of molecular hosts, guests, and their complexes (Nobel Lecture) Angew. Chem., Int. Ed. Engl., 1988, 27, 10091020.