Universidad Zaragoza

Academic Year/course: 2021/22

60461 - Chemistry of advanced materials

Syllabus Information

Academic Year: 2021/22
Subject: 60461 - Chemistry of advanced materials
Faculty / School: 100 - Facultad de Ciencias
Degree: 543 - Master's in Molecular Chemistry and Homogeneous Catalysis
ECTS: 2.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The preparation of materials to meet technological demands of the society is an important area of work in which a Chemist should interrelate the synthetic and structural knowledge acquired in their previous training. The development of new materials is based on the knowledge of the relationship between chemical structure and physical properties associated with a particular application, as well as the knowledge of the synthetic strategies that allows obtaining the required material.

Therefore, it is pursued

- To interrelate the chemical structure and the properties in the design of advanced materials.
- To identify the specific synthetic methodologies of materials and how to approach their preparation and processing depending on the required optimal structure.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/), in such a way that the acquisition of the results of subject learning provides training and competence to contribute to some extent to its achievement. Goal 4: Quality Education, Goal 5: Gender equality and Goal 10: Reduced Inequalities.

1.2. Context and importance of this course in the degree

The course is part of the optional module *Horizons in Molecular Chemistry and Catalysis*. It is a four-month teaching course given in the second semester of the academic year with a workload of 2 ECTS.

Because knowledge of the synthetic principles and of the molecular structure are key issues for preparing materials, the course aims to apply them to the field of materials. In this course, the specific synthetic methods for the preparation of chemicals conventionally used for materials are revised and how the structural design determines the synthetic methodology and the final processing of the material. Therefore, the course requires of the knowledge acquired in the compulsory courses of the Master and complements other optional curses such as Supramolecular Chemistry, Advanced Structural characterization techniques and is useful for some others like Chemistry on the border frontier with biology.

1.3. Recommendations to take this course

It is advisable prior knowledge (bachelor's degree level in Chemistry) on Inorganic Chemistry and Organic Chemistry. Basic knowledge on Materials Science is recommended.

2. Learning goals

2.1. Competences

1. To design of materials with the appropriate molecular structure to meet specific properties.
2. To be able to propose appropriate synthetic strategies as a function of the molecular or macromolecular structure of the material.
3. Relate concepts of Organic and Inorganic Chemistry, Macromolecular Chemistry and Nanoscience in the design of advanced materials.

4. To anticipate advanced applications for organic and inorganic materials.
5. To be able to select characterization techniques for the study of the materials in both its synthetic process and structural or physical properties characterization.

2.2. Learning goals

1. To recognize advanced materials of current interest of both organic and inorganic nature.
2. To identify the involvement of Chemistry in the development of advanced materials.
3. To know the basics of rational design of these materials.
4. To apply novel chemical principles to the synthesis and preparation of advanced materials.
5. To evaluate the most suitable techniques for the preparation and characterization of advanced materials.

2.3. Importance of learning goals

Technological development implies a demand for new materials. This demand requires of an interdisciplinary response that implies adequate structural design and a viable synthesis of these new materials. This course aims to raise awareness of the importance of chemistry in this process From the results of this course, starting from significant examples, students will expand their knowledge of materials while will implement previous skills and training either acquired in the degree or compulsory courses of the master, to address problems related to the design and development of advanced materials.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

1. The ongoing assessment of the course will be based on the following activities

   A1.- Preparation, presentation and defense of a practical case based on a scientific paper or a specific topic. The critical discussion/presentation will be taken into account. Rated as 30% of the final mark

   A2.- Written test based on theory questions. Rated as 70% of the final mark

2. For those students that did not pass the ongoing assessment or wish to increase their markit will be a global exam during the official calls in February and September. The assessment will consist of a written test based on theory questions, problems and case analysis. Also, the preparation, presentation and defense of a practical case will be required. Final mark will be calculated as follows:

70% of the written mark + 30% of the practical case

Students with a score equal to or greater than 5 out of 10 in A2 activity in the ongoing assessment can maintain their qualification for the global examination both in June or September.

The number of official examination calls per registration and their use will be subjected to the statements of the *Regulation of Permanence in Master Studies* and the *Regulation of the Learning Assessment* (https://ciencias.unizar.es/normativas-asuntos-academicos). The latest document will also regulate the general design and scoring criteria of the assessment activities, as well as the exam schedules and timetable for the post-examination review.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course includes lectures, practice sessions (problem-based) and seminars.

The active participation of the student will be promoted with a critical analysis of the theoretical contents, in particular, by proposing problems and practical cases.

The student must prepare a case study that will by supervised by the lecturer. This activity will imply the search of the appropriate bibliography, preparation, presentation and/or defense of the project.

The lecture notes used in class will be available.

4.2. Learning tasks

The course includes the following learning tasks:

- 1. Participatory lectures (1.5 ECTS).
- 2. Practice sessions (0.4 ECTS).
- 3. Supervised project (0.1 ECTS).
- 4. Tutorials.

Teaching and assessment activities will be carried out in the classroom with all students onsite unless, due to the health situation, the provisions issued by the competent authorities and the University of Zaragoza arrange to carry them out by

telematics means or in a reduced rotating capacity.

4.3. Syllabus

The course will address the following topics:

Section I. General Aspects

Topic 1. Introduction to advanced materials

- Definition and classes of materials. Molecular design of materials. From the molecule to the material. Basic experimental techniques for the characterization of materials: General aspects.

Section II. Synthesis of advanced materials. Examples of applications.

Topic 2. Fundamentals of the synthesis of macromolecules

- Macromolecular chemistry. Conventional polymerization techniques. Living polymers. Fundamentals of macromolecular engineering. Controlled radical polymerization: ATRP and RAFT. Ring opening polymerization and enzymatic polymerization: development of biodegradable polymers and from natural resources.

Topic 3. Design and functionalization of macromolecules

- Design of copolymers: control of topology and composition. Hyperbranched macromolecules. Dendrimers. Functionalization of macromolecules. Development of advanced polymers.

Topic 4. Development of nanoparticles: inorganic, organic and hybrid nanoparticles

- Types of nanoparticles and properties. Synthesis of nanoparticles. Functionalization of nanoparticles and applications.

Topic 5. Porous materials

- Microporous, mesoporous and macroporous materials. Zeolites and other porous materials. Mesoporous and macroporous materials. Metal-organic frameworks (MOFs). Applications.

4.4. Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Faculty of Science website https://ciencias.unizar.es.

The submission date for the supervised project's presentations will be announced in advance.

Students will be provided with different scholar material either at reprography or through the University's virtual platform https://moodle2.unizar.es/add.

The information about schedules, calendars and exams is available at the websites of the Sciences Faculty, https://ciencias.unizar.es/calendario-y-horarios, and the Master, http://masterqmch.unizar.es.