Universidad Zaragoza

Year : 2020/21

66111 - Assembly and Fabrication of Nanoestructures

Syllabus Information

Academic Year: 2020/21
Subject: 66111 - Assembly and Fabrication of Nanoestructures
Faculty / School: 100 - Facultad de Ciencias
Degree: 539 - Master's in Nanostructured Materials for Nanotechnology Applications
ECTS: 6.0
Year: 1
Semester: First semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

The aim of this course is to make students aware of the importance of order at the atomic and molecular levels and how this order can determine the properties of a nanostructured material; how they can be different to what this same compound exhibits in a three-dimensional structure with no preferential order. It is precisely this order that, naturally or imposed by different assembly techniques, directed intermolecular interactions, 'click' chemical strategies, controlled polymerization, chemical functionalization of nano-objects, etc., on a nanoscopic scale can create properties that condition the possible applications and uses for these materials - which will be analysed in later modules in this Master's. Therefore, it is essential that students on this course identiy and know how to apply the chemical and physical processes that can result in this order.

1.2.Context and importance of this course in the degree

As a continuation of the previous course, ?*Preparation of Nanostructured Materials*? , here the necessary basic chemistry concepts are introduced to make the molecular self-assembly and self-organisation processes understandable as they let students make practical use of this chemistry to the benefit of the production of structures of interest in Nanoscience and Nanotechnology.

This course, together with the ?*Preparation of Nanostructured Materials*? module, pursues the instruction in the different methods available to obtain nanostructured materials, which is the first stage in the production of nanodevices with properties that are of interest in fields as diverse as physics, chemistry, biochemistry and medicine.

1.3.Recommendations to take this course

The ?*Assembly and Fabrication of Nanostructures*? course is obligatory and is equivalent to 6 ECTS credits or 150 student work hours. Of these 6 credits, 4 are for theory and 2 correspond to laboratory practicals. The course is given in the first term of the academic year.

The objective of this module is to show the student the various assembly and production methods for Nanostructures.

This is an eminently oriented and practical module where students analyse, debate and evaluate different nanostructure assembly and production methods. The theory classes are accompanied and complemented by six practicals through which the students can see up close in the laboratory the difficulties and advantages of the different preparation methods for these materials, with access to highly specialised equipment that they will be able to use - under supervision of the staff - as there will be so few people per group.

As the whole course is taught in English, students need to have an upper-intermediate level in the language: minimum level B1 in the European Common Framework Language Reference, but preferably level B2. Level B1 is reached when the student is able to understand the main points of clear, standard-language texts when covering known matters - whether in terms of work, study or leisure; when able to cope in most situations which the student encounters during a trip to places where the language is spoken; when able to write simple, coherent texts on familiar topics or those in which the student has an interest; and when able to describe experiences, happenings, wishes and ambitions as well as briefly justify opinions or explain plans. B2 is achieved when the student is able to understand the main ideas of complex texts that deal with both specific and abstract topics, even if these are technical - though lying within the field of specialisation; when able to communicate with native speakers with the degree of fluency and ease such that the communication takes place without effort on either side; and when able to write clear, detailed texts on diverse subjects as well as defend a point of view on general topics - giving the pros and cons of the different options.

2.Learning goals

2.1.Competences

After completing the course, the student will be competent in the following skills:

- Assess how an extensive control of order at an atomic and molecular level allows the properties of the materials to be optimised and strengthened

- Recognise the chemistry potential in the production of self-assembled nanostructures, hierarchical structures, chirality, etc.

- Make use of the necessary chemical and chemical-physical knowledge to see the real applications of the assembly and production of functional nanostructures.

2.2.Learning goals

The student, in order to pass the course, will have to show her/his competence in the following skills:

- Clearly identify the different nanostructure types (0D, 1D, 2D and 3D) and the chemical and physical methods available for their production.

- Recognise the different supramolecular and macromolecular architectures, their importance in chemistry and their potential application in various fields in Nanotechnology, suggesting rational structural designs and effective chemical synthesis tools to produce and assemble functional structures.

- Plan, design and undertake experiments aimed at producing nanomaterials, evaluating the problems, risks and results.

2.3.Importance of learning goals

The first step to fabricate a nanodevice is choosing and designing an appropriate method for the assembly of the constituent atoms or molecules for the nanodevice. Therefore, this subject, taught just after the course 66112- *Assembly and Fabrication of Nanostructures*, takes place before later moving on to studying how the nanostructured material obtained can be characterised and its properties and potential market applications assessed.

3.Assessment (1st and 2nd call)

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

The student will prove that he/she has achieved the expected learning results by means of the following assessment tasks:

For students choosing **CONTINUOUS Assessment** (attendance to at least 80% of both module lectures and practicals is required).

- Assessment of the **4 ECTS theory credits** is partially achieved through:

  a) A written exam (50% of the mark for these 4 theory credits). Here the abilities acquired by the student in the shape of theoretical knowledge obtained in relation to nanostructure assembly and production are assessed. The exam will feature theory matters including: (i) topic(s) expanded from those corresponding to the contents of this subject, given in the "brief introduction to the subject" section and (ii) short answer or multiple choice questions. In these theory questions, the student has to show that the abilities required for the subject have been obtained which, consequently, will be scored between 1 and 10 for accuracy in topic presentation (scientific quality and written communication abilities) as well as conciseness and quality in the answers given. Plagiarism is not aceptable.

  b) Problem solving, exercises and questions during the classes answered by the student at that time or later according to the lecturer's indications will also be scored (50% of the qualification for these 4 theory credits). Specifically, a score of 1 to 10 is given for: the right approach to solving the question or problem, correct solution, interpretation of the results and explanation of how the problem was solved, giving equations or graphs where necessary. Likewise, the student's oral and written communication skills will also be evaluated.

- Assessment of the **2 ECTS credits** for the **practicals**. The lecturers will assess (scored between 1 and 10) several aspects of the practical which may include, depending on each practical, abilities and skills of the students in the laboratory, instrument handling ability, accuracy performing experiments, attention to detail, ability to solve problems or unforeseen difficulties that may arise, ability to work on experiments in a group, and answers to multiple choice questions and Q&As laid out before, during and/or after the practical sessions.

A minimum qualification of 4 out of 10 is needed in each of the two parts -theory and practice- to pass the subject. In any case, the average over the two sections must be at least 5 out of 10 to pass the subject. Plagiarism (the illicit copying of another person's work, especially written content, for presentation as one's own) is not allowed.

The **GLOBAL ASSESSMENT,** for the students that did not pass the ongoing assessment or wish to increase their mark, consists of:

1.- A written test (75% of the global mark) with theory questions including: (i) topic(s) to de developed based on those given in the "brief introduction to the subject" section in this teaching manual where the complete contents are given and (ii) multiple choice and/or short answer questions, also in reference to the class course content and problem solving and exercises where the student shows knowledge regarding the manufacturing of nanomaterials, nanostructures and nanolithographic techniques. A score of 1 to 10 will be given for scientific quality and communication skills.

2.- A practical exam (25% of the global mark) involving three exercises. Firstly, a multiple choice test where the judgement is on whether or not the student is ready to respect the laboratory safety norms and if the student is able to manage the instruments involved in the practical test. This is an elimination test which can only be passed with a score of 8 out of 10. This first test counts for 5% of the total for the practical exam. Once the test is passed, the student begins the laboratory exam. This consists of an experiment in which the student must show the capability to plan the necessary experiments given the objectives to be achieved. These experiments must be performed adequately, correctly using the corresponding instruments (an expert will at all times be supervising and will halt the exam if this person sees that the student is endangering the equipment used or their own safety). This part counts for 65% of the mark in the practical exam. Lastly, the student must interpret the data obtained and write a report in which the results obtained are analyzed and the main conclusions given. A score of between 1 and 10 will be given for the scientific quality of the report presented and the student's communication skills. This report is worth 30% of the total mark for the practical exam.

A minimum qualification of 4 out of 10 is needed in each of the two parts -theory and practice- to pass the subject. In any case, the average over the two sections must be at least 5 out of 10 to pass the subject. Plagiarism (the illicit copying of another person's work, especially written content, for presentation as one's own) is not allowed.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The aim of this module is to provide students with knowledge on the nanostructure assembly and production methods, identification of the relevance of chemistry in molecular assembly, supramolecular chemistry, obtaining chiral and functionalized structures, etc.

Therefore, following a general examination of these possibilities through lectures, there will be case and problem analysis activities where these principles can be observed, examined in depth, evaluated and clarified.

The lectures are complemented with laboratory practice sessions where the students can apply the acquired theoretical knowledge to real nanostructure production cases.

Following practical case analysis, there will be a seminar preparation activity for which the student will write a report on more specific details not previously examined in class of a preparation method and its importance in the scientific, technological, social and economic context.

The methodology followed in this course is oriented towards achievement of the learning objectives. Students are expected to participate actively in the class throught the semester. Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the description of the practicals sessions, the course syllabus, as well as other course-specific learning materials. Further information regarding the course will be provided by the coordinator of the course on the first day of class.

4.2.Learning tasks

The programme offered to the students to help them achieve the learning results includes the following activities:

- Each topic area making up the programme for the module will be presented, analysed and discussed by the lecturer through lecturers of 50 min. The lecturers will provide the students with notes, handouts or summaries of class content prior to the beginning of the class (preferably via Moodle) along with the recommended reading for more in-depth understanding of the topic.

- Open forum on the basic concepts and their application, comparison with real developments, and problem-solving and practical case studies.

- Laboratory practicals through which the student will face real problems during the preparation of nanostructured materials. Thanks to the work with their colleagues in practical groups, the students will develop group work skills.

4.3.Syllabus

The course will address the following topics:

- Nanomaterials, nanostructures and their production: nanoparticles, quantum points, nanotubes, nanothreads, nanosheets, nanocomposites, block copolymers, dendrimers and liposomes.
- Hierarchical self-assembly and molecular self-organisation: liquid crystals, helical nanostructures, growth by biochemical self-assembly, etc.
- Surface chirality.
- Nanostructure functionalization.
- Inorganic layers.

The theory classes are complemented by six practical sessions including:

- Synthesis of Nanoparticles by wet chemistry
- Synthesis of Nanoparticles by Laser pyrolisis
- Synthesis of nanowires by wet chemistry
- Preparation of block co-polymer micelle aggregates
- Helical nanostructures based on liquid crystals
- Preparation of inorganic films and coatings from individual entities//Well-intergrown zeolite membranes

4.4.Course planning and calendar

The course is given in the afternoon and the calendar for classes and exam dates will be published prior to the beginning of each academic year in the web site of the Faculty of Science. Furthermore, the google calendar for this course will be shared with the students for a more efficient and effective communication.

The course starts at the end at the end of course 66112 "Preparation of Nanostructured Materials" (around the first week of December) and continue for about five teaching weeks.

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class by the coordinator of the course.

4.5.Bibliography and recommended resources