Universidad Zaragoza

Year : 2020/21

66112 - Preparation of Nanostructured Materials

Syllabus Information

Academic Year: 2020/21
Subject: 66112 - Preparation of Nanostructured Materials
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 main aim of this module, together with course ?*Assembly and Production of Nanostructures*?, is to instruct the student in the different methods available to obtain nanostructured materials, i.e. the first stage in the production of nanodevices with properties that are of interest in fields as diverse as physics, chemistry, biochemistry and medicine.

1.2.Context and importance of this course in the degree

An extensive control of order at an atomic and molecular level allows the properties of the materials to be optimised and strengthened. Current science and technology allow the manipulation of the material atom by atom or molecule by molecule. Therefore, in this module, different nanostructured materials production techniques will be examined, linking the most appropriate technique in each case to the material we wish to handle and the architecture and end properties of the nanodevice we intend to produce.

Some of these techniques require highly specialised scientific instruments. Zaragoza University and the Nanoscience and Materials Institute of Aragon (INMA) provide the Master's students with next generation equipment allowing them to acquire abilities and skills in the management of instruments that are of great value on the curriculum of a professional in disciplines within the field of Nanoscience and Nanotechnology.

1.3.Recommendations to take this course

The ?*Preparation of Nanostructured Materials*? 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 chemical and physical methods for preparing nanostructured materials.

This is an eminently practical module where students analyse, debate and evaluate different nanostructured materials manufacturing methods. The theory classes are accompanied and complemented by four 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 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.

- Classify the nanostructure production methods, identifying the most appropriate in each case in accordance with the starting materials and the intended end properties.

- Use specific equipment to prepare nanostructured materials.

- See and use the vocabulary appropriate to this discipline, being able to assess, judge and contrast results obtained for the nanostructure production processes with other students.

- Design a production process for a nanostructured material.

2.2.Learning goals

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

- Possess a critical view of the different chemical and physical methods for the preparation of nanostructured materials, identifying the pros and cons of each method in accordance with the material type with which they are going to work.

- Identify and correlate the unique features of the original materials, the preparation technique used and the end nature and properties of the nanostructures obtained.

- Assess the practical difficulties involved in the manufacturing of nanostructured materials, developing the ability to design strategies to solve them and being able to choose the most appropriate approach in each case.

- The student is able to plan, design and perform experiments that allow value added nanomaterials to be produced, assessing the problems, risks and results.

- Identify the main applications of nanolithographic processes.

2.3.Importance of learning goals

The first step to producing a nanodevice is choosing and designing an appropriate method for the assembly of the constituent atoms or molecules for the nanodevice. Therefore, this module takes place at the beginning of the academic year before later moving on to studying how the nanostructured material obtained can be characterised and its properties and potential market applications assessed.

The ?*Preparation of Nanostructured Materials*? module aims to make the student aware of the importance of correctly choosing the nanostructure technique or production method in accordance with the working material and the intended end properties.

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 **Ongoing Assessment** (attendance to at least 80% of both module lectures and practicals is required) **:**

- Assessment of the **4 ECTS credits** in this subject is partly achieved through:

  - 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 are assessed in relation to nanostructure assembly and production. The exam consists of:

    a) Theory questions including topic(s) developed from those taught in class and included in the contents section of this teaching manual, plus answers to short questions, problems and exercises, where the student should use his/her own words to communicate the discussed topic. Scientific knowledge and written communication skills are scored between 1 and 10 in this test. A minimum mark of 4 is required for the written test. Plagiarism is not aceptable.

    b) Problem solving, exercises and questions set during the classes responded to individually by the student in the same classes or handed in later to the lecturer giving the class. In these Q&As, the student will have to show knowledge about production of nanomaterials, nanostructures and nanolithographic techniques. 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.

  - An individual monographic project related to some of the topics included in the module descriptors (with details in the "brief introduction to the subject" section for this module) (50% of the mark for the 4 theory credits). Through this test, the results of the learning process will be assessed with regard to the abilities required for the module such as bibliographic searching, data interpretation, synthesis ability, oral and written communication skills, interaction with colleagues and professionals from other areas, etc. Specifically for the report, a score of 1 to 10 is given for: i) structure (logical division of content); ii) quality of scientific and technical content (presentation of state of art, correct use of formulae, use of consistent arguments, and correct presentation of most important conclusions); iii) good use of bibliography (number and quality of sources consulted); iv) presentation (well written, correct and fluent use of English, care taken over style). Plagiarism is not acceptable.

The following are assessed in the oral presentation: i) structure (logical division of content) and good distribution of time; ii) good scientific communication (concise presentation, direct, clear and pedagogical); iii) correct use of audiovisual equipment. Each project will be supervised by one of the teachers of the module, who advise the student in their preparation. The committee, if required, will ask the supervisor for additional information.

-Assessment of the **2 ECTS credits** for the practical part. The teachers for the practicals will assess the knowledge, abilities and skills of the students in the laboratory. They will score between 1 and 10 on basic aspects of the practical and/or the fundamental aspects of the practical. These, depending on each specific topic, may include instrument handling skills, accuracy when performing experiments, attention to detail, ability to resolve unforeseen problems or difficulties that may arise, etc. Students will also answer questions posed by the practical teachers which include questions on the theoretical bases on which the practicals are based as well as the analysis and interpretation of the results obtained in the laboratory. The teachers of the practical may also ask the students to write reports handed in by the students on their laboratory results and the interpretation of these. Special attention will be paid to checking that students have acquired the necessary abilities from these practical sessions, i.e. handling of nanomaterial production techniques, recognition of experimental difficulties in these processes, problem, risk and difficulty evaluation, interpretation of results obtained, professional presentation of laboratory-acquired results and written communication ability with specific language appropriate to the topic under consideration.

A minimum qualification of 4 out of 10 is needed in each of the three parts of the exam to pass the subject. In any case, the average over the three 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.

GLOBAL EXAMINATION for students that did not pass the ongoing assessment or wish to increase their mark.

The global assessment consists of:

1.- A written test (50% of the global mark) with theory questions including: (i) topic(s) to be 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. The student should use his/her own words to communicate the discussed topic.

2.- Dissertation and oral presentation (25% of the global mark) made in front of a board of three examiners of a monographic piece of work (for which a written report is also presented). A score of between 1 and 10 is given in this test for bibliographic searches, correctly explaining the state of art of the topic which has been worked on, and synthesis capacity. Scientific communication skills will also be scored between 1 and 10 for these tests in which correct use of scientific language, audiovisual aids, graphs, presentation clarity, etc. is required. Both oral and written exams will take place in the languae used for the course: English.

3.- A practical test (25% of the global mark). Firstly, a multiple choice test to judge if the student is ready to respect the laboratory safety norms and 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 mark for the practical test. 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) and obtaining a series of data that the student must then interpret. This second part counts for 95% of the total mark for the practical test

A minimum qualification of 4 out of 10 is needed in each of the three parts of the global exam to pass the subject. In any case, the average over the three 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 of the basic nanostructured materials production methods, identifying the pros and cons of each technique in accordance with the starting material and the intended properties.

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

These sessions will be complemented by laboratory practice sessions where the students can study, observe and handle the correct instruments for the production of nanostructured materials.

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 lectures lasting 50 minutes. 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.

- Other learning tasks taking place during lectures are open forum on the basic concepts and their application, comparison with real developments, problem-solving and practical case studies.

- Completion of individual Q&As. Each student will complete the Q&As that the lecturers give them over the course. The Q&As are to be completed individually by students and sent electronically or handed in to the relevant lecturers. Students will receive a reply from the lecturers as a result of the Q&As and there will be a discussion on the areas of discrepancy in the answers.

- Completion of individual pieces of work. Each student will create - under the supervision of a module lecturer - a written report on a nanostructured materials preparation technique, going in depth on more specialised aspects of the technique that have not previously been analysed in class. In addition, the students will present this work before their colleagues and teachers in an oral presentation.

- Four laboratory practice sessions through which the student will face real-life problems in the preparation of nanostructured materials. Thanks to the work with their colleagues in the practical groups, the students will develop group work skills and, through reports on the practicals, the students will become used to professionally presenting pieces of work, learning how to communicate the results through the shared language for the academic and industrial research community: English.

4.3.Syllabus

The course will address the following topics:

Preparation methods for thin film, single and multi-layer molecules: chemical vapour deposition (CVD), physical vapour deposition (PVD), liquid phase deposition (?cast films?, ?spin coating?, ?spray coating?, ?ink printing?, ?dip-coating?, ?layer-by-layer?, Langmuir-Blodgett, liquid phase epitaxy, electroplating, etc.), solid phase deposition (?powder deposition?, ?screen printing?). Clean Rooms. Optical lithography. Electron beam lithography. Ion beam lithography. Nanoimprint lithography and the different Scanning Probe Lithographies.

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 of course 66100 Fundamentals Properties of Nanostructured Materials (around the mid of October) and lasts approximately for some 4 or 5 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