66114 - Characterization I: Physical-chemical Techniques

Syllabus Information

Academic Year: 2020/21
Subject: 66114 - Characterization I: Physical-chemical Techniques
Faculty / School: 100 - Facultad de Ciencias
Degree: 539 - Master's in Nanostructured Materials for Nanotechnology Applications
ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

This course, together with course 66104 ?*Characterization II: Advanced Microscopies*?, is aimed at instructing the student in the different methods available for the characterization of nanostructured materials and in their practical application to obtain morphological, structural, analytical, optical, electric or magnetic information of interest.

In this course, students will have the opportunity to use highly specialised scientific instruments to characterise nanostructured materials (the students will study some of the materials that they have prepared in previous modules). Zaragoza University, the Nanoscience and Materials Institute of Aragon (INMA) and the singular scientific installation LMA (Advanced Microscopies Laboratory) provide the Master's students with next gen 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.

1.2.Context and importance of this course in the degree

Characterization of a nanostructured material is vital to know the architecture, order and structure of the material as well as its optical, electrical and magnetic properties. This, in addition, allows the chemical structure of the compounds to be correlated with the assembly technique used and the end properties of the material.

In this subject, a wide range of physical and chemical techniques are introduced for the characterization of nanostructured materials. Generally speaking, the correct use of various complementary techniques allows one to acquire an advanced level of knowledge about the structure of the material, degree of order, particle size, chemical composition, presence of aggregates, etc, as well as the optical, electrical, magnetic and spectroscopic properties of the nanosystem under study.

1.3.Recommendations to take this course

The ?*Characterization I: Physical-Chemical Techniques*? module is obligatory and equivalent to 6 ECTS credits or 150 student work hours. Of these 6 credits, 2 are for theory and 4 correspond to laboratory practicals. The course is given in the second term of the academic year. As with the other modules in this Master's, this module is taught and assessed completely in English.

The objective of this module is to show the student the various chemical and physical characterization methods for nanomaterials.

This is an eminently practical module where students analyse, debate and evaluate different characterization methods for nanostructured materials. The theory classes are accompanied and complemented by numerous laboratory practicals. Through these practical classes, the students will have access to sophisticated characterization equipment, seeing the possibilities and information offered by each of the methods studied and the fact that characterization of a nanostructured material requires the use of diverse complementary techniques.

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.

Additional information about this master (grants, events, etc.) can be found on the web site:
http://ina.unizar.es/academic/master/grants/

2.Learning goals

2.1.Competences

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

- Identify specific phenomena and problems for which this kind of tool can provide vital information for the characterization of nanostructured materials.

- Distinguish the contributions of morphological, structural, analytical and magnetic nature of different basic nanoscience techniques

- Assess the observation difficulties linked to the resolution of the tools and the environmental conditions in which the measurements are taken.

- Understand the type of information provided by each characterization method - assuming that complete analysis requires the complementary information obtained from several of these techniques.

- Design experiments to clarify the composition, structure, morphology or properties of a material on the nanoscale.

2.2.Learning goals

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

- Gain awareness of a collection of different characterization techniques for surfaces and nanosystems, understanding the information from each of them.

- Be able to apply the most appropriate characterization technique in accordance with the morphological, structural, analytical or magnetic information desired.

- Identify specific phenomena and problems for which this kind of tool can provide crucial information.

- Assess the observation difficulties linked to the resolution of the tools and the environmental conditions in which the measurements are taken.

2.3.Importance of learning goals

This module aims to give the student a collection of powerful tools for the characterization of nanostructured materials. In the context of the Master's, the identification of the nanostructure of materials is a key step so that students will be able to correlate by the end of the course the chemical structure and the assembly technique used in the production of a nanodevice and its architecture, morphology and molecular order, as well as the end properties of the device.

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), will be assessed as follows**:**

1.- Assessment of the **2 ECTS theory credits** of the module (33% of the final mark):

a.- Written exam (50% of the theory credits). Here, the abilities acquired related to surface characterization through the techniques seen in this module 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 demonstrate that the abilities required for the subject have been obtained. To do so the student must discuss science using his/her own words since plagiarism is not acceptable. This section will be scored between 1 and 10 for accuracy in topic presentation (scientific quality and written communication skills) as well as correctness of the answers given.

b.- Problem solving, exercises and questions set during the classes responded to individually by the student in the same classes or handed in after to the lecturer giving the class (50% of the theory credits). Specifically, the following will be assessed: 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. Specifically, a score of 1 to 10 is given for: the right approach to solving the problem, correct solution, interpretation of the results and explanation of how the problem was solved, giving equations or graphs where necessary.

2. Assessment of the **4 ECTS practical credits** of the module (67% of the final mark):

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 for each of the three parts to pass the subject. In any case, the average over the three parts 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.

For students that did not pass the ongoing assessment or wish to increase their mark, the **Global Assessment** comprises:

1.- Assessment of theory credits (33% of the final mark). A written exam 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 or short answer questions, exercises and problems also in reference to the class course content and problem solving and exercises where the student shows knowledge, expressed using his/her own words, and discussion abilities regarding characterization of materials through the techniques analyzed in this module. A score of 1 to 10 is given for both the scientific rigor and quality and the written communication skills of the student.

2.- Assessment of the practical credits (67% of the final mark). Firstly, there will be a multiple choice test which must be passed before going into the laboratory. Here the judgment 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 this 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 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). Likewise, the data obtained must be interpreted. This part of the test counts for 95% of this assessment of the practical credits.

A minimum qualification of 4 out of 10 is needed for each of the two sections to pass the subject. In any case, the average over two parts must be at least 5 out of 10 to pass the subject.

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4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The aim of this module is to provide students with knowledge on the different characterization techniques for nanostructured materials, identifying the information type provided by each method.

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

The theory sessions are complemented by laboratory practice sessions where the students can study, observe and handle the correct instruments for the characterization of nanostructured materials. In addition, in keeping with the previous subjects in the Master's related to the production of nanosystems, in this module students will have the opportunity to characterise some of the samples they have already prepared by themselves.

The module will conclude with the analysis of practical cases where the lecturers will present specialised seminars studying real-life cases.

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 of the course will be presented, analysed and discussed by the lecturer through Lectures of 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.

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

- Presentation of Seminars by highly specialised lecturers where real cases are analysed.

- Eight Laboratory Practice Sessions through where students will face real problems in the characterization of nanostructured materials. Thanks to the work with their colleagues in practical groups, the students will develop group work skills.

Other activities such as visits to Singular Scientific Facilities may be included in this course.

4.3.Syllabus

The course will address the following topics:

- Introduction to surface preparation and characterization.
- Photoelectron spectroscopies (XPS and UPS).
- Auger Spectroscopy (AES). SANS techniques
- X-ray and neutron diffraction. Mössbauer spectroscopy.
- Techniques based on the use of sinchrotron radiation: XANES, EXAFS, and magnetic dichroism.
- Magnetic characterization of nanosystems (SQUID, VSM). Hall probes and micro-SQUIDS.
- Characterization of Textural Properties by N2 physisorption.
- Particle size and zeta potential determination by DLS.
- FTIR, Raman and Raman-SERS Spectroscopies.
- Quartz Crystal Microbalance (QCM) and Electrochemical techniques.

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.

In addition, the google calendar for this course will be shared with the students for a more efficient and effective communication.

The course starts at the beginning of the second semester (around the first week of February) 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