66103 - 4. Characterisation I: Physical-chemical techniques

Course 2013 - 2014

Curso: 1, Semestre: 0, Créditos: 7.0

Basic information

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Recommendations to attend this course

The “Characterization I: Physical-Chemical Techniques” module is obligatory and counts for 7 ECTS credits or 175 student work hours. Of these 7 credits, 3 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: www.unizar.es/nanomat

Course Schedule and Deadlines

The classes for this module begin at the start of the second term and will last approximately four weeks.

The classes and laboratory practicals are given in the afternoon and the calendar for these and the exam dates will be published prior to the beginning of each academic year in the web site of the Faculty of Science (https://ciencias.unizar.es/web/horarios.do).

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Learning outcomes that define this course

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

1:
Gain awareness of a collection of different characterization techniques for surfaces and nanosystems, understanding the information from each of them.

2:
Be able to apply the most appropriate characterization technique in accordance with the morphological, structural, analytical or magnetic information desired.

3:
Identify specific phenomena and problems for which this kind of tool can provide crucial information.

4:
Assess the observation difficulties linked to the resolution of the tools and the environmental conditions in which the measurements are taken.

Introduction

Brief presentation of the course

In this subject, a wide range of physical chemical techniques are presented 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, parcelling, presence of aggregates, etc, as well as the optical, electrical and magnetic properties of the nanosystem under study.

A description of the contents of this module is:

Introduction to surface preparation and characterization. Optical spectroscopes (UV-vis, FTIR, etc.). Photoelectron spectroscopy (XPS and UPS). Auger spectroscopy (SAS). Mossbauer spectroscopy. SANS techniques, X-ray difraction, X-ray relection, and neutron diffraction. Techniques based on the use of synchrotron radiation: XANES, EXAFS and magnetic dichroism. Magnetic nanosystem characterization (SQUID, VSM, MOKE). Magnetotransport in nanostructures. Hall waves and micro-SQUIDS. Porosymetry (BET).

The lectures are complemented by practical sessions including:

1.- VSM

2.- XPS

3.- SQUID

4.- Mossbauer

5.- X-ray diffraction and reflection

6.- Porosymetry

7.- QCM

Competences

General aims of the course

The expected results of the course respond to the following general aims

The subject and its expected results respond to the following general planning and objectives:

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 module, 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 and the Aragonese Institutes of Nanoscience (INA) and Science of Materials (ICMA) 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.

Context/Importance of the course for the master degree

This module, together with module 5 “Characterization II: advanced microscopies”, is aimed at instructing the student in the different methods available for the characterization of nanostructured materials and the application of various of these to a nanosystem with the intention of characterising it to obtain morphological, structural, analytical, optical, electric or magnetic information of interest.

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

1:
Identify specific phenomena and problems for which this kind of tool can provide vital information for the characterization of nanostructured materials.

2:
Distinguish the contributions of morphological, structural, analytical and magnetic nature of different basic nanoscience techniques.

3:
Assess the observation difficulties linked to the resolution of the tools and the environmental conditions in which the measurements are taken.

4:
Understand the type of information provided by each characterization method - assuming that complete analysis requires the complementary information obtained from various of these techniques.

5:
Design experiments to clarify the composition, structure, morphology or properties of a material on the nanoscale.

Relevance of the skills acquired in the course

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.

Evaluation

Assessment tasks

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

1:
For students choosing **ongoing assessment**:

1. Assessment of the 3 ECTS credits for the theory part of the module (43% of the final qualification):

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 show that the abilities required for the subject have been obtained which 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.- (50% of the theory credits) 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. 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 credits for the practical part of the module (57% of the final mark for the module):

a.- The teachers for the practicals will assess the abilities and skills of the students in the laboratory (50% of the practical credits). 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, etc. will be taken as essential aspects in this area.

b.- Answers to multiple choice questions and/or Q&As laid out before, during and/or after the practical sessions (50% of the practical credits). A score of 1 to 10 will be given for answers to these Q&As both in terms of scientific nature and the oral and written communication skill of the student, language use with appropriate rigour, quality and presentation of the Q&As.

A minimum mark of 4 out of 10 is needed for each of the two parts of the assessment to pass the subject. In any case, a pass requires an average of 5 out of 10 or higher over the sections.

2:

For hybrid students coming to other sittings or wishing to increase their mark, the assessment consists of:

1.- Assessment of theory credits (43%) A written test 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 regarding characterization of materials through the techniques analysed 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 (57%). 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 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). Likewise, the data obtained must be interpreted. This part of the test counts for 95% of this assessment of the practical credits.

A minimum mark of 4 out of 10 is needed for each of the two parts of the exam to pass the subject. In addition, an average of 5 out of 10 or more needs to be obtained to pass.

Activities and resources

Course methodology

The learning process that has been designed for this course is based on the following activities:

The learning process created for this subject is based on:

The aim of this module is to provide students with knowledge of the different characterization techniques for nanostructured materials, identifying the information type provided by each method. Therefore, following a general examination of these methods through participatory master classes, there will be case and problem analysis activities where these principles can be observed, examined in depth, evaluated and clarified. These classes are complemented by laboratory practicals 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 themselves have prepared.

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

Outline of the Programme

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

1:

Each topic area making up the programme for the module will be presented, analysed and discussed by the lecturer through participatory master classes 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 ADD) along with the recommended reading for more in-depth understanding of the topic.

2:

Open forum on the basic concepts and their application. Comparison with real developments. Problem solving, identifying spectra and practical case studies. All the above will take place in participatory 50 minute classes.

3:

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

4:

Seven laboratory practicals through which the student faces real problems in the characterization of nanostructured materials.

Course planning

Calendar of actual sessions and presentation of works

This calendar will be published at the beginning of each academic year in the web site of the Faculty of Science: https://ciencias.unizar.es/web/horarios.do. All classes will be in the afternoon.

Bibliographic references of the recommended readings