60038 - Nanoscience and nanotechnology

Información del Plan Docente

Academic Year	2016/17
Academic center	100 - Facultad de Ciencias
Degree	538 - Master's in Physics and Physical Technologies
ECTS	5.0
Course	1
Period	First semester
Subject Type	Optional
Module	---

1.Basic info

1.1.Recommendations to take this course

1.2.Activities and key dates for the course

2.Initiation

2.1.Learning outcomes that define the subject

2.2.Introduction

3.Context and competences

3.1.Goals

3.2.Context and meaning of the subject in the degree

3.3.Competences

3.4.Importance of learning outcomes

4.Evaluation

A continued evaluation will take into account the personal work of the students throughout the course. The students will receive a questionnaire after each of the main sections of the course. The evaluation (50% of the final mark) will reflect the quality of the solutions given to these questionnaires. The course will also comprise five practical sessions at the laboratory. After such sessions, the students will write a short report including the objective of the practical session and the obtained results. The evaluation (50% of the final mark) will reflect the quality of the reports.

The course has been primarily designed for students who are able to attend the lectures on site. However, there will also be an evaluation test for those students who are either unable to attend these lectures or who fail in their first evaluation. The test will consist of solving a questionnaire connected with the expected results of the course. The questionnaire will consist of the following two parts:

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1. One part will contain questions related to the main concepts discussed in the theory part of the course. The student will be given 1,5 hours to solve this part. It will be evaluated from 0 to 10 and the result will count as 50 % of the final mark.

2. A second part will contain questions related to experimental aspects of the five practical sessions developed during the course. The student will be given 1,5 hours to solve this part. It will be evaluated from 0 to 10 and the result will count as 50 % of the final mark.

5.Activities and resources

5.1.General methodological presentation

Nanotechnology is nowadays an emerging technology which quickly spreads into real applications. As an example, the increasing miniaturization of electronic devices for more optimized behavior is a driving force to understand the basis of the observed and limiting phenomena and to learn how to produce such small structures. Additionally, new biomedical applications rely on the use of nanoparticles which dimensions and physical properties need to be controlled to produce the desired functionality. These are only two examples of the importance of this course to gain comprehensive understanding of the existing and future technologies in our life. Moreover, the students will be able to use some of the most advanced instrumentation to fabricate and analyze the matter at the smallest scales, gaining an invaluable formation for their future professional development. The properties and functionality of the nano-systems depend on an extensive control of their dimensions. This is why the student needs to know how to achieve such dimensions with physical methods. The student will learn how to grow materials layer-by-layer, even atom by atom. Therefore, in this course, 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 nano-device we intend to produce. Some of these techniques require highly specialized scientific instruments. Zaragoza University and the Aragonese Institutes of Nanoscience (INA) and Science of Materials (ICMA) provide the Master's students with the latest-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.

The course will comprise theory lectures (3.5 ECTS) and practical sessions (1.5 ECTS), which will allow the student to become familiar with the main concepts used in Nanoscience and to perform experimental work using research equipment in the field of Nanoscience.

Together with the courses on "Material Science", "Physics of Magnetic Materials" and "Low Temperature Physics and Quantum Technologies", the present course forms a very complementary and profound introduction to the concepts, experimental tools and applications of the research in modern Condensed Matter Physics and Nanotechnology.

5.2.Learning activities

The learning activities foreseen to provide the student the background to acquire the targets are:

- Attendance to lectures where the main concepts in Nanoscience will be discussed.
- Study and investigation by the student in order to go deeper in the concepts developed in class.
- The student will fill in tests aiming to check how well the different concepts have been acquired by the student.
- The student will develop 5 practice lessons regarding 5 topics in Nanoscience
- The student will analyze the data and will write reports on the practical work.

5.3.Program

The lectures aim at the acquisition of the basic knowledge required in Nanoscience and Nanotechnology. These lessons will be supported by the recommended bibliography, as well as by audiovisual material, powerpoint presentations and complementary information, all of them available for the students in digital form. Participation of the student along the lectures will be continuously stimulated by the teachers. Autonomous work of the student is required and tutorial support

will be always at student disposal.

Topics will be:

1. Introduction. The basic concepts of Nanoscience and Nanotechnology will be addressed as well as the precise description of the course.
2. Preparation of Nanostructures: Vacuum technologies. Technologies for the growth of thin films: sputtering, laser ablation, molecular beam epitaxy, evaporation. Artificial methods for fabrication: optical lithography, electron and ion beam lithography, local probe lithography, nanoimprinting. Self-assembly and self-organization. Fabrication of nanoparticles.
3. Characterization techniques in Nanoscience: Local probe microscopies (STM, AFM, MFM). Scanning and Transmisión Electrón Microscopy (SEM, TEM, STEM). Characterization techniques of thin films, surfaces and interfaces (XRD, XRR, XPS, Auger, RBS, RHEED). Physical characterization techniques of nanoparticles for biomedical applications.
4. Applications of Nanoscience and Nanotechnology: Storage and processing of information. Sensors. Biosensors. Nanoelectromechanical systems (NEMS). Applications in telecommunications. Miniaturization in Electronics. Bioferrofluids and magnetic carriers. Contrast agents for MRI. Drug delivery.

Practical sessions

Five practical work sessions will be organized using existing research equipment at INA in the Campus Río Ebro. Teachers as well as technicians will help the student to use the required tools and will guide him/her in the writing of the report. The data will be provided for the subsequent student's analysis.

1. Growth of thin films and heterostructures by sputtering and laser ablation
2. Optical lithography in Clean Room
3. Nanolithography in Dual Beam in Clean Room
4. Scanning Probe Microscopy: Atomic Force Microscopy
5. Magnetic relaxivity of magnetic biocompatible fluids.

5.4.Planning and scheduling

It will be fixed in due time.

5.5.Bibliography and recomended resources