60038 - Nanoscience and nanotechnology

Información del Plan Docente

Academic Year	2018/19
Subject	60038 - Nanoscience and nanotechnology
Faculty / School	100 - Facultad de Ciencias
Degree	538 - Master's in Physics and Physical Technologies
ECTS	5.0
Year	1
Semester	First semester
Subject Type	Optional
Module	---

1.General information

1.1.Aims of the course

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. 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.

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

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2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

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

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:

1. 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. 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.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

Five practice sessions will be organized using existing research equipment at INA in the Campus Río Ebro. Teachers as well as technicians will help the students to use the required tools and will guide them along the process of writing their reports. 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.

4.2.Learning tasks

The course includes the following learning tasks:

- Attendance to **lectures** where the main concepts in Nanoscience will be discussed. These sessions will be complemented with the recommended bibliography, as well as audiovisual material, powerpoint presentations and complementary information, all of them available for the students on the virtual platform Moodle. Student participation will be continuously stimulated by the teachers. Autonomous work of the student is required and tutorial support will be always at student disposal.
- **Autonomous work and study** of the course contents.
- The student will fill in **tests** aiming to check how well the different concepts have been acquired by the student.
- The student will attend to 5 **practice sessions** regarding 5 topics in Nanoscience. They will be organized using existing research equipment at INA in the Campus Río Ebro.
- The student will analyze the data and will write **reports** on their practical work. Teachers as well as technicians will help the students to use the required tools and will guide them in the writing of the report. The data will be provided for the subsequent student's analysis.

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4.3.Syllabus

The course will address the following topics:

Lectures

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.

Practice sessions

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.

4.4.Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Faculty of Science http://ciencias.unizar.es/

4.5.Bibliography and recommended resources