Máster en Erasmus Mundus en Ingeniería de Membranas
69130 - Fundamental properties of nanostructured materials

Guía docente para el curso 2013 - 2014

Curso: 2, Semestre: 1, Créditos: 6.0

Información básica

Profesores

- **Pilar Cea Mingueza** pilarcea@unizar.es
- **Ignacio Gascón Sabaté** igascon@unizar.es
- **María Valeria Grazú Bonavia** vgrazu@unizar.es
- **Manuel Ricardo Ibarra García** ibarra@unizar.es
- **Luis Alberto Morellón Alquézar** morellon@unizar.es
- **Luis Teodoro Oriol Langa** loriol@unizar.es
- **Antonio Monzón Bescós** amonzon@unizar.es
- **Raquel Giménez Soro** rgimenez@unizar.es
- **Marta María Martínez Júlvez** mmartine@unizar.es
- **Gerardo Fabián Goya Rossetti** goya@unizar.es
- **Carlos Gómez-Moreno Calera** gomezm@unizar.es
- **Irene Lucas Del Pozo** ilucas@unizar.es
- **María Blanca Ros Latienda** bros@unizar.es
- **José Luis Hueso Martos** jlhueso@unizar.es
- **María Pilar Pina Iritia** mapina@unizar.es

Recomendaciones para cursar esta asignatura

Recommendations for taking this subject

The "*Fundamental Properties of Nanostructured Materials*" module is obligatory and counts for 6 ECTS credits or 150 student work hours. The course is given in the first term of the academic year.

The objective of this module is to introduce the student to state of the art Nanoscience and Nanotechnology, highlighting their multi-discipline nature as well as their scientific, social, economic and legal implications.

Therefore, it is an introductory module that provides prior preparation for students to assimilate and correlate the contents of the successive modules that, sequentially, will train the student in the synthesis, processing and characterising of nanostructured materials so that they will, in turn, be able to design and plan nanodevices with marketplace applications.

As this is a preparatory module, it is essential that students are available to study the theory sections in the course to be able to successfully face the other modules of this Master's with a solid theoretical base.

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.

Actividades y fechas clave de la asignatura

Dates and key points for the subject

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

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 page www.unizar.es/nanomat

---

Inicio

Resultados de aprendizaje que definen la asignatura

El estudiante, para superar esta asignatura, deberá demostrar los siguientes resultados...

1:

In order to pass this subject, the students must show that they... (Passing this subject, the students achieve the following results...)

1. Recognise materials and compounds of particular relevance on the nanoscale, noting the degree of advance achieved and the problems still to be solved.

2. Distinguish between macro, micro and nano systems; identify the physical-chemical tools necessary to work on the nanoscale.

3. Assess the current legislation on nanostructured materials; analyse the toxic potential and possible effects on health, environment and sustainability.

4. Identify the scientific and technological possibilities of nanostructured materials: on the one hand, assessing social interest for miniature devices and the new and revolutionary applications for these; on the other, recognising the existence of a new scientific and technological context governed by nanoscale laws - the Laws of Quantum Mechanics.

Introducción

Breve presentación de la asignatura

A brief introduction to the subject

On atomic- and molecular-scale - known as nanoscale - there is a convergence between Physics, Chemistry, Biochemistry, Science of Materials, Engineering and Bioengineering towards the same theoretical principles and experimental techniques. This first module covers the basic concepts of these disciplines so that students understand and take in the more advanced information to be studied in later modules.

A brief description of the contents of this subject includes:

Introduction to Nanoscience and Nanotechnology. Nanomaterials vs. macroscopic materials. Introduction to Supramolecular Chemistry. Structure and properties of nanoscopic organic molecules (nanotubes, fullerenes, dendrimers, block co-polymers, etc.) Surface Physical Chemistry. Colloids, surfactants, monolayers, micelles, vesicles, capsules. Nano-biomaterials. Bio-macromolecules. Optical, electric, magnetic and mechanical properties of nanomaterials. Nanotoxicology and eco-nanotoxicology.

Contexto y competencias

Sentido, contexto, relevancia y objetivos generales de la asignatura

La asignatura y sus resultados previstos responden a los siguientes planteamientos y objetivos:

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

It is expected that scientific advances in the nano world will cause evident changes in our understanding of the design and manufacturing of nanodevices that exploit some of the exceptional qualities of those materials that are only present on the nanoscale. This is why people say that Nanotechnology will be - if it is not yet already - the 21st century revolution due to the great number of social consequences that Nanoscience and Nanotechnology will have on our daily lives (food, clothing, housing, cars, medical treatments, etc.).

With this first module in the Master's, the potential for work on the nanoscale will be highlighted in areas as diverse as nanophysics, nanochemistry and nano-biomedicine. The student will gain a series of understandings about the current state (scientific, social, economic, legal, etc.) of Nanoscience and Nanotechnology. This will allow the students to see basic theory about the nature and properties of nanomaterials helping them understand the link between the chemical structure and composition of the materials and their chemical, physical and mechanical properties.

Contexto y sentido de la asignatura en la titulación

Context and position of the subject in the qualification:

As previously mentioned, this module is meant to provide the theory regarding the fundamental concepts in Chemistry, Physics, Science of Materials, Biochemistry, Engineering, Bioengineering and Nanosafety so that students can successfully take on the descriptors to be studied in later modules in this Master's.

Al superar la asignatura, el estudiante será más competente para...

1:

On passing this subject, the student will be better able to:

1. Understand the state of art of Nanoscience and Nanotechnology, assessing its multidisciplinary nature as well as the social, economic and legal implications.

2. Comprehend the conceptual differences between macro and nano systems, obtaining the necessary theoretical knowledge to acquire understanding of the nanoscale.

3. Identify materials and compounds of particular relevance on the nanoscale, assessing the degree of advance achieved and the problems still to be solved.

4. Understand the importance of the surface effects and the new forces that appear on the nanoscale and their influences on the properties of nanoscopic systems.

5. Assess properties of particular interest in nanostructured materials.

6. See the current legislation on nanostructured materials; analyse the toxic potential and possible effects on health, environment and sustainability.

Importancia de los resultados de aprendizaje que se obtienen en la asignatura:

The results of the learning process for this subject are important because:

The enormous potential of Nanoscience and Nanotechnology has caught on deeply in politicians, businessmen and society itself creating new demands for specialists at the very highest level in the field. Therefore, a prime objective of this Master's is the creation of professionals with the understanding, knowledge and abilities necessary to exercise as senior professionals in diverse areas (industry - production of new materials, electronics industry, pharmaceuticals, chemistry, aerospace, etc. –

consultancy, research, teaching, etc.).

In the context of this Master's, the "*Fundamental Properties of Nanostructured Materials*" module aims to make the student aware of the relevance of Nanoscience and Nanotechnology in the scientific and technological atmosphere of 21st century society. The student will gain the essential tools necessary to be able to study in depth all areas corresponding to the design and creation of new and efficient nanodevices, covering synthesis, processing, characterization and property determination for these devices. At the same time, the student will assess other areas such as sustainability, safety, financial benefits, etc.

Evaluación

Actividades de evaluación

El estudiante deberá demostrar que ha alcanzado los resultados de aprendizaje previstos mediante las siguientes actividades de evaluacion

1:

The student must show the expected results of the learning process through the following assessment methods:

For students choosing **continuous assessment**:

1.- Written test (50% of the final result for the module). Here, theoretical knowledge obtained and its application to problems of interest in Nanoscience and/or Nanotechnology is evaluated as well as the extent to which the abilities relevant to this module have been acquired. This written exam consists of:

(a) Theory questions including: (i) topic(s) to be explained and (ii) short answer and/or multiple choice questions. On a scale of 1 to 10, this written test will assess the knowledge of the student regarding the state of the art in Nanoscience/Nanotechnology; electrical, magnetic, optical and mechanical properties of nanomaterials; links between the structure and chemical composition of nanostructured materials; importance of surface effects; and the state of current legislation on Nanoscience and Nanotechnology.

(b) The exam will also contain a section on problem solving and exercises where - on a scale of 1 to 10 - data treatment ability, chemical-physical property assessment, differentiation between macro- and nanoscale, use of appropriate SI units, etc. will be assessed.

2.- Exercise, problem and question solving of matters seen in class and seminars (where the students need to show knowledge of the topic and oral communication skills); in addition, Q&As to be completed by students following classes (50% of the final result of the module). Through these tests, the results of the learning process will be assessed with regard to the abilities required for the module such as data interpretation, oral and written communication skills, interaction with colleagues and professionals from other areas, etc.

HYBRID AND OTHER SITTINGS

For **hybrid students coming to other sittings or wishing to increase their mark,** the assessment consists of a written test (50%) and an oral test (50%) before a tribunal of three lecturers from the subject area. In these tests, the student must display knowledge of the topics taught in this module as well as their ability to apply this knowledge to specific problems and situations showing good use of the units system, correct treatment and interpretation of experimental data, current legislation in the areas of Nanoscience and

Nanotechnology, toxicity, nanosafety, etc. This knowledge will be assessed on a scale of 1 to 10. Scientific communication skills will also be evaluated through these tests - on a scale of 1 to 10 - and here correct use of scientific language, audiovisual techniques, graphics, clarity of presentation, etc. will be expected. Both oral and written exams will take place in the language used for the course: English.

Actividades y recursos

Presentación metodológica general

El proceso de aprendizaje que se ha diseñado para esta asignatura se basa en lo siguiente:

The learning process created for this subject is based on:

The aim of this module is to establish the basic principles of Physics, Chemistry, Biology, Science of Materials, Engineering, Bioengineering and Nanosafety necessary to successfully tackle the following modules which have an eminently applied nature.

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

Actividades de aprendizaje programadas (Se incluye programa)

El programa que se ofrece al estudiante para ayudarle a lograr los resultados previstos comprende las siguientes actividades...

1:

The programme offered to the student to help achieve the expected results contains 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 and practical case studies. All the above will take place in participatory 50 minute classes.

3. Completion of individual Q&As. Each student will complete the Q&As that the subject lecturers give them over the length of the course. The Q&As are to be completed individually by students and sent electronically or handed in to the relevant lecturers. In some cases, the Q&As will be presented and openly debated during class. Here, the students must also show their oral communication skills. 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.

2:

PROGRAM

- Introduction to Nanoscience and Nanotechnology. Nanomaterials vs. macroscopic materials.
- Optical, electric, magnetic, and mechanical properties of nanomaterials. Physical Chemistry of Surfaces:

thermodynamic and electrical aspects of surface chemistry and interfaces.

- Colloids, tensoactives, monolayers, micelles, vesicles, capsules.
- Meso and microporous materials, zeolites.
- Nanobiomaterials. Biomacromolecules.
- Applications of nanoparticles in biomedicine.
- Nanotoxicology and eco-nanotoxicology.

Planificación y calendario

Calendario de sesiones presenciales y presentación de trabajos

Class calendar and work presentation

This calendar will be published at the beginning of each academic year in the web page: www.unizar.es/nanomat. All classes will be in the afternoon.

Referencias bibliográficas de la bibliografía recomendada