Syllabus

Subject

Subject / Group	11283 - Functional Materials / 1
Degree	Master's in Chemical Science and Technology Master's in Advanced Physics and Applied Mathematics
Credits	3
Period	1st semester
Language of instruction	English

Professors

Lecturers	Office hours for students					
	Starting time	**Finishing time**	**Day**	**Start date**	**End date**	**Office / Building**
Rubén Santamarta Martínez ruben.santamarta@uib.es	14:30	15:30	Tuesday	09/09/2019	12/02/2020	Direccció / Antoni Maria Alcover i Sureda. Sol·licitar cita prèvia
	12:30	13:30	Thursday	09/09/2019	12/02/2020	Direccció / Antoni Maria Alcover i Sureda. Sol·licitar cita prèvia
Joan Torrens Serra j.torrens@uib.es	You need to book a date with the professor in order to attend a tutoring session.					

Context

A big number of materials can change one (or more) properties in a controlled way by means of external applied fields, which make them very attractive for both applications as well as for the scientific point of view. There are a huge number of these types of materials and a lot of time can be devoted to each of them. In this subject only some examples of the most common functional (or smart) materials will be introduced, as conventional and magnetic shape memory alloys, piezoelectric materials and magnetostrictive materials.

The academic and research background of the lecturers fit perfectly with the topic of the subject. Rubén Santamarta has a degree in Physics by the UIB and a PhD in Physics by the same university (2002, with honors). He is an Associate Professor in the area of Materials Physics and Metallurgical Engineering, he has teaching experience since 2001 and two master's degrees in teaching. He belongs to the Material Physics research group in which his main line of research is shape memory alloys, field in which he has published more than 40 articles in indexed international journals, collaborated on more than 50 contributions in international conferences and participated in more than 10 national and international projects. Between 2002 and 2004 he held a post-doctoral stay at the EMAT (Antwerp, Belgium) to improve his skills in transmission electron microscopy (TEM).

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Joan Torrens has a degree in Physics and also in Materials engineering and is Doctor in Materials Science (Physics) from the UAB. Currently is assistant professor in the area of Applied Physics and researcher in Materials Physics Group of the UIB. He has spent 2 years at IFW Dresden working in the field of Metallic Glasses. He has published about 20 papers in international indexed journals.

Requirements

We can divide the requirements in two groups: the essential, or mandatory, requirements and the recommendable ones:

Essential

Those stablished by the general regulation of the Master in Advanced Physics and Applied Mathematics (FAMA in Spanish).

Recommended

It is recommended to have some background in materials science.

Skills

Specific

* EFM1: Deepening on the fundamentals of materials science and knowledge of basic criteria for selection of materials for specific applications
* EFM7: Understanding various types of functional materials and the mechanisms related to its functionality

Generic

* Systematic understanding of a field of study and mastery of skills and methods of research associated with that field

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Range of topics

1. Introduction to functional materials

2. Conventional shape memory alloys
   - Introduction to the martensitic transformation
   - Crystallography of the martensitic transformation
   - Common effects and properties of shape memory alloys

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NiTi based alloys, Cu-based alloys and other systems showing shape memory properties.
Characterization of shape memory alloys
Applications

3. Magnetic shape memory alloys
   Ferromagnetic shape memory alloys
   Metamagnetic shape memory alloys
   Coupling of the magnetic and structural transition
   Alloys with magnetic shape memory properties

4. Magnetocaloric and multiferroic materials
   Magnetocaloric effect
   Multiferroic materials

5. Magnetrostrictive materials
   Classical magnetostriction
   Magnetostrictive materials

6. Piezoelectric and ferroelectric materials
   Piezoelectricity
   Ferroelectricity
   Applications of piezo- and ferroelectric materials

7. Other functional materials

Teaching methodology

In-class work activities (0.72 credits, 18 hours)

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Theory classes	Large group (G)	The theoretical basis of the content will be introduced by the lecturers by means of master classes.	13
Seminars and workshops	Seminars	Medium group (M)	The student will be asked to attend to one or two seminars about recent research on functional materials.	1
Laboratory classes	Laboratory classes	Medium group 2 (X)	Some demonstrations on shape memory alloys applications and the martensitic transformation will be shown to the students in the laboratory.	1
Assessment	Oral defense of a research paper	Small group (P)	The students will read, prepare and defend a research paper on functional materials that will be provided by the lecturers. The defense will consist in an oral presentation of about 15 minuts and it will take place few weeks after the end of the lessons (if possible, to be scheduled with all the students).	1
Assessment	Theoretical examination	Large group (G)	The student will be partially avaluated by means of a written assessment consisting on theoretical short questions about functional materials. This assessment will take place few weeks after the end of the lessons (if possible, to be scheduled with all the students).	2

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At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Aula Digital platform.

Distance education tasks (2.28 credits, 57 hours)

Modality	Name	Description	Hours
Individual self-study	Work on the research paper	The students must read and prepare an oral presentation based on a research paper proposed by the lecturers of the subject.	25
Individual self-study	Study for the assessment	The student should study the contents of the course in order to pass an examination with short theoretical questions.	32

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

If the final mark, considering the average weight of each activity, is equal to or greater than 5 but the student has not obtained the minimum score required in all the elements of assessment, an overall grade of 4.5 will be applied.

Frau en elements d'avaluació

In accordance with article 33 of Regulation of academic studies, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

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Oral defense of a research paper

Modality	Assessment
Technique	Oral tests **(retrievable)**
Description	The students will read, prepare and defend a research paper on functional materials that will be provided by the lecturers. The defense will consist in an oral presentation of about 15 minuts and it will take place few weeks after the end of the lessons (if possible, to be scheduled with all the students).
Assessment criteria	Both subject skills(EFM1 and EFM7) will be considered for the final grade. The ability of the student to understand the content and the phenomena related with functional materials of the research paper, as well as the ability to communicate them to their colleagues, will be taken into account.

Final grade percentage: 50%with a minimum grade of 4

Theoretical examination

Modality	Assessment
Technique	Extended-response, discursive examinations **(retrievable)**
Description	The student will be partially avaluated by means of a written assessment consisting on theoretical short questions about functional materials. This assessment will take place few weeks after the end of the lessons (if possible, to be scheduled with all the students).
Assessment criteria	Both subject skills (EFM1 and EFM7) will be considered for the final grade. The amount of information and accuracy of responses from the student, always in comparison to the material provided at the theoretical classes and/or published in the recommended bibliography, will be assessed.

Final grade percentage: 50%with a minimum grade of 4

Resources, bibliography and additional documentation

Basic bibliography

· Shape memory materials/ edited by K. Otsuka and C.M. Wayman.Cambridge : Cambridge University Press, 1998.

· Functional materials: preparation, processing and applications / [edited by] S. Banerjee, A.K. Tyagi.Amsterdam : Elsevier, 2012

Other resources

· Papers from scientific journals related with functional materials (hard or digital copies will be provided to the students)

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