



Academic year	2014-15
Subject	11283 - Functional Materials
Group	Group 1, 1S
Teaching guide	A
Language	English

## Subject identification

<b>Subject</b>	11283 - Functional Materials
<b>Credits</b>	0.72 de presencials (18 hours) 2.28 de no presencials (57 hours) 3 de totals (75 hours).
<b>Group</b>	Group 1, 1S (Campus Extens)
<b>Teaching period</b>	1st semester
<b>Teaching language</b>	English

## Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Rubén Santamarta Martínez <a href="mailto:ruben.santamarta@uib.es">ruben.santamarta@uib.es</a>	17:30h	19:30h	Thursday	25/09/2014	17/07/2015	F114 - 1r pis, Edifici Mateu Orfila (imprescindible concertar cita prèvia per email)
Joan Torrens Serra <a href="mailto:j.torrens@uib.es">j.torrens@uib.es</a>	15:00h	17:00h	Monday	29/09/2014	01/07/2015	f132

## Contextualisation

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 belongs to the Physics of Materials research group and is Associate Professor in the area of Applied Physics. He has teaching experience from 2001 and two teaching master's degrees. His main line of research are shape memory alloys (a type of functional materials), field in which he has published more than 40 articles in indexed international journals, he has collaborated on more than 50 papers in international conferences and participated in more than 10 national and international projects. Between 2002 and 2004 held a post-doctoral stay at the EMAT (Antwerp, Belgium) to improve his skills in Transmission Electron Microscopy (TEM). 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

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

### Essential requirements

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

### Recommendable

It is recommended to have some background in materials science.

## Skills

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The following skills are supposed to be trained, or achieved, during the course (the codes of the competences are the ones used in the official Master Program).

### 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/](http://estudis.uib.cat/master/comp_basiques/)

## Content

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### Theme content

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. Magnetostrictive 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

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.	14
Seminars and workshops	Seminars	Medium group 2 (X)	The student will be asked to attend to one or two seminars about recent research on functional materials.	1
Laboratory classes	Laboratory classes	Small group (P)	Some laboratory activities will be carried out in the research laboratory of the Materials Physics research group under the supervision of a lecturer.	1
Assessment	Oral communication	Small group (P)	The students should make a presentation of the final report in a scientific style.	1
Assessment	Theoretical examination	Large group (G)	The student will be partially evaluated by means of a written assessment consisting on theoretical short questions about functional materials.	1

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 Campus Extens platform.





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## Distance education work activities

Modality	Name	Description	Hours
Individual self-study	Report	The students must write a report on a subject that will be proposed by the lecturers of the subject.	30
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.	27

## 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, a overall grade of 4.5 will be applied.

### Oral communication

Modality	Assessment
Technique	Oral tests ( <b>retrievable</b> )
Description	The students should make a presentation of the final report in a scientific style.
Assessment criteria	
Final grade percentage:	20% with minimum grade 4

### Theoretical examination

Modality	Assessment
Technique	Extended-response, discursive examinations ( <b>retrievable</b> )
Description	The student will be partially evaluated by means of a written assessment consisting on theoretical short questions about functional materials.
Assessment criteria	
Final grade percentage:	30% with minimum grade 4





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### Report

Modality	Individual self-study
Technique	Papers and projects ( <b>retrievable</b> )
Description	The students must write a report on a subject that will be proposed by the lecturers of the subject.
Assessment criteria	
Final grade percentage:	50% with minimum grade 4

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### Resources, bibliography and additional documentation

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#### 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

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#### Other resources

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

