Course guide
295023 - ECMA - Materials Structure and Characterization

Last modified: 02/02/2024

Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: MARTA PEGUEROLES NEYRA

Others: MARTA PEGUEROLES NEYRA
NICOLAS CANDAU
JOSE MARIA MANERO PLANELLA
JOSE MANUEL GARCÍA TORRES

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Transversal:
07 AAT N1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

TEACHING METHODOLOGY

Sessions will be taught in a theory, problems and laboratory practices format in which the subject's specific competencies will be introduced. Present directed activities to work on spoken and written communication and team work will take place. Autonomous learning and the solvent use of information resources by means of non-presence directed activities will also be encouraged.

LEARNING OBJECTIVES OF THE SUBJECT

The subject's objective is that students acquire knowledge on the fundaments of material families, their structure and defects. In addition, students will have to know the different microstructural characterisation techniques as well as knowing to interpret results obtained by means of different techniques.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

TOPIC 1. Engineering materials

Description:
- Material's science and engineering.
- Types of materials: metals, ceramics and glasses, polymers, composite materials, semiconductors.
- From structure to properties.

Related competencies :
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Full-or-part-time: 15h
Theory classes: 4h
Laboratory classes: 1h
Self study : 10h

TOPIC 2: The chemical bond

Description:
- Primary bonds: ionic, covalent, metallic, mixed
- Secondary bonds
- Force and bonding energy, relationship with properties of materials
- Band theory

Full-or-part-time: 2h
Theory classes: 2h

TOPIC 3: Polymers' structure and characterisation

Description:
- Obtaining polymers (polymerisation reactions). Average molecular mass and techniques to determine it.
- Architecture molecular (linear, ramified and reticulated) and polymer classification into thermoplastics, Thermostables and elastomers.
- Polymers' structure (amorphous and semicrystalline). Techniques to determine vitreous transmission temperature.
- Aggregation states.
- Copolymers.

Related competencies :
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Full-or-part-time: 20h
Theory classes: 4h
Laboratory classes: 1h
Self study : 15h

TOPIC 4: Crystalline structure

Description:
- Unit cell.
- Crystal systems.
- Primary crystal structures (BCC, FCC, HCP)
- Crystallographic directions and planes. Miller indices.
- Octahedral and tetrahedral interstices
- Solid metal solutions: interstitial and substitute
- Rules of Hume-Rothery
- Ceramic solid solutions

Related competencies :
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Full-or-part-time: 35h
Theory classes: 9h
Practical classes: 6h
Self study : 20h

TOPIC 5: Crystalline defects

Description:
- Defects in crystalline materials (point defects, linear defects, planar defects, volumetric defects)
- Dislocations (Geometry of dislocations and Burguers vector)
- Movement of dislocations (dislocation glide)

Related competencies :
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Full-or-part-time: 35h
Theory classes: 9h
Laboratory classes: 6h
Self study : 20h

TOPIC 6: Analysis of crystal structures

Description:
- Diffraction techniques: X-Ray Diffraction (properties and X-ray sources, formulation Bragg powder diffractometer)
- Spectroscopic techniques: Infrared Spectroscopy
- Identification and analysis of crystalline phases

Related competencies :
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Full-or-part-time: 20h
Theory classes: 7h
Laboratory classes: 3h
Self study : 10h

TOPIC 7: Experimental techniques to identify microstructures and defects

Description:
- Optical metalography. Preparing samples. Grain size according to ASTM and determining the grain's diameter.
- Sweeping electronic microscopy (SEM). Electronic microscopy techniques. Secondary electrons mode and retrodispersion mode.
- Transmission electronic microscopy (TEM).

Related competencies :
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Full-or-part-time: 25h
Theory classes: 7h
Laboratory classes: 3h
Self study : 15h

GRADING SYSTEM

A student's grade will be:
Final Mark= 0,35*Final Exam + 0,35*Midterm Exam + 0,15* Lab Practices * 0,15*Works

Finally, as detailed in the academic normative of the EEBE, a reevaluation exam will take place (midterm+final contents). To be able to do the reevaluation exam, the student has to fail and has to attend to all the evaluation exams of the subject and its mark, N, for the part which can be reevaluated has to be such that N > 3,0 (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-ipermanencia-18-19-aprovat-je-2018-06-13.pdf).
Final Mark = 0,8*Reassessment Exam + 0,1* Lab Practices * 0,1*Works

BIBLIOGRAPHY

Basic:
- Smith, William Fortune. Fundamentos de la ciencia e ingeniería de materiales [on line]. 5a ed. Mexico: Mc Graw Hill, 2014 [Consultation: 29/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=5732. ISBN 9781456240004.
- Callister, William D. Introducción a la ciencia e ingeniería de los materiales [on line]. México: Reverté, 2013 [Consultation: 23/11/2021]. Available on: https://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=2616389. ISBN 9788429195606.
- Askeland, Donald R. Ciencia e ingeniería de los materiales. Madrid: Thomson, 2001. ISBN 8497320166.
- Shackelford, James F. Introducción a la ciencia de materiales para ingenieros [on line]. 7a ed. Madrid: Pearson, 2010 [Consultation: 29/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1258. ISBN 9788483229606|.

Complementary:
- Beeston, BE. Electron diffraction and optical diffraction techniques. Amsterdam [etc.]: North-Holland, 1994. ISBN 0720442532.
- Bermúdez-Polonio, joaquín. Métodos de difracción de rayos X : principios y aplicaciones. Madrid: Pirámide, 1981. ISBN 8436801806.

RESOURCES

Other resources:
Teaching material available in Atenea