Course guide
295750 - 295EM011 - Advanced Characterisation of Materials

Last modified: 04/06/2026

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

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN MATERIALS SCIENCE AND ADVANCED MATERIALS ENGINEERING (Syllabus 2019). (Compulsory subject).
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: JOSE MARIA MANERO PLANELLA

Others: Primer quadrimestre:
CONRADO JOSE APARICIO BADENAS - Grup: T1
MONTSERRAT ESPAÑOL PONS - Grup: T1
JOSE MARIA MANERO PLANELLA - Grup: T1
MERITXELL MOLMENEU TRIAS - Grup: T1
ORLANDO ONOFRE SANTANA PEREZ - Grup: T1

PRIOR SKILLS

Knowledge of engineering materials, physics and chemistry

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMCEAM-03. (ENG) Realizar estudios de caracterización y evaluación de materiales según sus aplicaciones

Transversal:
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

The classes will be taught in theoretical format, problems where the specific competences of the subject will be introduced. Face-to-face activities will be carried out to work on oral and written communication and teamwork.

LEARNING OBJECTIVES OF THE SUBJECT

The objective of the subject is that the student acquires knowledge of the different existing experimental techniques for the microstructural and physicochemical characterization of materials. Depending on the problem or needs of each case, the student must have sufficient criteria to select the most appropriate technique, as well as the interpretation of their results.

STUDY LOAD

Type	Hours	Percentage
Hours small group	6,0	4.00
Self study	96,0	64.00
Hours large group	48,0	32.00

Total learning time: 150 h

CONTENTS

1. Introduction. The concept of microstructure.title english

Description:
Structure-property relationships. Microstructural scale. Microstructural paarmeters. Interatomic bonding in solids. Crystalline and Amorphous phases. The crystal lattice.

Specific objectives:

Related activities:

Full-or-part-time: 4h
Theory classes: 4h

2. X-ray diffraction analysis of the crystalline structure

Description:
Scattering of radiation by crystals. Reciprocal Space. X-Ray diffraction methods. The X-Ray diffractometer. Powder diffraction technique. Diffraction analysis.

Full-or-part-time: 3h
Theory classes: 3h

3. Contact angle in surface analysis

Description:
Determining surface energy of a homogeneous solid surface. Equation of state. Measuring contact angle. Static and dynamic sessile drop. Captive air bubble method.

Specific objectives:

Related activities:

Full-or-part-time: 5h
Theory classes: 5h

4. Characterization of surface roughness and porosimetry.

Description:
Roughness evaluation. Techniques for roughness evaluation: perfilometry, AFM. What is porosity? Basic principles of the porosity techniques.

Specific objectives:

Related activities:

Full-or-part-time: 4h
Theory classes: 4h

5. Spectroscopic analysis of surface composition.

Description:
X-Ray Photoelectron Spectroscopy. Fourier transform infrared spectroscopy.

Specific objectives:

Related activities:

Full-or-part-time: 4h
Theory classes: 4h

ELECTRON MICROSCOPY OF MATERIALS: 6 Interaction of an electron beam with a specimen. The physics of the process.

Description:
Electron-sample interactions: Secondary electrons. Backscattered electrons. X-Ray Continuum. Characteristic X- Rays. Auger Electron Emission. Photon-specimen interactions: Absorption. Secondary fluorescence

Specific objectives:

Related activities:

Full-or-part-time: 4h
Theory classes: 4h

ELECTRON MICROSCOPY OF MATERIALS 7. Fundamentals and techniques.

Description:
Electron beams as waves. Lenses for electron beams. Lens defects and resolution. Structure of transmission electron microscopes. Mechanism of images formation; contrast. Structure of scanning electron microscopes (SEM, ESEM).

Specific objectives:

Related activities:

Full-or-part-time: 4h
Theory classes: 4h

ELECTRON MICROSCOPY OF MATERIALS:8. Sample preparation.

Description:
Sample preparation for SEM. Sample preparation for TEM: Jet-polishing methods. Ion beam milling technique. Focus ion beam (FIB). Ultramicrome cutting. Replica technique for surfaces. Extraction replica. Preparation of Powders.

Specific objectives:

Related activities:

Full-or-part-time: 5h
Theory classes: 5h

ELECTRON MICROSCOPY OF MATERIALS: 9. Electron diffraction

Description:
Fundamentals. Deybe-Scherrer patterns, standerization. Reciprocal lattice. Electron diffraction patterns. Method of Rn ratios. Correlation of image and diffraction pattern (magnetic rotation). Kikuchi lines. Examples of indexing single-crystals diffraction patterns.

Specific objectives:

Related activities:
Practical exercises for the electron diffraction pattens

Full-or-part-time: 5h 30m
Theory classes: 5h 30m

ELECTRON MICROSCOPY OF MATERIALS: 10. Contrast theory and applications

Description:
Dynamical theory. Application of the basic equation to real crystals: derivation of the contrast of a dislocation. The g.b criterion. Determination of Burger vector b. Determination of dislocation densities. Analysis of twin structures.

Specific objectives:

Related activities:

Full-or-part-time: 3h
Theory classes: 3h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

The student's grade will be: Final grade = 0.5 (1st partial exam) + 0.5 (2nd partial exam). In case of re-evaluation, the student's grade will be: Final grade = Reevaluation exam.
The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

EXAMINATION RULES.

BIBLIOGRAPHY

Basic:
- Zhang, Sam; Li, Lin; Kumar, Ashok. Materials characterization techniques [on line]. CRC Press, 2008 [Consultation: 09/10/2018]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1446735. ISBN 9781420042955.
- Advanced techniques for materials characterization [on line]. Trans Tech Pubn, 2009 [Consultation: 09/10/2018]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1869163. ISBN 0878493794.
- Leng, Yang. Materials characterization : introduction to microscopic and spectroscopic methods [on line]. 2nd ed. Weinheim, Germany: John Wiley & Sons, cop. 2013 [Consultation: 19/05/2020]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9783527670772. ISBN 9783527670772.
- Sibilia, John P. A Guide to materials characterization and chemical analysis. New York, NY [etc.]: VCH, cop. 1988. ISBN 0895732696.
- Cullity, B. D.; Stock, S. R. Elements of X-ray diffraction. 3rd ed. Upper Saddle River, NJ: Prentice-Hall, cop. 2014. ISBN 9781292040547.
- Beeston, B. E. Electron diffraction and optical diffraction techniques. Amsterdam [etc.]: North-Holland, 1972. ISBN 0720442532.
- Heimendahl, Manfred von. Electron microscopy of materials : an introduction. New York: Academic Press, 1980. ISBN 0127251502.