Universidad Zaragoza

Academic Year of Degree: 2026/27

69795 - Characterisation II: Advanced microscopies

Teaching Plan Information

Academic year: 2026/27
Subject: 69795 - Characterisation II: Advanced microscopies
Faculty / School: 100 - Facultad de Ciencias
Tipo de enseñanza: In person
Ambit: Chemical engineering, materials engineering and environmental engineering
Degree: 641 - Máster Universitario Erasmus Mundus en Ingeniería de Membranas para un Desarrollo Sostenible / Erasmus Mundus Master in Membrane Engineering for a Sustainable Development
ECTS: 6.0
Year: 01
Semester: Second semester
Subject type: Optional
Module:

1. General information

This course, "Characterization II: Advanced Microscopies", teaches students about the various techniques available for characterizing nanostructured materials and their properties, including morphological, structural, analytical, optical, electric, and magnetic properties. The course covers advanced microscopies such as electronic, dual-beam, and scanning probe microscopes, which offer nanometric resolution and the ability to analyze materials at the atomic and molecular scale. Students will gain theoretical knowledge and practical experience using specialized scientific instruments to characterize nanostructured materials.

These approaches and objectives are aligned with the achievement of SDG 9, Industry, innovation and infrastructure of the Agenda 2030. More specifically, they will create action to enhance research, foster innovation and upgrade industrial technologies.

2. Learning results

• Identify the importande of surface effects and phenomena that appear at the nanoscale, and understand their influence on the properties of nanoscopic systems.

• Understand the fundamentals of advanced electron and local probe microscopy techniques for the study of nanostructured materials.

• Know the general working rules in a laboratory for the advanced microscopical characterization of nanostructured materials.

• Describe the state of the art of Nanoscience and Nanotechnology, assessing its multidisciplinary nature, as well as its ethical, social, environmental and legal implications.

•Select and appropriately apply the advance microscopy techniques commonly used in nanoscience depending on the nanostructured material or device.

•Appreciate the potential of nanostructured materials as a key enabling technology in various application areas and the entrepreneurial opportunities they offer

•Search, critically analyze, and transmit specific, up-to-date information in the field of Nanoscience and Nanotecnology.

• Interpret experimental results of advanced microscopy, draw conclusions, and present them using scientific language

• Actively collaborate with a group of people to achieve a common goal by combining different talents

• Discuss about a topic, being able to deliberate on its validity by subjecting one's own and external convictions to debate

• Design and perform a new task or project using creativity and curiosity to add value with an entrepreneurial attitude

• Respect diversity in any human group and ensure non-discrimination based on any personal circumstances.

3. Syllabus

The course will address the following topics:

• Introduction to electron and scanning probe microscopy.

• Scanning electron microscopy.

• Transmission electron microscopy (image and diffraction).

• Analytical techniques linked to electron microscopy: energy dispersive X-ray spectroscopy and electron energy loss spectroscopy.

• Atomic and magnetic force microscopy.

• Scanning tunnelling microscopy.

• Surface spectroscopy.

• Other advanced optical microscopes: confocal and near-field

4. Academic activities

- Lectures that cover the course topics, with accompanying notes, handouts, and open forum activities to reinforce the concepts.
- Laboratory sessions involve practicals in the characterization of nanostructured materials, with task guidelines and visits to LMA facilities.
- Assignments. Q&As at the end of each topic are to be completed individually and presented in class, with monographic reports on specialized topics assigned to groups (2-3 students) for oral presentation.
- Autonomous work is expected, with students spending approximately 90 hours to study, solve problems, prepare for lab sessions, assignments and exams.
- Tutorials are also available to solve questions and clarify any unclear course content.

5. Assessment system

For students choosing Continuous Assessment (attendance to at least 80% of this module is required)

1.- Individual Assessments including exercises, problem and question solving of matters seen in class and seminars (25% of the final result for the module).

2.- A monographic project prepared by groups (25 % of the final result for the module) related to some of the topics included in the module descriptors.

3.- Practical Assessment (50% of the final result for the module) where the knowledge, instrument handling skills, accuracy, attention to detail, and ability to solve problems are evaluated. Lectures may also ask the students to write reports on their laboratory results.

For students that did not pass the ongoing assessment or wish to increase their mark Global Assessment comprising a written test (25% of the final mark), a viva with a board of examiners (25% of the final mark) and a practical exam (which counts for the remaining 50% of the mark).

A minimum qualification of 4 out of 10 is needed in each of the tasks to pass the subject. In any case, the average over the sections must be at least 5 out of 10 to pass the subject.

6. Sustainable Development Goals

9 - Industry, Innovation and Infrastructure

7. Bibliography

Williams D. B. and Carter C. B. (2009) Transmission Electron Microscopy: A Textbook for Materials Science (2nd Edition), Springer, New York.

Wiesendanger, Scanning Probe Microscopy and Spectroscopy: Methods and Applications. Cambridge University Press

Chen, C. J. (2021) Introduction to Scanning Tunneling Microscopy (3rd Edition). Oxford University Press.

Haugstad, G. (2012) Atonic Force Microscopy: Understanding Basic Modes and Advanced Applications. John Wiley & Sons, Inc.