COURSE DATA

DATA SUBJECT

Code: 44996
Name: Characterisation of Inorganic Solids
Cycle: Master's Degree
ECTS Credits: 5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2249 - Master's Degree in Chemistry	Facultat de Química	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2249 - Master's Degree in Chemistry	Aplicaciones de la Química Inorgánica	COMPULSORY

COORDINATION

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SUMMARY

The subject "Characterisation of Inorganic Solids" is taught in the first four-month period of the M.U. in Chemistry and forms part of the subject Applied Chemistry as a compulsory subject. The aim of the course is for students to acquire the necessary skills to determine and interpret the properties of any type of inorganic solid, as an essential step for its use in the scientific, technological or industrial field. Given that the duration of the course does not allow for covering all the characterisation techniques, we have selected those that are of more general application and which provide information on the chemical composition, crystalline structure, morphology and thermal behaviour of the materials. In all cases, the techniques under study will be approached from the basic principles strictly necessary to understand how they work, to immediately go on to learn about the equipment and the sample preparation methodology, and finally to consider a variety of practical assumptions that provide experience in the processing of the data.

Among the set of techniques studied are those of X-ray diffraction of polycrystalline samples. In this case, experiments will be carried out on phase identification and structural analysis. For morphological characterisation, optical microscopy techniques will be described and the different scanning electron microscopy techniques will be described, both in image acquisition (SEM, TEM and HRTEM) and in chemical characterisation by backscattered electrons (SEM-EDX and TEM-EDX). Finally, thermal analysis methods will also be studied, such as thermogravimetric analysis (TGA), differential thermal analysis (DTA) and differential scanning calorimetry, with emphasis on the handling of the instrumentation and the interpretation of the results.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

Chemistry knowledge acquired during the Chemistry or recommended entry degrees are required.

COMPETENCES / LEARNING OUTCOMES

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Apply the advanced theoretical and practical knowledge gained in the different specialties of chemistry to R&D and innovation.

Be able to conduct any type of research in the field of chemistry and/or the chemical industry, as a specialist.

Be able to defend positions in debates and colloquia in a rigorous and reasoned manner.

Be able to design, conduct, analyse and interpret complex experiments and data, as a specialist.

Be able to present and defend publicly the results obtained in scientific research or as a result of work in a chemical industry.

Be able to solve complex chemistry problems, whether in the academic, research or industrial application areas at a specialization or masters-level.

Fomentar, en contextos académicos y profesionales del ámbito de la política económica,
el avance tecnológico, social o cultural dentro de una sociedad basada en el conocimiento y en el respeto a: a) los derechos fundamentales y de igualdad de oportunidades entre hombres y mujeres, b) los principios de igualdad de oportunidades y accesibilidad universal de las personas con discapacidad y c) los valores propios de una cultura de paz y valores democrático.

Gain experience in the use of information tools and in the management of the information obtained.

Gain skills and knowledge in different advanced characterisation techniques for selecting the most suitable techniques, according to chemical criteria, for the characterisation of inorganic solids at an industrial level.

Have the ability to plan and to manage time and resources and gain experience in decision-making.

Possess the ability to plan and manage time and resources and gain experience in decision-making.

Possess the necessary skills to develop multidisciplinary activities within the field of chemistry at the master's level.

Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.

Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.

Students should demonstrate self-directed learning skills for continued academic growth.

Students should possess and understand foundational knowledge that enables original thinking and research in the field.

DESCRIPTION OF CONTENTS

1. X-ray diffraction

Basic concepts of Crystallography. X-ray diffraction. Single crystal diffraction vs powder diffraction. Instrumentation. Determination of lattice parameters. Indexing. Determination of the space group of symmetry. Determination of the crystal structure. Polymorphism. Identification and quantitative analysis of crystalline phases. Measurement of stress in a polycrystalline solid. Measurement of the texture in a polycrystalline solid. Measurement of the mean particle size of a polycrystalline solid. Use of database.

2. Electron microscopy

Microscopy fundamentals. Electromagnetic spectrum. Interaction of radiation with matter. Introduction to microscopy and resolution techniques.
Scanning electron microscopy (SEM). Electronic optics. Image formation and interpretation. Working modes and detectors. EM-EDX microanalysis. Qualitative analysis. Sample preparation for SEM Application to the characterization of various inorganic substances, such as ceramic materials.
Transmission electron microscopy (TEM) and high resolution (HRTEM). Parts of the microscope. Imaging, diffraction patterns and aberration correction. Techniques: parallel beam, STEM. Analytical techniques for TEM: X-ray energy dispersion microanalysis (EDX) Electronic energy loss spectroscopy (EELS), High Angle Anular Dark Field (HAADF). Sample preparation for TEM.

3. Thermal analysis

Thermogravimetric methods (TG), differential thermal analysis (DTA), differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA) and dilatometry: instrumentation and applications in the thermal characterization of inorganic samples and composites.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours

Tutorials	10,00
Theory	40,00
Total hours	**50,00**

NON PRESENCIAL ACTIVITIES

Activity	**Hours**
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	75,00
Preparation of lessons	0,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**75,00**

TEACHING METHODOLOGY

The course will be taught in asynchronous online mode. The practical sessions, seminars and tutorials will focus on the resolution of practical cases of interest for different industrial sectors, with special attention to the ceramic sector.

The practical sessions will include filmed material in the laboratory to familiarise students with the techniques described and also sessions of analysis and exploitation of the data obtained from the different techniques for the practical cases presented.

Use will be made of the Virtual Classroom platform, a virtual space where all the information considered appropriate for the development of teaching and the control of student participation in the proposed activities is deposited.

EVALUATION

The qualification of the subject for both the first and the second call will be obtained from:

- Written exams: based on the learning results and the objectives of each subject, in its theoretical and / or practical part that will account for 60% of the final grade.
- The preparation and presentation of work by the students of questions raised by the teacher at the end of each topic will account for 20% of the final grade.
- The continuous evaluation of the activity developed by the student through participatory assistance, problem solving, etc ... will count for 20% of the final grade.

The grade necessary to pass the course is 5 points.

REFERENCES

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