Materials Science

Code: 102511
ECTS Credits: 6

2024/2025

Degree	Type	Year
2502444 Chemistry	OB	3

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Teachers

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Teaching groups languages

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Prerequisites

It is recommended that for the subject "Materials Science", all first year subjects and the "Chemistry of the Elements" and the "Structure and Reactivity of Organic Compounds" of the second year of the Chemistry degree have been passed.

Objectives and Contextualisation

"Material Science" is a compulsory subject of the Chemistry degree third year. It includes knowledge of a general and transversal nature, as it combines scientific areas such as applied physics, chemistry and geology, along with areas of engineering, such as selection, testing and behavior of materials.

Its contents are based on the competences achieved in the subjects of the first year and those of "Chemistry of the Elements", "Structure and Reactivity of Organic Compounds" and "Chemistry of Coordination and Organometallic". With this subject, the student will complete a basic training cycle in the field of the structure, properties and applications of the different solids, classified according to their atomic structure and chemical bond.

Its objective is to establish the relationship existing between the structure of matter at the atomic or molecular level and its macroscopic properties. This allows to explain and predict the characteristics and behaviors of macroscopic and nanomaterial dimensions. Within this context, mechanical properties are highlighted, which once linked to the defects and the multifacic nature of the solids, allow the understanding of the mechanical behavior of materials as important as metals and alloys, ceramics and polymers. This knowledge is basic to establish methodologies for the selection of the most suitable material for each application based on the specific requirements demanded. In the case of practical classes, the objective is to start the student in the

techniques of preparation and characterization of solids, which have characteristic features different from those used in molecular chemistry.

Competences

- Adapt to new situations.
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Be ethically committed.
- Communicate clearly in English.
- Communicate orally and in writing in one's own language.
- Have numerical calculation skills.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show initiative and an enterprising spirit.
- Show motivation for quality.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Be ethically committed.
3. Communicate clearly in English.
4. Communicate orally and in writing in one's own language.
5. Describe the basic aspects of the synthesis and properties of solid materials, of polymers and of compound materials.
6. Describe the structures of crystalline materials by means of cell parameters.
7. Determine phase transformations in two-component systems and their relation with thermal treatments of metal alloys.
8. Draw the structures of metals and ionic compounds.
9. Evaluate results of calculations on properties of materials.
10. Have numerical calculation skills.
11. Learn autonomously.
12. Manage the organisation and planning of tasks.
13. Manage, analyse and synthesise information.
14. Obtain information, including by digital means.
15. Perform bibliographic research of documentation on the properties of materials.
16. Perform calculations with the structural parameters of metal cells and ionic solids.
17. Perform correct relative calculations of the thermal, mechanical, electrical, magnetic and optical properties of solid, soft and nano materials.
18. Predict the most relevant properties associated to a certain material.
19. Predict the thermal, mechanical, electrical, magnetic and optical properties of solid, soft and nano materials from their composition and structure.
20. Propose creative ideas and solutions.

21. Propose the best preparation method to obtain a certain material.
22. Propose the most suitable methods to characterise a certain material, both on a macrometric and nanometric level.
23. Read, analyse and extract information from texts in the English language on the different areas of the field of material chemistry.
24. Reason in a critical manner
25. Recognise the English names of terms in the field of material science.
26. Relate the electrical, magnetic and optical properties of materials with their structural characteristics.
27. Relate the mechanical properties of solids with structural imperfections.
28. Resolve problems and make decisions.
29. Show initiative and an enterprising spirit.
30. Show motivation for quality.
31. Show sensitivity for environmental issues.
32. Use IT to treat and present information.
33. Work in a team and show concern for interpersonal relations at work.

Content

1.- Study of the perfect crystal. Crystalline and non-crystalline materials Structure of crystalline solids.

2.- The real crystal. Imperfections in solids and microscopic observation. Uni, bi and three-dimensional defects. Diffusion in solids.

3.- Mechanical properties of solids. Deformation and hardness. Mechanisms of hardening. Recovery, recrystallization and growth of grain.

4.- Metallic materials. Diagrams of phase equilibrium and phase transformations. Thermal treatments of metals and alloys.

5.- Ceramic materials. Structure and mechanical properties of ceramics. Applications, forming and processing of ceramics.

6.- Polymeric materials. Polymeric compounds; Synthesis, structure and mechanical and thermomechanical characteristics. Applications and forming of polymers.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	47	1.88	1, 11, 3, 29, 30, 5, 6, 7, 8, 12, 13, 2, 31, 14, 18, 19, 22, 20, 24, 25, 26, 27, 33
Seminars	2	0.08	1, 11, 9, 3, 4, 29, 30, 7, 8, 17, 12, 13, 31, 14, 18, 21, 22, 20, 24, 16, 15, 25, 26, 27, 28, 10, 33, 32
Type: Supervised			
Tutorial	5	0.2	3, 4, 29, 30, 12, 13, 14, 20, 24, 25
Type: Autonomous			
Problem Solving	19	0.76	9, 5, 6, 7, 8, 17, 12, 13, 14, 18, 19, 22, 16, 15, 25, 26, 27, 28, 10, 32

Study	46	1.84	1, 11, 9, 5, 6, 7, 8, 17, 12, 2, 14, 18, 19, 21, 22, 20, 24, 15, 25, 26, 27, 28, 32
Text reading and drafting of works	23	0.92	11, 3, 4, 29, 30, 12, 13, 23, 14, 24, 15, 32

The subject consists of two types of supervised activities; the lectures and the problems classes, that are given in a concerted manner and are distributed throughout the course in an approximate 3 to 1 ratio.

Lectures

Through the teacher's explanations the student must acquire the own knowledge of this subject and complement them with the study of each subject treated with the help of the material that the professor provides through the Virtual Campus and the Recommended bibliography. The lectures will be open to the students participation, who will be able to raise to the professor any questions and clarifications needed.

Problems classes

The objective of this supervised activity is to solve problems and questions that have been previously raised to the students through the Virtual Campus and that have had to be resolved previously, in group or in person. Due to the smaller number of students in this type of classes, it is intended to stimulate participation in the discussion of the alternatives to solve the problems, taking advantage of it to consolidate the knowledge acquired in theory classes and through the personal study.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Follow up work	15	2	0.08	1, 11, 9, 3, 4, 29, 30, 6, 7, 8, 17, 12, 13, 23, 2, 31, 14, 18, 19, 21, 22, 20, 24, 16, 15, 25, 26, 27, 28, 10, 33, 32
Midterm examinations or Global second-chance examination	85	6	0.24	1, 9, 4, 29, 30, 5, 6, 7, 8, 17, 13, 2, 31, 18, 19, 21, 22, 20, 24, 16, 15, 25, 26, 27, 28, 10

Exams

For evaluation purposes, the subject can be considered divided into two parts.

Throughout the semester two midterm exams will be carried out, one from each part (ExP1 and ExP2), and a global second-chance exam (ExG), all of them with a grade between 0 and 10.

Follow-up work

Throughout the semester a certain number of tests of student follow-up will be collected (for example,

problems solved individually or in groups, short classroom tests, reading of scientific texts, questionnaires, online activities, etc.). For each part of the subject, each student will have a minimum of two grades of these follow-up tests. Each student will obtain, therefore, two follow-up notes (S1 and S2), which will be the averages of the grades obtained in the follow-up tests of each part of the subject.

Ratings:

Each part of the subject will have a grade (Not1 and Not2) that will be:

Not1 = 0.85 x ExP1 + 0.15 x S1

Not2 = 0.85 x ExP2 + 0.15 x S2

The final grade (NF) will be obtained in the following way:

NF = (Not1 + Not2) / 2

In case the distribution of teaching hours destined to each part was very unbalanced, a different weighting will be used other that the 50% for Not1 and Not2 in the calculation of NF

To pass the subject, the following two conditions must be met:

1) The final grade for the subject (NF) must be $\geq$ 5.0

2) To be able to do media, Not1 and Not2 must be $\geq$ 4.0

In case the above requirements are not met, the student must go to the second-chance exam, where he / she will be able to recover one or both parts, since the subjects of each part will be separated and identified as it (NR1 and NR2). The NF will be calculated by replacing the EXP1 and / or EXP2 values obtained in the NR1 and / or NR2 second chance exam.In case that the grade obtained in one or both NRX notes (x = 1, 2) is less than 4, the final grade (NF) will be obtained by the average of NRX, but it never will exceed 4.

In order to pass the subject in the second chance exam, the following two conditions must be met:

1) The final grade of the subject must be $\geq$ 5.0

2) To be able to do media, Not1 and Not2 (NR1 and NR2 in case of recovery) must be $\geq$ 4.0

Students who pass the course by midterm evaluation but want to improve their qualification, they have the option to do the second chance exam but must do it fulfilled; that is, the two subtests corresponding to each part. In this case the final grade (NF) will be the average of the grades obtained in the second chance examinations.

In order to be considered as assessable, it is necessary to:

- Deliver complete, with all the exercises solved, at least 66% of the requested activities (evidences + exams)

If this requirement is not met, the student will be considered not assessable.

Not-continuous evaluation

The students that chose this evaluation will do a final test that will consist in an exam of all the subject and the delivery of 2 exercises (which will be assign at the beginning of the course) to be done the same day as the continuous evaluation students do the exam of the second part of the subject. The qualification will be 15% of the average mark of the delivered problems (ExP) + 85% of the final exam.

If the mark is lower than 5 the student will have a second opportunity to pass the subject through another exam which will take place the day assigned by the degree coordination. The final mark will be 15% of the ExP and 85% of this exam's mark.

Bibliography

W.D. Callister, D.G. Rethwisch; "Materials Science and Engineering" John Wiley & Sons Inc; Edición: 9th Edition SI Version; ISBN-10: 1118319222

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R. Tilley; "Understanding Solids: The Science of Matherials" J. Wiley & Sons, 2004.

A.R. West; "Basic Solid State Chemistry" J. Wiley & Sons, 1988.

W.F. Smith "Fundamentos de la Ciencia e Ingeniería de Materiales". Mc Graw-Hill/Interamericana de España.

L. Smart, E.Moore; "Solid State Chemistry. An Introduction. 2nd Ed." Chapman & Hall 1995.

Chapman & Hall "Materials Science" en CD ROM.

Software

In some of the evidencies it may be recomended to use excel or similar programs

Language list

Name	Group	Language	Semester	Turn
(SEM) Seminars	1	Catalan	second semester	morning-mixed
(SEM) Seminars	2	Undefined	second semester	morning-mixed
(TE) Theory	1	Catalan	second semester	morning-mixed
(TE) Theory	2	Undefined	second semester	morning-mixed