Universitat Autònoma de Barcelona

2022/2023

Solid State Chemistry

Code: 102507
ECTS Credits: 6

Degree	Type	Year	Semester
2502444 Chemistry	OT	4	2

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Prerequisites

To have studied and passed the 3rd year course "Material Science"

Objectives and Contextualisation

"Solid State Chemistry" aims to expand the knowledge acquired with the obligatory subject of the third year "Material Science" by introducing significant concepts such as methods of preparation of materials and the physical properties of materials. Thus, at the beginning, the basic aspects of the synthesis of solid materials will be described, following with the study of their electrical, magnetic and optical properties. These properties will be related to their structural characteristics.

Competences

- Adapt to new situations.
- Be ethically committed.
- Communicate orally and in writing in one's own language.
- 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
- 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 orally and in writing in one's own language.
4. Describe the optical properties of materials and their most important applications.
5. Differentiate between the different types of solid electrical conductors and relate them with their structure, bonds and most important applications.
6. Distinguish the models of chemical bonding in solids and relate them with the physical and chemical properties of the same.
7. Interpret the magnetic behaviour of materials in accordance with their structure and bonds, and relate this with their most important applications.
8. Learn autonomously.
9. Manage the organisation and planning of tasks.
10. Manage, analyse and synthesise information.
11. Obtain information, including by digital means.
12. Propose creative ideas and solutions.
13. Read, analyse and extract information from texts in the English language on the different areas of the field of material chemistry.
14. Reason in a critical manner
15. Resolve problems and make decisions.
16. Show initiative and an enterprising spirit.
17. Show motivation for quality.
18. Show sensitivity for environmental issues.
19. Use IT to treat and present information.
20. Work in a team and show concern for interpersonal relations at work.

Content

Solid State chemistry

6 ECTS: 31 hours of theory + 10 hours of exercises

Bond in solids and electronic properties: Model of bands in solids. Fermi energy, density of states. Conductors, semiconductors and insulators.

Materials with electrical properties I: Metallic conductivity. Metals and alloys. Semiconductors. Type of semiconductors. Band system. Silicon and germanium. Devices. Applications. Conjugated systems: polyacetylene and other polymers. Doping. Superconductors: Zero resistance. Perfect Diamagnetism: Meissner Effect. Critical temperature. Types of superconductors. Ceramic superconductors. Applications of superconductors.

Materials with electrical properties II: Ionic conductivity. Vacancies conductivity. Interstitial conductivity. Alkalinearth fluorides. Characteristics of solid electrolytes. β-Alumina. Silver salts. Anionic conductors. Li + and H + conductors. Applications: Batteries, fuel cells, solar cells and gas sensors. Dielectric materials. Polarization and prerovskite polarization. Ferroelectricity. Pyroelectricity. Piezoelectricity. Applications and devices based on dielectrics.

Materials with magnetic properties: Basic concepts. Magnetic moment. Effect of T. Type of magnetic behavior. Ferromagnetism, ferrimagnetism and antiferromagnetism. Examples of magnetic materials: metals and alloys, lanthanides and oxides. Structure-properties relationship. Applications. Storage of information.

Materials with optical properties: Interaction of the radiation with the atoms. Phosphorescence and fluorescence. Absorption and emission of radiation in semiconductors. Lasers Optical fibers.

Synthesis of solids: Methods of solids preparation. Nucleation and crystalline growth. Ceramic methods at high Temperature: Combustion methods, Carbotermic methods, Microwave and ceramic methods. High Pressuremethods: Solvotermic processes, Synthesis by direct pressure. Sol-Gel methods. Methods of intercalation and deintercalation. Chemical Vapor Transport methods (CVT). Monocrystal preparation:

Float-Zone methods, Bridgman and Stockbarger methods, Czochralski method. Chemical Vapor Deposition (CVD) and Physical Vapor Deposition (PVD) methods.

Methodology

The subject is given in the form of lectures and classroom practices. In addition, the students will have to do a bibliographical work and solve the questions posed by the teacher.

1) Lectures

Through the presentations of the teacher 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 bibliography recommended The lectures will be open to the participation of the students, who will be able to ask the professor the questions and clarifications they need. The teacher can assign specific exercises or questions to the students to solve them (at home or in the classroom) and discuss them in the classroom. The presentations of the bibliographical works of the students will also be done in these classes and the participation of all the students will be invoked in the sessions of questions and discussions regarding the works.

2) Bibliographical work.

Students must prepare a bibliographical work on a topic proposed by the teacher and they will have to defend it in public. They will also have to solve the exercises or questions raised by the teacher at home or in the classroom.

The objective of activity 2) is to work the subject autonomously and / or in group, deepening in specific subjects and solving issues raised by the teacher. The aim is to stimulate the participation of the students in the discussion of the subjects and in the approach of alternatives to solve certain problems.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	40	1.6	1, 8, 4, 5, 6, 7
Type: Supervised			
Tutorial	6	0.24	1, 8, 16, 17, 4, 5, 6, 9, 10, 7, 13, 2, 18, 11, 12, 14, 15, 20, 19
Type: Autonomous			
Elaboration of a work	30	1.2	1, 8, 16, 17, 4, 5, 6, 9, 10, 7, 13, 2, 18, 11, 12, 14, 15, 20, 19
Preparation and presentation of work on the subject	19	0.76	1, 8, 16, 17, 4, 5, 6, 9, 10, 7, 13, 2, 18, 11, 12, 14, 15, 20, 19
Reading of texts	13	0.52	1, 8, 16, 17, 4, 5, 6, 9, 10, 7, 13, 2, 18, 11, 12, 14, 15, 20, 19
Study	35	1.4	1, 8, 16, 17, 4, 5, 6, 9, 10, 7, 13, 2, 18, 11, 12, 14, 15, 20, 19

Assessment

Subject evaluation:

Class attendance is mandatory. Unjustified absences of a maximum of 15% of the supervised activities will be admitted and attendance at the presentation sessions is mandatory for all students. Failure to comply with this attendance policy will result in the student being unassessed.

Exams

For assessment purposes, the subject can be considered divided into two parts. Two will be held throughout the semester
partial exams, one for each part (ExP1 and ExP2), and a final recovery exam (ExF), all with a grade between 0 and 10.

Bibliographic work and follow-up work

At the beginning of the course, each student will be assigned to carry out a bibliographic work that will be carried out throughout the semester. The characteristics and presentation of the work will be specified by the teacher at the time of assignment. In addition, teachers can assign other follow-up assignments (individual or group exercises) during the course.

The evaluation of the bibliographic work and of the follow-up works will give rise to a note between 0 and 10 for each student (Treb)

Qualifications:

There will be two partial exams whose grades will be ExP1 and ExP2.

To pass the subject per course (by part) the following conditions must be met:

1) Attendance at ExP1 and ExP2 as well as the completion of bibliographic work is mandatory; otherwise the student will be considered non-assessable.

2) ExP1 and laExP2 must be ≥ 4

3) The Treb grade must be ≥ 4

4) The final grade of the subject NF = [0.70 x (ExP1 + ExP2) / 2] + (0.30 x Treb) must be ≥ 5

In the event that the above requirement is not met, the student must do the recovery exam (ExRx), where he / she will be able to retake one or both of the exams (ExR1 and ExR2).

The NF will be calculated as explained above, but replacing the values of ExP1and ExP2 with those obtained in ExR1 and / or ExR2, which must also be equal to or greater than 4. In any case, NF must be greater than or equal to 5 to pass the subject.

Students who pass the course but want to improve their grade, may take the global exam but must complete it; that is, (ExR1 + ExR2) and their final grade will be exclusively the sum obtained in these exams.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Bibliographic work and exercises	30	3	0.12	1, 8, 3, 16, 17, 4, 5, 6, 9, 10, 7, 13, 2, 18, 11, 12, 14, 15, 20, 19
Written exams	70	4	0.16	1, 8, 16, 17, 4, 5, 6, 7, 2, 18, 12, 14

Bibliography

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

D. R. Askeland; "The Science and Engineering of Materials"; Wadsworth Publishing Co Inc; Edición: 6th ed ISBN-10: 0495296023

A. R. West; "Solid State Chemistry and its Applications" (Second edition) Wiley&Sons ISBN: 978-1-119-94294-8

L. E. Smart, E. A. Moore; "Solid State Chemistry: An Introduction" (Fourth Edition); CRC Press; ISBN-10: 1439847908

Software

None