Teaching Guide				
Identifying Data				2022/23
Subject (*)	Solid State		Code	610G04022
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Third	Obligatory	6
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Química			
Coordinador	Señaris Rodriguez, Maria Antonia	E-mail	m.senaris.rodriguez@udc.es	
Lecturers	Sanchez Andujar, Manuel Señaris Rodriguez, Maria Antonia	E-mail	m.andujar@udc.es m.senaris.rodriguez@udc.es	
Web				
General description	Solid State is an obligatory subject of the first semester of the third year of the Nanoscience and Nanotechnology Degree. It is clearly interdisciplinary character dedicated to the study of solid substances, mainly crystalline, and their relevant properties (mechanical, electrical, magnetic, optical, etc.), which are rationalized through the establishment of structure-micro/nanostructure-composition-properties relationships, and which derive the main technological applications of these materials.			

Study programme competences / results	
Code	Study programme competences / results
A1	CE1 - Comprender los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología.
A2	CE2 - Aplicar los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología a la resolución de problemas de naturaleza cuantitativa o cualitativa.
A3	CE3 - Reconocer y analizar problemas físicos, químicos, matemáticos, biológicos en el ámbito de la Nanociencia y Nanotecnología, así como plantear respuestas o trabajos adecuados para su resolución, incluyendo el uso de fuentes bibliográficas.
A4	CE4 - Desarrollar trabajos de síntesis y preparación, caracterización y estudio de las propiedades de materiales en la nanoescala.
A5	CE5 - Conocer los rasgos estructurales de los nanomateriales, incluyendo las principales técnicas para su identificación y caracterización
B1	CB1 - Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio
B3	CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
B5	CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
B9	CG4 - Trabajar de forma autónoma con iniciativa.
B12	CG7 - Comunicarse de manera efectiva en un entorno de trabajo.
C1	CT1 - Expresarse correctamente, tanto de forma oral coma escrita, en las lenguas oficiales de la comunidad autónoma
C2	CT2 - Dominar la expresión y la comprensión de forma oral y escrita de un idioma extranjero
C5	CT5 - Entender la importancia de la cultura emprendedora y conocer los medios al alcance de las personas emprendedoras
C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad

Learning outcomes

Learning outcomes	Study programme competences / results		
1. Acquire a general vision of Solid State Science, of its interdisciplinary nature as well as basic notions about different families of solids and different criteria for classifying materials.	A1	B1 B3 B8 B9 B12	C1 C5
2. Know the structure and microstructure of crystalline solids, and the factors on which they depend. Know the nature of the bond in solids and their electronic structure.	A1 A5	B8 B9	
3. Know the most important physical properties of crystalline solids and be able to relate them to their composition, structure and micro/nanostructure.	A1 A2	B3	C1
4. Know the fundamentals and application of materials in the electrical and electronic industry, as well as magnetic and optical materials.	A1 A3	B3	C5 C8
Develop criteria for the selection of materials based on their application.		B3 B5	
Know the usual work techniques and methodologies in a solid state and materials laboratory.	A3 A4	B9 B12	C2 C8

Contents	
Topic	Sub-topic
I.- Introduction to Solid State	- Introduction to Solid State Chemistry and Physics and its relationship with other disciplines - Classification criteria for solids and properties - Selection criteria
II.- Basic aspects of crystalline solids	?Ideal Solids: - Crystalline structures of solids and aspects on which they depend. Ionic bond model - Electronic structure of solids. bands model ?Real solids: - Defects in solids and non-stoichiometric - Consequences of the existence of defects and the influence of the nanometric scale on its electronic structure
III.- Properties and applications of solids	?Mechanical properties ?Magnetic properties: - dia- e para-magnetism - ferro-, ferri-, and antiferro-magnetism Influence of particle size reduction: superparamagnetism - main applications ?Electronic properties: - electronic drivers - semiconductors (p-n junctions, photovoltaic cells, LEDs) - superconductors - Insulators (dielectric, ferroelectric, piezoelectric, pyroelectric) - Influence of particle size (quantum dots, etc.) ?Ionic properties: - ionic conductors (batteries, fuel cells) - Influence of particle size ?Introduction to optical properties and their applications
IV: New trends in Solid State and examples of material selection	? Biomaterials, MOFs, etc. ? Examples of material selection

V:Solid State Laboratory	? Synthesis and processing of materials ? Characterization and study of the properties of materials

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Problem solving	A1 A2 A3 A4 B1 B3 B5 B8 B9 B12 C1 C8	8	16	24
Events academic / information	A1 B5 B8 C5 C8	1	1.1	2.1
Objective test	A1 A2 A3 A5 B8 C1	0.5	0	0.5
Guest lecture / keynote speech	A1 A3 B8 C8	27	59.4	86.4
Laboratory practice	A1 A2 A3 A4 A5 B1 B3 B5 B8 B9 B12 C2 C5 C8	14	14	28
Mixed objective/subjective test	A1 A2 A3 A5 B8 B12 C1	3	4.5	7.5
Personalized attention		1.5	0	1.5
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Problem solving	The problem solving classes will be dedicated to solving problems and questions that were proposed in advance to the students, so that they can work on them before the corresponding face-to-face session.
Events academic / information	The possibility is also contemplated, as complementary activities, of visiting centers related to the subject, attending scientific conferences, etc. These activities will be specified during the development of the course.
Objective test	On a regular basis, in the problem-solving sessions, the students will carry out a series of short tests, multiple choice or short answer, aimed both at evaluating the degree of acquisition of skills and at consolidating the content seen during the sessions. masterful. This activity will allow not only to monitor the evolution of students, but will also serve to detect those aspects of the subject that are more difficult to understand.
Guest lecture / keynote speech	In the guest lecture, the contents of the corresponding topics will be introduced, emphasizing their most important aspects and focusing particularly on those fundamental concepts and/or those that are most difficult for students to understand.
Laboratory practice	Synthesis and processing work of different types of materials, their characterization and study of their properties under the supervision of the teaching staff.
Mixed objective/subjective test	Subjective test that will be carried out in the calendar agreed by the Faculty Board. Its objective is to contribute to the evaluation of the level of knowledge and skills acquired by the students and their ability to relate them and to obtain an overview of the subject.

Personalized attention	
Methodologies	Description

Mixed objective/subjective test Laboratory practice Guest lecture / keynote speech Problem solving Events academic / information	Personalized attention will be given mainly through activities carried out in reduced groups, and also in individualized tutorials, fundamentally associated with the methodologies "problem solving" and "laboratory practices". For students with "academic dispensation": - the tutorials associated with "laboratory practices" will be the same as for the rest of the students; - the rest of the tutorials may be replaced by personalized tutorials that will not be evaluated. These students would pass a particular examination, in addition to the compulsory mixed test, which would leave no doubt about their level of knowledge, competences, skills and abilities, and which would score 10% of the overall grade. In order to benefit from this system, the student must notify the responsible teacher at the beginning of the course. Obviously, and apart from the tutorials proposed by the teacher, any student can carry out tutorials at their own request (face-to-face or virtual) within the 6 hours of weekly tutorial that the teacher makes available to the student and/or at the most convenient times for the student, by prior agreement with the teacher.

Assessment			
Methodologies	Competencies / Results	Description	**Qualification**
Mixed objective/subjective test	A1 A2 A3 A5 B8 B12 C1	It will consist of an ensemble test to be held at the end of the semester. It may consist of both development questions, short or multiple choice questions and problems that will be similar to those made throughout the course.	70
Laboratory practice	A1 A2 A3 A4 A5 B1 B3 B5 B8 B9 B12 C2 C5 C8	The work carried out in the laboratory will be evaluated from the points of view of: organization and safety, performance in the laboratory, knowledge of the techniques, manual dexterity and especially the ability to understand and rationalize the processes carried out. In addition, it will evaluate the preparation prior to each practice, and the preparation of the corresponding laboratory notebook or alternative delivery established by the teacher. Taking into account that the qualification will be based on a continuous evaluation model, if in any case the teaching staff considers it appropriate, they can take a practice exam.	20
Objective test	A1 A2 A3 A5 B8 C1	Sometimes, the student may be given short tests, multiple choice or short answer. These objective tests are designed both to assess the degree of acquisition of skills, and to strengthen the content seen in the master sessions. This activity will not only make it possible to monitor the evolution of the students, but it will also serve as a tool to detect those aspects of the subject that are more difficult to understand. It will be evaluated jointly: "master sessions" + "problem solving" + "scientific and/or informative events" + "objective evidence".	0
Guest lecture / keynote speech	A1 A3 B8 C8	The degree of prior preparation and follow-up of the students of the subject that is being taught in these sessions, as well as their active participation in them, will be assessed. It will be evaluated jointly: "master sessions" + "problem solving" + "scientific and/or informative events" + "objective evidence".	0

Problem solving	A1 A2 A3 A4 B1 B3 B5 B8 B9 B12 C1 C8	Both the answers of the students and their participation in the corresponding face-to-face activities will be valued. Occasionally and at the request of the teaching staff, the students must submit the problem reports that can also be evaluated. It will be evaluated jointly: "master sessions" + "problem solving" + "scientific and/or informative events" + "objective evidence".	10
Events academic / information	A1 B5 B8 C5 C8	The conclusions that the students draw from the corresponding activities are valued, and that they will also be reflected in a summary that they must present after their completion. It will be evaluated jointly: "master sessions" + "problem solving" + "scientific and/or informative events" + "objective evidence".	0

Assessment comments

The final grade will result from the addition of the following partial contributions:
- Final exam ("Prueba mixta"): up to a maximun of 7 points.
-Activities carried out during the different sessions (seminars, exercises, tutoring sessions, scientif events, etc): up to a maximum of 1 points.
-Laboratory sessions: up to a maximum of 2 points.
A minimum of 5 points will be required to pass the Materials Science subject, with the restriction that a minimum of 3.15 (over a maximum of 6) will be necessary in the final exam ("prueba mixta"), as well as a minimum of 0.8 (over a maximum of 2) in the laboratory sessions. If these minima are not achieved the studentt will fail. When a sum of more than 5 points is obtained but the minimum required mark is not reached in one of the activities, the final grade will be "Failed: 4.5 points".
As the assessment of this subject is based on a continuous evaluation model, the progression of the student throughout the semester will be taken into consideration with a maximum of 1 point.
Also, and according to this evaluation model, if the student has participated in activities whose relativeweight is more than a 25% of the total grade, he/she will be assessed.
In this same context, and according to the rules contained in ?Probas de Avaliación e Actas de Cualificación de Grao e Mestrado?, the so-called ?second opportunity of July? is understood as a second opportunity to carry out a final exam ("prueba mixta"). Nevertheless, and in very special cases, the teacher could also include a second part concerning aspects of the Laboratory Sessions. This mark will be considered together with the others obtained during the course corresponding to the other activities (seminars, exercises, scientific events, etc.). The percentages of the different contributions will be the same as those of the former "first opportunity".
The highest grade "Matricula de Honor" will be mainly given to students that pass the subject in the "first opportunity". And it will only be given in the so-called "second opportunity" if there are still any available.
In the case of exceptional, objective and adequately justified circumstances (such as in the case of students with an academic exemption of attendance), the responsible teacher could totally or partially exempt the student from attending the continuous assessment process. In any case, this student will have to undergo a particular examination (in addition to the compulsory mixed test) that will leave no doubt about their level of knowledge, competences, abilities and skills, and that will score 20% of the overall grade.
The teaching-learning process, including assessment, refers to an academic year (this implies that each year starts a new process, including all assessment activities and procedures).
Finally, it is reminded that the fraudulent performance of activities or exams required for the endorsement of the subject will be sanctioned with a failure as stated in the "Student Statute" of the UDC (artíticle 35, point 3, https://www.udc.es/es/normativa/estudantes/estatuto_estudantado/index.html).

Sources of information

Basic	- A.R. WEST (2014). Solid State Chemistry and its Applications. Chichester, John Wiley and Sons - A.R. WEST (1999). Solid State Chemistry. Chichester, John Wiley and Sons - L.E. SMART, E.A. MOORE (2005). Solid State Chemistry. Boca Raton, Taylor and Francis - L.E. SMART, E.A. MOORE (1995). Solid State Chemistry. Boca Raton, Taylor and Francis - S. ELLIOT (1998). The Physics and Chemistry of Solids. Chichester, John Wiley and Sons - A.G. SHACKELFORD (2009). INTRODUCTION TO MATERIALS SCIENCE FOR ENGINEERS. New York, Prentice Hall. - W.D. CALLISTER, D.G. RETHWISCH (2016). Ciencia e Ingeniería de los Materiales. Barcelona, Reverté
Complementary	- G. CAO (2004). Nanostructures and Nanomaterials. Singapore, Imperial College Press - D. VOLLAT (2013). Nanomaterials. Erlangen , Wiley-VCH - N. W. ASHCROFT, N. D. MERMIN (1976). Solid state physics. Forth Worth : Saunders College Publishers The following bibliographic resources are also available as electronic texts through different consultation platforms:- Solid State Chemistry (3rd edition), L. Smart, disp. vía: EBSChost Ebooks. - Inorganic Structural Chemistry (2nd edition), U. Müller, disp. vía: Wiley Ebooks (AP). -Introducción a la Ciencia de Materiais para Ingenieros 7ª ed. J.F. SHACKELFORD, disp.. via INGEBOOK

Recommendations
Subjects that it is recommended to have taken before
Synthesis and Preparation of Nanomaterials/610G04020 Chemistry of the Elements/610G04011 Chemistry: Structure and Bonding/610G04005 Crystallography and Symmetry/610G04006
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
Green Campus Program Faculty of SciencesTo help achieve a sustainable immediate environment and comply with point 6 of the "Environmental Declaration of the Faculty of Sciences (2020)" the documentary work carried out on this matter:a.- They will be requested mostly in virtual format and computer support.b.- If done on paper:- No plastics will be used.- Double-sided printing will be done.- Recycled paper will be used.- Drafts will be avoided.