



## 1. General information

Course: INORGANIC CHEMISTRY OF SOLID STATE

Type: CORE COURSE

Degree: 409 - CHEMISTRY

Center: 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY

Year: 3

Main language: Spanish

Use of additional languages:

Web site:

Code: 57322

ECTS credits: 6

Academic year: 2023-24

Group(s): 20 23

Duration: C2

Second language:

English Friendly: Y

Bilingual: N

Lecturer: FELIX ANGEL JALON SOTES - Group(s): 20 23				
Building/Office	Department	Phone number	Email	Office hours
San Alberto Magno/Planta primera	QUÍMICA INORG., ORG., Y BIOQ.	926052184	felix.jalon@uclm.es	Monday, Tuesday and Wednesday from 5:00 p.m. to 7:00 p.m.
Lecturer: BLANCA ROSA LOURDES MANZANO MANRIQUE - Group(s): 20 23				
Building/Office	Department	Phone number	Email	Office hours
San Alberto Magno/first floor	QUÍMICA INORG., ORG., Y BIOQ.	926052050	blanca.manzano@uclm.es	Monday, Tuesday and Wednesday from 5:00 p.m. to 7:00 p.m.
Lecturer: ANA MARIA RODRIGUEZ FERNANDEZ-PACHECO - Group(s): 20 23				
Building/Office	Department	Phone number	Email	Office hours
Politécnico/A23	QUÍMICA INORG., ORG., Y BIOQ.	926051961	anamaria.rfdez@uclm.es	Monday, Tuesday and Wednesday from 4:30 p.m. to 6:30 p.m.
Lecturer: ELENA VILLASEÑOR CAMACHO - Group(s): 20 23				
Building/Office	Department	Phone number	Email	Office hours
Edificio San Alberto Magno (primer piso)	QUÍMICA INORG., ORG., Y BIOQ.	926052133	elena.villasenor@uclm.es	Monday, Tuesday and Wednesday from 5:00 p.m. to 7:00 p.m.

## 2. Pre-Requisites

Not established

## 3. Justification in the curriculum, relation to other subjects and to the profession

The subject of Inorganic Chemistry of the Solid State corresponds to the matter of Inorganic Compounds, included in the module of Basic Concepts of Chemistry. It is given in the second semester of the third year of the Bachelor in Chemistry. In this subject, the student is introduced to the basic chemical concepts of the solid state. Along with the acquisition of knowledge in relation with the chemical bonding and the structure of solids, it is intended to facilitate the acquisition of knowledge in the main techniques of solid preparation and also in techniques of structural determination, both at a theoretical and at an experimental level (in the practical teaching of the subject). Criteria to deduce some of the solid properties considering the chemical bonding, structure and composition are also given.

## 4. Degree competences achieved in this course

## Course competences

Code	Description
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
CB05	Have developed the necessary learning abilities to carry on studying autonomously
E03	Handle chemicals safely and with respect to the environment
E06	Know the structural properties of chemical compounds, including stereochemistry, as well as the main structural research techniques
E07	Relate macroscopic properties with those of atoms, molecules and non-molecular chemical compounds
E15	Know how to handle the standard chemical instrumentation and be able to elaborate and manage standardized procedures of work in the laboratory and chemical industry
G01	Know the principles and theories of Chemistry, as well as the methodologies and applications characteristic of analytical chemistry, physical chemistry, inorganic chemistry and organic chemistry, understanding the physical and mathematical bases that require
G02	Be able to gather and interpret data, information and relevant results, obtain conclusions and issue reasoned reports on scientific, technological or other problems that require the use of chemical tools
G03	Know how to apply the theoretical-practical knowledge acquired in the different professional contexts of Chemistry
T05	Organization and planning capacity
T07	Ability to work as a team and, where appropriate, exercise leadership functions, fostering the entrepreneurial character
T10	Ability to use specific software for chemistry at user level
T11	Ability to obtain bibliographic information, including Internet resources

## 5. Objectives or Learning Outcomes

## Course learning outcomes

Description

Know the main methods of preparation of inorganic solids

Apply and interpret some techniques of structural determination or study of properties of molecular and solid inorganic compounds

Apply advanced techniques of preparation of molecular and solid inorganic compounds.

Know some of the main properties of inorganic solids and relate them to structural aspects

Know the techniques of structural determination for the study of inorganic solids and their surfaces.

Know the most important aspects about the structures of ideal and real inorganic solids.

Know the most important theoretical fundamentals of the chemical bond in inorganic solids

Train the student for autonomous work and learning, as well as for personal initiative.

Train the student to search for information, its analysis, interpretation and use for practical purposes.

## 6. Units / Contents

**Unit 1: Introduction to inorganic solids. Solids stability. Solids preparation methods: solid state reactions, crystallization of melts, glasses and gels, vapor phase transport, modification of structures by ion exchange and interstitial reactions, hydrothermal and high pressure methods, electrochemical reduction methods. Methods of preparing thin sheets.**

**Unit 2: Crystal structures. Compact packing. Hole occupation and structural types. Internal coordinates of the unit cell. Condensed polyhedra. Miller indices.**

**Unit 3: Solids structural determination techniques. Thermal methods. X-ray diffraction. Electron microscopy.**

**Unit 4: The chemical bond in solids I. Ionic model. Ratio of radii and limitations. Partially covalent bonds. Mooser-Pearson graphs.**

**Unit 5: The chemical bond in solids II. Band theory. Bloch functions. Brillouin zones. Bands structure for conductors, insulators and semiconductors. Effect of temperature on electrical conduction.**

**Unit 6: Crystal defects. Point, line (dislocations), two-dimensional defects, grain defects. Not stoichiometry. Solid solutions: substitutional, interstitial and complex.**

**Unit 7: LABORATORY WORK. Preparation of a silicone. Preparation of coloured glasses. Preparation of a type A zeolite. Preparation of magnetite and zinc ferrite.**

## 7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	E06 E07 G01 G03	1.16	29	N	-	
Class Attendance (practical) [ON-SITE]	Practical or hands-on activities	E03 E15 G03 T05	0.8	20	Y	Y	
Problem solving and/or case studies [ON-SITE]	Guided or supervised work	G02 G03 T10 T11	0.24	6	Y	N	
In-class Debates and forums [ON-SITE]	Group tutoring sessions	E06 E07 G01 G02 G03	0.08	2	N	-	
Writing of reports or projects [OFF-SITE]	Self-study	G03 T05 T07 T10 T11	2.48	62	Y	Y	
Study and Exam Preparation [OFF-SITE]	Self-study	E06 E07 E15 G01 G02 G03	1.12	28	N	-	
Final test [ON-SITE]	Self-study	E06 E07 E15 G01 G02 G03	0.08	2	Y	Y	
Progress test [ON-SITE]	Self-study	E06 E07 E15 G01 G02 G03	0.04	1	Y	N	
<b>Total:</b>			<b>6</b>	<b>150</b>			
<b>Total credits of in-class work: 2.4</b>			<b>Total class time hours: 60</b>				
<b>Total credits of out of class work: 3.6</b>			<b>Total hours of out of class work: 90</b>				

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

## 8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Progress Tests	10.00%	0.00%	It will be evaluated (1) In the selection of materials for the preparation of a written seminar: originality and adaptation to the topic, leadership capacity, ability to work in groups, adaptation of the seminar to the time of exposition. (2) In the elaboration of a written work in which the answers to the proposed seminar are included: adequate answer to the questions of the seminar, editorial adequacy that makes this work understandable for the study of the seminar, leadership capacity, ability to team work. (3) In the class presentation of the seminar: adaptation of the computer media, clarity of the presentation, interaction with the audience, making the seminar participatory.
Final test	35.00%	80.00%	There will be a written exam of the second half of the subject. Students who have not passed the progress test must attend a written exam of the entire course. For these students the assessment of the final test will be 70%. It is necessary to achieve a grade of 4 in each of the two halves of the subject to average with the rest of the activities.
Mid-term tests	35.00%	0.00%	If in these tests a grade greater than or equal to 4 (out of 10) is reached, it will be possible to average out with other grades

Laboratory sessions	20.00%	20.00%	Experimental work in the laboratory will be evaluated: attitude, scripts, skill and a practical exam after the face-to-face sessions. A grade of 4 must be reached to average out with other grades.
<b>Total:</b>	<b>100.00%</b>	<b>100.00%</b>	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences).

#### Evaluation criteria for the final exam:

##### Continuous assessment:

See previous table

##### Non-continuous evaluation:

The student must carry out the practical laboratory activities in person. Their performance in the laboratory will be evaluated, as well as a written practical exam. The student must pass this part of the course, which is 20% of the grade. The exam corresponding to the theoretical part represents 80% of the final grade.

#### Specifications for the resit/retake exam:

In this call, the grade acquired in those tests that have passed 5 (out of 10) during the same academic year will be kept. The qualification of the practical sessions will be kept for the time indicated by the regulations if they have been passed (minimum 4)

9. Assignments, course calendar and important dates	
Not related to the syllabus/contents	
Hours	hours
<b>Unit 1 (de 7): Introduction to inorganic solids. Solids stability. Solids preparation methods: solid state reactions, crystallization of melts, glasses and gels, vapor phase transport, modification of structures by ion exchange and interstitial reactions, hydrothermal and high pressure methods, electrochemical reduction methods. Methods of preparing thin sheets.</b>	
<b>Activities</b>	<b>Hours</b>
Class Attendance (theory) [PRESENCIAL][Lectures]	5
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.3
Writing of reports or projects [AUTÓNOMA][Self-study]	8.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	4.5
Final test [PRESENCIAL][Self-study]	.3
Progress test [PRESENCIAL][Self-study]	.14
<b>Unit 2 (de 7): Crystal structures. Compact packing. Hole occupation and structural types. Internal coordinates of the unit cell. Condensed polyhedra. Miller indices.</b>	
<b>Activities</b>	<b>Hours</b>
Class Attendance (theory) [PRESENCIAL][Lectures]	5
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.3
Writing of reports or projects [AUTÓNOMA][Self-study]	8.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	4.1
Final test [PRESENCIAL][Self-study]	.3
Progress test [PRESENCIAL][Self-study]	.16
<b>Unit 3 (de 7): Solids structural determination techniques. Thermal methods. X-ray diffraction. Electron microscopy.</b>	
<b>Activities</b>	<b>Hours</b>
Class Attendance (theory) [PRESENCIAL][Lectures]	7
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.3
Writing of reports or projects [AUTÓNOMA][Self-study]	9.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	4.1
Final test [PRESENCIAL][Self-study]	.3
Progress test [PRESENCIAL][Self-study]	.16
<b>Unit 4 (de 7): The chemical bond in solids I. Ionic model. Ratio of radii and limitations. Partially covalent bonds. Mooser-Pearson graphs.</b>	
<b>Activities</b>	<b>Hours</b>
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.3
Writing of reports or projects [AUTÓNOMA][Self-study]	8.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	4.1
Final test [PRESENCIAL][Self-study]	.3
Progress test [PRESENCIAL][Self-study]	.16
<b>Unit 5 (de 7): The chemical bond in solids II. Band theory. Bloch functions. Brillouin zones. Bands structure for conductors, insulators and semiconductors. Effect of temperature on electrical conduction.</b>	
<b>Activities</b>	<b>Hours</b>
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.3
Writing of reports or projects [AUTÓNOMA][Self-study]	8.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	4.1
Final test [PRESENCIAL][Self-study]	.3
Progress test [PRESENCIAL][Self-study]	.16

Unit 6 (de 7): Crystal defects. Point, line (dislocations), two-dimensional defects, grain defects. Not stoichiometry. Solid solutions: substitutional, interstitial and complex.	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	5
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.3
Writing of reports or projects [AUTÓNOMA][Self-study]	8.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	4.1
Final test [PRESENCIAL][Self-study]	.3
Progress test [PRESENCIAL][Self-study]	.16
Unit 7 (de 7): LABORATORY WORK. Preparation of a silicone. Preparation of coloured glasses. Preparation of a type A zeolite. Preparation of magnetite and zinc ferrite.	
Activities	Hours
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	20
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	.2
Writing of reports or projects [AUTÓNOMA][Self-study]	10
Study and Exam Preparation [AUTÓNOMA][Self-study]	3
Final test [PRESENCIAL][Self-study]	.2
Progress test [PRESENCIAL][Self-study]	.06
Global activity	
Activities	hours
In-class Debates and forums [PRESENCIAL][Group tutoring sessions]	2
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	20
Writing of reports or projects [AUTÓNOMA][Self-study]	62
Class Attendance (theory) [PRESENCIAL][Lectures]	29
Progress test [PRESENCIAL][Self-study]	1
Final test [PRESENCIAL][Self-study]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	6
Study and Exam Preparation [AUTÓNOMA][Self-study]	28
<b>Total horas: 150</b>	

10. Bibliography and Sources						
Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Rankin, David W. H.	Structural Methods in Inorganic Chemistry <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Blackwell Scientific	Oxford	0-632-02963-3	1994	Libro de consulta específico
Rao, C.N.R.	New directions in solid state chemistry <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Cambridge University Press	Cambridge	0-521-49907-0	2004	Libro de consulta general
Cotton, Frank Albert	Química Inorgánica Avanzada <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Limusa, cop.	Mexico	968-18-1795-8	1995	Libro de consulta específico
A. K.Cheetham and Peter Day	Solid State Chemistry: techniques <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Oxford Science publications	Oxford	0-19-855286-6	2001	libro de consulta específico
Müller, Ulrich	Inorganic Structural Chemistry <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	John Wiley & Sons	New York	0-471-93717-7	1992	Libro de consulta específico
West, A. R.	Basic Solid State Chemistry <a href="http://biblioteca.uclm.es/">http://biblioteca.uclm.es/</a>	John Wiley and Sons	New York	0-471-98755-7	1999	Libro de consulta importante
Smith, William F	Fundamentos de la ciencia e ingeniería de materiales <a href="http://biblioteca.uclm.es/">http://biblioteca.uclm.es/</a>	McGraw-Hill Interamerican	Madrid	978-607-15-1152-2	2010	Libro de consulta importante
Wells, A. F	Química Inorgánica Estructural <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Reverté	Barcelona	84-291-7524-5	1978	Libro de consulta general
Smart, Lesley	Solid State Chemistry <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Taylor & Francis	New York	0-7487-7516-1	2005	libro de consulta importante
West, A. R.	Solid State Chemistry <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	John Wiley and Sons	New York	0-471-90874-6		Libro de consulta importante
Dwight, Kirby	Solid State Chemistry : synthesis, structure, and properties of selected oxides and sulfides	Chapman & Hall	New York	0-412-03611-5	1993	Libro de consulta general
West, Anthony R.	Solid State Chemistry and its applications <a href="https://catalogobiblioteca.uclm.es/cgi-bin/abnetopac/O7682/IDbed4c285/NT1">https://catalogobiblioteca.uclm.es/cgi-bin/abnetopac/O7682/IDbed4c285/NT1</a>	John Wiley and Sons	Chichester	978-1-119-94294-8	2014	Libro de consulta importante
A. K.Cheetham and Peter Day	Solid State Chemistry <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Clarendon Press Oxford  Longman		0-19-855166-5	2001	Libro de consulta específico

DUFFY, J. A.	Bonding, energy levels and bands in inorganic solids <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Scientific & Technical	Essex	0-582-03495-7	1990	Libro de consulta específico
Greenwood, N. N.	Chemistry of the elements <a href="http://biblioteca.uclm.es">http://biblioteca.uclm.es</a>	Butterworth-Heinemann	Amsterdam	978-0-7506-3365-9	2008	Libro de consulta general