Teaching Guide				
Identifying Data				2020/21
Subject (*)	Molecular Materials		Code	610509123
Study programme	Mestrado Universitario en Investigación Química e Química Industrial (Plan 2020)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	Yearly	First	Optional	3
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Departamento profesorado másterQuímica			
Coordinador	Pazos Chantrero, Elena	E-mail	elena.pazos@udc.es	
Lecturers	Pazos Chantrero, Elena	E-mail	elena.pazos@udc.es	
Web	www.usc.es/gl/centros/quimica/curso/master.html			
General description	The subject completes the module Nanochemistry and new materials from the molecular point of view. It also provides panoramic views of the most important applications of these materials			
Contingency plan	1. Modifications to the contents 2. Methodologies *Teaching methodologies that are maintained *Teaching methodologies that are modified 3. Mechanisms for personalized attention to students 4. Modifications in the evaluation *Evaluation observations: 5. Modifications to the bibliography or webgraphy			

Study programme competences / results	
Code	Study programme competences / results
A1	Define concepts, principles, theories and specialized facts of different areas of chemistry.
A3	Innovate in the methods of synthesis and chemical analysis related to the different areas of chemistry
A4	Apply materials and biomolecules in innovative fields of industry and chemical engineering.
B1	Possess knowledge and understanding to provide a basis or opportunity for originality in developing and / or applying ideas, often within a research context
B4	Students should be able to communicate their conclusions, and the knowledge and the reasons that support them to specialists and non-specialists in a clear and unambiguous manner
B5	Students must possess learning skills to allow them to continue studying in a way that will have to be largely self-directed or autonomous.
B7	Identify information from scientific literature by using appropriate channels and integrate such information to raise and contextualize a research topic
B10	Use of scientific terminology in English to explain the experimental results in the context of the chemical profession
B11	Apply correctly the new technologies to gather and organize the information to solve problems in the professional activity.
B12	Being able to work in a team and adapt to multidisciplinary teams.
C1	CT1 - Elaborar, escribir e defender publicamente informes de carácter científico e técnico
C3	CT3 - Traballar con autonomía e eficiencia na práctica diaria da investigación ou da actividade profesional.
C4	CT4 - Apreciar o valor da calidade e mellora continua, actuando con rigor, responsabilidade e ética profesional.

Learning outcomes			
Learning outcomes	Study programme competences / results		
The students will understand how the molecular properties and the supramolecular interactions determine the properties of molecular materials	AC1 AC3 AC4	BC1 BC4 BC5 BC7 BC10 BC11 BC12	CC1
The students will know the main types of molecular materials (liquid crystals, semiconductors, etc.) as well as their characteristics	AC1 AC3 AC4	BC1 BC4 BC5 BC7 BC10 BC11 BC12	CC3
The students will know the techniques used to study molecular materials (polarization optical microscopy, differential scanning calorimetry, etc.)	AC4	BC1 BC5 BC7 BC10 BC11 BC12	
The students will have an overview of the important applications of molecular materials, such as screens, field effect transistors (FETs), light emitting diodes (LEDs), solar cells, sensors and molecular machines	AC1 AC3 AC4	BC1 BC4 BC5 BC7 BC10 BC11	CC4
The students will know the main specific characteristics of molecular materials	AC1 AC3 AC4	BC1 BC4 BC5 BC7 BC10 BC12	

Contents	
Topic	Sub-topic
UNIT 1. Molecular materials	Basic concepts
UNIT 2. Molecular structures of main molecular materials.	Conjugated polymers: polyacetylenes, polyphenylenevinylenes, polythiophenes -structure, properties and synthesis Polycyclic aromatic compounds: -2D: acenes, nanographenes, graphene --structure, properties and synthesis -3D: fullerenes, carbon nanotubes --structure, properties and synthesis Other compounds: polyamines, heterocyclic compounds, metal complexes - structure, properties and synthesis

UNIT 3. Types of molecular materials: liquid crystals, semiconductors, optoelectronic materials, molecular magnets	Liquid crystals - basic concepts -classification: calamitic, discotic -characterization methods: optical polarization microscopy, DSC, X-rays -representative structures -optical and electrical properties, interaction with surfaces Semiconductors and molecular electronics - basic concepts (intrinsic conductivity and doping, band models and hopping, polarons and solitons) - methods of characterization -representative structures Optoelectronic materials - basic concepts (excitons, quantum dots) -representative structures Molecular magnets
UNIT 4. Devices and applications.	Displays and liquid crystal displays. Smart windows. Field effect transistors (FETs) Light emitting diodes (LEDs) -lighting -screens Solar cells Gears and molecular machines Sensors

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B1 B4 B5 C3 C4	12	34	46
Seminar	B4 B7 B10 B11 B12	7	7	14
Oral presentation	B4 B7 B10 B11 B12 C1	2	9	11
Mixed objective/subjective test	A1 A4 A3 B1 B4 B5	2	0	2
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Expositive classes (use of blackboard, computer, projector), complemented with the tools of virtual teaching
Seminar	- Seminars carried out by the Master's teaching staff, or with professional guests from companies, administration or other universities. Interactive sessions related with the different subjects, discussions and exchange of opinions with the students. - Resolution of practical exercises (problems, information interpretation and processing, evaluation of scientific publications, etc.).
Oral presentation	The oral presentation will be prepared individually on a topic related to the theoretical contents of the subject
Mixed objective/subjective test	A final exam will be programmed, which will allow to assess objectively the degree of assimilation and the ability to apply the contents of the subject by the student

Personalized attention	
Methodologies	Description

Seminar	The proposed teaching methodology is based on student work, which thus becomes the main protagonist of the teaching-learning process. In order for the student to obtain optimum performance of his effort, it is important that there is a continuous and close student-teacher interaction, so that the latter can guide the student in this process. This interaction will be given in a special way in the workshops and problem-solving sessions. Through the student-teacher interaction, as well as the different assessment activities, it will be determined to what extent the students achieved the competency objectives established in each thematic unit, and will help to identify the students who need personalized attention through individualized tutorships. Therefore, periodically the teaching staff may organize tutorships, which will be held in the most suitable hours for each student, with the intention of receiving the necessary guidance. Regardless of the tutorships proposed by the teaching staff, the student can attend the tutorships at his own request, as many times as desired, and at the time that is most convenient.

Assessment			
Methodologies	Competencies / Results	Description	**Qualification**
Mixed objective/subjective test	A1 A4 A3 B1 B4 B5	In order to evaluate the acquisition of knowledge and competencies a final test will be carried out (according to the calendar established in the Center). This test will consist in problems and questions related with the contents of the subject, analogous to the ones done during the course sessions	60
Guest lecture / keynote speech	B1 B4 B5 C3 C4	The participation of the student will be assessed in the keynote sessions, through questions asked by the teacher or through discussions with the classmates.	10
Oral presentation	B4 B7 B10 B11 B12 C1	The students will present orally, during the course, one or several of the results obtained within the activities carried out in the seminars	10
Seminar	B4 B7 B10 B11 B12	Within the seminars a series of evaluable activities will be organized: Problems resolution and practical cases (10%) Written report preparation (10%)	20

Assessment comments

The student must review the theoretical concepts introduced in the different topics using the support material provided by the teaching staff and the recommended bibliography for each topic. Those students who encounter important difficulties when working on the proposed activities should consult the teacher, with the objective of being able to analyze the problem and help solve these difficulties. Attendance to all the evaluable activities is necessary to pass the subject. The absences associated with any of the face-to-face activities (seminars, oral presentations, seminars) must be justified, accepting only the reasons contemplated in current university regulations. To pass the subject it will be necessary to obtain an average mark in all the evaluable activities of 5 out of 10. The students who participate in a number of evaluable activities not exceeding 15% will obtain the qualification Not Presented. Regarding the second opportunity of evaluation, the qualification of the exam of July will replace that one obtained in the exam of June. The qualification corresponding to the other evaluable activities may be retained in the July opportunity or, alternatively, as a final part of the July exam, the students will be able to carry out a free exercise, with activities similar to those developed in the seminars during the course. The students assessed in the second opportunity can only opt for the qualification "with honors" if the maximum number of these for the corresponding course has not been fully covered in the first opportunity. Regarding successive academic courses, the teaching-learning process, including assessment, refers to an academic course, and therefore would start with a new course, including all activities and assessment procedures that are scheduled for the course.

Sources of information

Basic	Básica (manuais de referencia).? Molecular Electronics: From Principles to Practice. M. C. Petty, John Wiley & Sons, 2007Complementaria.? Dekker Encyclopedia of Nanoscience and Nanotechnology. J. A. Schwarz, C. I. Contescu, Karol Putyera (eds.). New York: Marcel Dekker, 2004? Handbook of Conducting Polymers. T. A. Skotheim, J. R. Reynolds (eds), 3rd ed., Boca Raton: CRC Press, 2007.? http://61.188.205.38:8081/hxgcx/polymer/UploadFiles/swf/???/Handbook%20of%20Conducting%20Polymers,%20Third%20Edition%20-%202%20Volume%20Set.pdf? Organic Optoelectronic Materials. Y. Li (ed), Springer, 2015? Organic Photovoltaics: Materials, Device Physics, and Manufacturing Technologies. C. Brabec, U. Scherf, V. Dyakonov, (eds), 2nd ed., Weinheim: Wiley-VCH, 2014? Organic Photovoltaics: Mechanism, Materials, And Devices. S.-S. Sun, N. S. Sariciftci, (eds.) Boca Raton: Taylor & Francis, cop. 2005? Light-Emitting Diodes. E. F. Schubert, Cambridge: Cambridge University Press, 2003? Chemical Sensors and Biosensors: Fundamentals and Applications. F.-G. B?nic?. Chichester: John Wiley, 2012? Introduction to Liquid Crystals Chemistry and Physics. P. J. Collings, London: Taylor & Francis, 2001? Liquid Crystals: Experimental Study of Physical Properties and Phase Transitions. S. Kumar, Cambridge: Cambridge University Press, 2001? Liquid Crystals. S. Chandrasekhar, Cambridge: Cambridge University Press, 1992
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Advanced Materials Characterization Techniques/610509121 Material Properties/610509122
Subjects that continue the syllabus
Other comments
It is mandatory to have previously studied the subjects of the Compulsory Advanced Formation module and it is advisable to take the remaining subjects of the Nanochemistry and New Materials module