Teaching Guide				
Identifying Data				2023/24
Subject (*)	Synthesis and Preparation of Nanomaterials		Code	610G04020
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Second	Obligatory	6
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Química			
Coordinador	Castro Garcia, Socorro	E-mail	socorro.castro.garcia@udc.es	
Lecturers	Bermúdez García, Juan Manuel Castro Garcia, Socorro Mosquera Mosquera, Jesús Sanchez Andujar, Manuel	E-mail	j.bermudez@udc.es socorro.castro.garcia@udc.es j.mosquera1@udc.es m.andujar@udc.es	
Web	https://campusvirtual.udc.gal/login/index.php			
General description	DESCRIPTION: Understanding of the fundamental synthetic strategies for the preparation of nanomaterials and the use of some basic techniques for their characterization. CONTEXTUALIZATION: The subject is framed in the fourth semester of the Degree in Nanoscience and Nanotechnology, when subjects that provide basic knowledge on structure and bonding, chemical equilibrium, chemistry of the elements, crystallography, basic laboratory techniques and X-ray diffraction (among others), which serve as a basis for this subject, have already been taken. In turn, this subject serves as a basis for further study of the characterization, reactivity and study of the properties and applications of nanomaterials in subsequent courses.			

Study programme competences	
Code	Study programme competences
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
A6	CE6 - Manipular instrumentación y material propios de laboratorios para ensayos físicos, químicos y biológicos en el estudio y análisis de fenómenos en la nanoescala.
A8	CE8 - Aplicar las normas generales de seguridad y funcionamiento de un laboratorio y las normativas específicas para la manipulación de la instrumentación y de los productos y nanomateriales.
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.
B10	CG5 - Trabajar de forma colaborativa.
C3	CT3 - Utilizar las herramientas básicas de las tecnologías de la información y las comunicaciones (TIC) necesarias para el ejercicio de su profesión y para el aprendizaje a lo largo de su vida
C6	CT6 - Adquirir habilidades para la vida y hábitos, rutinas y estilos de vida saludables
C7	CT7 - Desarrollar la capacidad de trabajar en equipos interdisciplinares o transdisciplinares, para ofrecer propuestas que contribuyan a un desarrollo sostenible ambiental, económico, político y social.

C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad
C9	CT9 - Tener la capacidad de gestionar tiempos y recursos: desarrollar planes, priorizar actividades, identificar las críticas, establecer plazos y cumplirlos

Learning outcomes			
Learning outcomes	Study programme competences		
To learn the different types of materials and the basic strategies for their synthesis.	A3	B3 B5 B8	C3 C8
To learn the aspects of the physical laws that predominate in the behavior of systems of nanometric dimensions.	A3 A5	B3 B5 B8	C3 C8
Plan, design and develop methods for the synthesis of nanoparticles and nanomaterials, depending on the desired properties.	A4 A6 A8	B8 B9 B10	C6 C7 C9
Collect and analyze problems associated to the synthesis of nanomaterials and propose strategies to solve them.	A5	B8 B9 B10	C3 C6 C7 C9
To understand the need to use a controlled environment laboratory (clean room).	A6 A8	B5	C6

Contents	
Topic	Sub-topic
Classification of materials.	Classification of materials.
Synthesis techniques and preparation of nanomaterials	Fundamentals of nanomaterials synthesis by top-down and bottom-up techniques. General aspects: nucleation and growth; stability. Use of controlled environment laboratories (clean room). Main methods of synthesis of nanoparticles, carbon nanostructures, nanostructured surfaces, mesoporous materials, others.
Basic characterization of nanomaterials	X-ray diffraction of crystalline powder. Thermal methods (thermogravimetric and thermodifferential analysis). Electron microscopy (transmission and scanning).
Measurement of particle size and Z-potential	Fundamentals of Dynamic Light Scattering (DLS) technique. Fundamentals of Zeta Potential measurement.
PREPARATION AND CHARACTERIZATION OF VARIOUS NANOMATERIALS	Selection of the synthesis method, based on the characteristics of the material to be prepared. Selection of the conditions and materials necessary for the synthesis (reagents, previous calculations, material, assemblies...). Evaluation of the risks associated with the experiment and their prevention. Experimental procedure of synthesis. Selection and/or handling of basic instrumental techniques for its characterization. Interpretation of the results of the characterization. Elaboration of the laboratory notebook. Elaboration and presentation of the final report.

Planning

Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Introductory activities	A3 C6 C8	1	0	1
Guest lecture / keynote speech	A3 A5 B5 B8 C6 C8	10	22	32
Laboratory practice	A3 A4 A5 A6 A8 B3 B8 B9 B10 C7 C9	44	5	49
Supervised projects	A3 A5 B3 B5 B8 B9 C3 C8	1	35	36
Summary	B3 B8 B9 C3	0	20	20
Oral presentation	B3 B5 B8 B9 B10 C3 C7 C9	2	8	10
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
Introductory activities	Presentation of the subject: methodology to follow and contextualization in the Degree in Nanoscience and Nanotechnology.
Guest lecture / keynote speech	Sessions previous to the laboratory practices. They serve to introduce the basic notions necessary for the understanding of the synthesis and characterization strategies that will be carried out in the laboratory. They consist of oral and interactive presentations by teachers, with a continuous exchange of ideas between teachers and students. They cover the first four topics of the section "Contents".
Laboratory practice	They cover the first four topics of the section "Contents". Individual laboratory work of synthesis and characterization of several nanomaterials (between 2 and 4), under the supervision of the teachers. It covers the last topic of the "Contents" section.
Supervised projects	Before the laboratory work. Individual and directed preparation, by means of bibliographic review, of the work to be done in the laboratory.
Summary	After the laboratory work. Laboratory notebook and brief report of each of the practices. They will be handed in individually at the end of the practicals and they will be corrected and evaluated.
Oral presentation	After the laboratory work. Group session in which the work done in the laboratory practices will be presented individually and discussed in group.

Personalized attention	
Methodologies	Description
Supervised projects	The LABORATORY PRACTICES phase includes several sessions of personalized attention: (i) Session to GUIDE in the preparation of the experimental work (at the request of each student, if needed, and with the necessary duration, according to each case). ii) Mandatory session, immediately prior to the beginning of the laboratory practices, to EVALUATE the degree of understanding by each student of the experimental work to be carried out (a minimum level must be reached in order to begin the experimental work). iii) Compulsory session, at the end of the laboratory practices, to EVALUATE the work done and to GUIDE on the possible deficiencies in the training achieved.

Assessment			
Methodologies	Competencies	Description	**Qualification**

Laboratory practice	A3 A4 A5 A6 A8 B3 B8 B9 B10 C7 C9	The evaluation of the EXPERIMENTAL PART of the course represents 100% of the final grade. It includes the following methodologies: LABORATORY PRACTICES: The experimental work: planning, organization, skill, safety and results of the synthesis and characterization. Evaluated during the laboratory sessions. SUPERVISED PROJECTS: The degree of previous preparation of the practices and the interpretation of the results and conclusions drawn from them. Evaluated through personal interviews. ORAL PRESENTATION: The oral presentation, in a group session in which the work done in the laboratory practicals will be presented individually and discussed in group. SUMMARY: Laboratory notebook and reports of each of the practices.	20
Oral presentation	B3 B5 B8 B9 B10 C3 C7 C9	(See description in LABORATORY PRACTICE)	15
Supervised projects	A3 A5 B3 B5 B8 B9 C3 C8	(See description in LABORATORY PRACTICE)	35
Summary	B3 B8 B9 C3	(See description in LABORATORY PRACTICE)	30

Assessment comments

Attendance at all face-to-face activities is mandatory.
FIRST OPPORTUNITY:
The maximum score is 10 points.
A minimum of 5 points (total) is required to pass the subject.
A minimum of 4 out of 10 points is required in each of the evaluable parts to pass the subject (if this minimum is not reached in any of the parts, the overall grade will be "suspense", with the numerical score achieved, up to a maximum of 4.5).
If it is reached to start the classroom work of laboratory practices, the evaluation process is considered to have begun and the grade may not be "not presented".
SECOND OPPORTUNITY:
The maximum score is 10 points.
A minimum of 5 points (total) is required to pass the course.
A MIXED TEST (which computes a maximum of 2.5 points out of 10), and a PRACTICAL LAB TEST (which computes a maximum of 7.5 points out of 10).
If you obtained a minimum of 4 points in the first opportunity, you are exempted from taking the PRACTICAL LAB TEST in the second opportunity.
It is necessary to have taken the "Laboratory Practicals" during the course in order to make up the PRACTICAL LAB TEST at the second opportunity.
The PRACTICAL LAB TEST consists of the preparation and execution of a laboratory practice, following the same criteria detailed in the "Methodology" section, but the previous preparation will not be tutored. If the previous preparation is done inadequately, the grade will be "fail" before starting the experimental work.
The student will only be eligible for the "Matrícula de Honor" in the second opportunity if the maximum number of MH for the corresponding course has not been exhausted in the first opportunity.
IN SUCCESSIVE ACADEMIC YEARS:
The teaching-learning process (including evaluation) refers to an academic year and, therefore, starts again with a new academic year, including all the activities and evaluation procedures that are scheduled for the new course.
RECOGNITION OF PART-TIME DEDICATION and ACADEMIC DISPENSATION OF ATTENDANCE EXEMPTION: For both the first and second opportunities, for students in this situation:
The EXPERIMENTAL PART (Lab Practicals, Tutored Work, Resume and Oral Presentation) is mandatory, and computes as for full-time students. They are exempted from attending the "expository teaching" classes.
IMPORTANT: "The fraudulent performance of the tests and/or activities will directly imply the grade of failure ("0") of the subject in the corresponding call, being without effect the grade obtained in all the activities for the next opportunity, if any, within the same academic year." " (Artículo 35.1 del Estatuto del Estudiante de la UDC, Ley 3/2022, de 24 de febrero, de convivencia universitaria y del régimen disciplinario de los estudiantes de la UDC)).

Sources of information	
Basic	- Guozhong Cao, Ying Wang (2004). Nanostructures and Nanomaterials: Synthesis, Properties and Applications. Singapore: World Scientific - Geoffrey Ozin, Andre Arsenault, Ludovico Cademartiri (2008). Nanochemistry: A Chemical Approach to Nanomaterials.. London: Royal Society of Chemistry - Dieter Vollath (2013). Nanomaterials: an introduction to synthesis, properties and applications. Berlin: Wiley.VCH (As mesmas para tódolos idiomas)(The same for all languages)
Complementary	- Anthony R. West (2014). Solid State Chemistry and its Applications. Berlin: Wiley.VCH - C.N.R. Rao (1997). New Directions in Solid State Chemistry. Cambrdge: Cambridge University Press - Ulrich Schubert, Nicola Hüsing (2004). Synthesis of inorganic materials. Berlin: Springer-Verlag - K.T. Ramesh (2009). Nanomaterials: Mechanics and Mechanisms. Berlin: Springer-Verlag - S. K. Kulkarni (2015). Nanotechnology: principles and practices. Berlin: Springer (As mesmas para tódolos idiomas)(The same for all languages)

Recommendations
Subjects that it is recommended to have taken before
Instrumental Analysis/610G04014
Chemistry of the Elements/610G04011
Chemistry: Equilibrium and Change/610G04008
Chemistry: Structure and Bonding/610G04005
Crystallography and Symmetry/610G04006
Integrated Basic Laboratory/610G04004
Subjects that are recommended to be taken simultaneously
Thermodynamics: Equilibrium and Phases/610G04018
Spectroscopy/610G04017
Subjects that continue the syllabus
Techniques of Characterisation of Nanomaterials 2/610G04030
Techniques of Characterisation of Nanomaterials 1/610G04025
Supramolecular Chemistry/610G04027
Polymers/610G04028
Surface Science/610G04021
Solid State/610G04022
Other comments
In order to guarantee safety conditions in the laboratory, a "laboratory notebook" in physical format should be used during the laboratory sessions. However, the final report can be delivered in digital format.