Teaching Guide				
Identifying Data				2022/23
Subject (*)	Polymers in Sustainable Energy Development		Code	730547014
Study programme	Máster Universitario en Eficiencia Enerxética e Sustentabilidade			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Optional	3
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Física e Ciencias da TerraQuímica			
Coordinador	Abad López, María José	E-mail	maria.jose.abad@udc.es	
Lecturers	Abad López, María José Ares Pernas, Ana Isabel González Rodríguez, María Victoria	E-mail	maria.jose.abad@udc.es ana.ares@udc.es victoria.gonzalez.rodriguez@udc.es	
Web				
General description	Provide basic knowledge and discuss the role that conductive polymers as active materials in devices capable of producing, storing or saving clean energy can play.			

Study programme competences	
Code	Study programme competences
A9	CE9 - Make decisions in a technological environment where materials are used in efficiency applications
B9	CG4 - Extract, interpret and process information, from different sources, for use in the study and analysis
B14	CG9 - Apply knowledge of advanced sciences and technologies to professional or research practice of efficiency
B16	CG11 - Evaluate the application of emerging technologies in the field of energy and the environment
C1	CT1 - Express themselves correctly, both orally and in writing, in the official languages of the autonomous community
C4	CT4 - Develop for the exercise of a respectful citizenship with the democratic culture, human rights and the gender perspective
C8	CT8 - Value the importance of research, innovation and technological development in the socioeconomic and cultural progress of society

Learning outcomes			
Learning outcomes	Study programme competences		
Learning of the fundamental concepts of conductive polymeric materials, highlighting the integration with the other subjects that make up the master		BC16	CC8
Familiarize yourself with a technological environment where the concepts of conductive polymers are oriented towards energy efficiency and sustainable development	AC9	BC14 BC16	CC8
Get used to the use of various written and electronic sources of information (databases, specialized technical and scientific magazines) valuing the importance of good documentation in the approaches of any type of project or study	AC9	BC9 BC14	CC1 CC4 CC8

Contents	
Topic	Sub-topic
1. Introduction to conductive polymers	1.1 . Polymers and environment 1.2 . Intrinsically conducting polymers 1.3 . Conducting polymer composites
2. Polymers in harvesting energy	2.1 . Harvesting energy concept 2.2 . Polymers in thermoelectricity 2.3 . Polymers in piezoelectricity

3. Conducting polymers in light emitting diodes and solar cells	3.1. Basis 3.2. Devices 3.3. Applications
4. Conducting polymers in electrochromic devices	3.1. Basis 3.2. Devices 3.3. Applications
5. Conducting polymers in batteries	5.1. Basis 5.2. Devices 5.3. Applications

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B9 B14 B16	9	0	9
Laboratory practice	A9 B14 B16 C4	12	1	13
Multiple-choice questions	B9 B16	0	4	4
Supervised projects	C1 C4 C8	1	47	48
Personalized attention		1	0	1
(*)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	Oral presentation supported by audiovisual media with the inclusion of some questions for students, to provide knowledge and to facilitate learning.
Laboratory practice	This methodology allows that students learn effectively doing practical activities, such as demonstrations, exercises, lab work and researches
Multiple-choice questions	After each class session, students will be able to take an online test on the subject they have seen, through the Moodle platform.
Supervised projects	Methodology is designed to promote autonomous learning of students in different environments (academic or more professional environment) under the guidance of a teacher. It refers mainly to learning "how to do things. In this option, students must assume the responsibility for their own learning.

Personalized attention	
Methodologies	Description
Laboratory practice Supervised projects	The students will do several sessions of lab work where they will work concepts related to the energy efficiency in conducting polymers. Each student must perform autonomously a work. The teacher will guide them by individual tutoring.

Assessment			
Methodologies	Competencies	Description	**Qualification**
Laboratory practice	A9 B14 B16 C4	Students will carry out several laboratory practices related to the energy efficiency of conducting polymers. Both the competences acquired in the laboratory and the practical report submitted will be assessed.	30
Supervised projects	C1 C4 C8	The student will carry out an individual work on a topic related to conducting polymers. It must be delivered and presented to the rest of the class. Both the written work submitted and its oral presentation will be assessed. A rubric will be used in the evaluation.	60

Multiple-choice questions	B9 B16	After each class session, students will be able to take an online test on the subject they have seen, through the Moodle platform. The test will count towards the final grade.	10

Assessment comments
Students who accumulate more than 20% of unjustified absences, who have not carried out all the laboratory practices (without justified cause) or who have not submitted the supervised work are excluded from the continuous evaluation process. They will be qualified as NOT ATTEND at the first opportunity. The fraudulent realization of the tests or evaluation activities, once verified, will directly imply the qualification of failure "0" in the subject in the corresponding call, thus invalidating any grade obtained in all the evaluation activities for the extraordinary call. Students with recognition of partial time dedication and academic exemption from attendance, must communicate it to the teachers at the beginning of the term and justify them adequately. In this case, teachers will be given appropriate instructions to ensure that the students follow the subject without problems, by replacing the classroom teching methodologies with other individual works with the same score REQUIREMENTS TO PASS THE SUBJECT AT THE FIRST OPPORTUNITY : 1.Attend and participate regularly in class activities. 2.Submit and present the supervised work on the date indicated.3. To do and submit all the laboratory practices on the indicated dates.3. Obtain a minimun total score of 5 out of 10. At the second opportunity (extraordinary call), the student will have to pass an objective test or exam (in classroom or online) that may have different types of questions (multiple choice, sorting, short answer, discrimination, completion and/or association). In addition, students will be asked to perform an additional work/laboratory practices. The rating will be 50% the objective test (exam), 30% the laboratory practices and 20% additional work/practices. REQUIREMENTS TO PASS THE SUBJECT AT THE SECOND OPPORTUNITY : 1.To pass the exam (minimum 50% of the maximum score) 2.To do and submit on time the additional work/practices 3. Obtain a minimun total score of 5 out of 10.

Sources of information	
Basic	- Hideki Shirakawa . The Discovery of Polyacetylene Film: The Dawning of an Era of Conducting Polymers. Angew. Chem. Int. Ed. 2001, 40, 2574 - 2580- Alan G. MacDiarmid . Synthetic Metals: A Novel Role for Organic Polymers. Angew. Chem. Int. Ed. 2001, 40, 2581 - 2590- Alan J. Heeger. Semiconducting and Metallic Polymers: The Fourth Generation of Polymeric Materials. Angew. Chem. Int. Ed. 2001, 40, 2591 - 2611- Olga Bubnova and Xavier Crispin. Towards polymer-based organic thermoelectric generators. Energy & Environmental Science 2012, 5, 9345-9362- Javier Padilla Martínez; Rafael Garcia Valverde; Antonio Jesús Fernández Romero y Antonio Urbina Yer. Polímeros conductores. Su papel en un desarrollo energético sostenible. Editorial Reverté- Sambhu Bhadraa; Dipak Khastgir; Nikhil K. Singhaa and Joong Hee Lee. Progress in preparation, processing and applications of polyaniline. Progress in Polymer Science 34 (2009) 783?810- Yong Dua, Shirley Z. Shenb, Kefeng Caia, Philip S. Casey. Research progress on polymer inorganic thermoelectric nanocomposite materials. Progress in Polymer Science 37 (2012) 820- 841- Petr Novák; Klaus Müller; K. S. V. Santhanam and Otto Haas . Electrochemically Active Polymers for Rechargeable Batteries. Chem. Rev. 1997, 97, 207-281- Pierre M. Beaujuge and John R. Reynolds (). Color Control in ?-Conjugated Organic Polymers for Use in Electrochromic Devices. Chem. Rev. 2010, 110, 268?320- Yasuhiko Shirota and Hiroshi Kageyama (). Charge Carrier Transporting Molecular Materials and Their Applications in Devices. Chem. Rev. 2007, 107, 953-1010- K. Walzer, B. Maennig, M. Pfeiffer, and K. Leo. Highly Efficient Organic Devices Based on Electrically Doped Transport Layers. Chem. Rev. 2007, 107, 1233-1271
Complementary	

Recommendations

Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
Recommendations Sustainability Environment and Gender Equality:1. The delivery of the documentary work (tutored work) to be carried out in this subject will be done in the following way: 1.1 It will be delivered in virtual format and/or computer support. 1.2. In the case of having to print something on paper (for example, posters, leaflets, etc...), the printing will be done on recycled paper and double-sided. No drafts shall be printed, only the final version. 2. A sustainable use of resources must be made and in order to prevent negative impacts on the natural environment, it will be encouraged that the materials that are discarded in the subject (paper, plastics), are thrown away in the respective containers provided in the centres where the subject is taught or in the street for that purpose. 3. We will try to transmit to students the importance of ethical principles related to the values of sustainability so that they apply them, not only in the classroom, but also in their personal and professional behaviour. 4. According to the different regulations applicable to university teaching, the gender perspective must be incorporated into this subject (non-sexist language will be used, bibliography of authors of both sexes will be used, the intervention of male and female students in class will be encouraged, etc.). 5.Work will be done to identify and modify sexist prejudices and attitudes, and the environment will be influenced in order to promote values of respect and equality. 6.Situations of gender discrimination will be detected and actions and measures will be proposed to correct them. 7. The full integration of students who, for physical, sensory, mental or socio-cultural reasons, experience difficulties in gaining suitable, equal and beneficial access to university life shall be facilitated.