UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2022/23
Subject (*)	Polymers in Sustainable Energy Development		Code	770523015
Study programme	Mestrado Universitario en Eficiencia e Aproveitamento Enerxético			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Optional	3
Language	SpanishGalicianEnglish			
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	E-mail	maria.jose.abad@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
A12	Capacidad para la toma de decisiones en un entorno tecnológico donde los materiales se utilicen en aplicaciones de eficiencia
B1	Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
B3	Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
B9	Extraer, interpretar y procesar información, procedente de diferentes fuentes, para su empleo en el estudio y análisis.
B14	Aplicar conocimientos de ciencias y tecnologías avanzadas a la práctica profesional o investigadora de la eficiencia
B16	Valorar la aplicación de tecnologías emergentes en el ámbito de la energía y el medio ambiente.
C1	Adquirir la terminología y nomenclatura científico-técnica para exponer argumentos y fundamentar conclusiones.
C4	Desarrollar el pensamiento crítico

Learning outcomes			
Learning outcomes	Study programme competences		
Capacity for decision -making in a technological environment where materials are used in applications efficiency	AJ12		
That the students can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study .		BC1	
Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas , often in a research context .		BC3	
Extract , interpret and process information from different sources , for use in the study and analysis .		BC9	
Apply knowledge of science and advanced technologies to professional practice or research efficiency		BC14	
Assess the application of emerging technologies in the field of energy and the environment .		BC16	
Acquire scientific and technical terminology and nomenclature to present arguments and justify conclusions.			CC1
Develop critical thinking			CC4

Contents	
Topic	Sub-topic
1. Introduction to conductive polymers	1.1 . Polymers and environment 1.2 . Intrinsically conducting polymers 1.3 . Conducting 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	4.1. Basis 4.2. Devices 4.3. 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	B3 B14 C1 C4	9	0	9
Supervised projects	A12 B3 B1 B9 B16 C1 C4	1	51	52
Laboratory practice	B3 B1 B9 C1 C4	12	1	13
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.
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.
Laboratory practice	This methodology allows that students learn effectively doing practical activities, such as demonstrations, exercises, lab work and researches

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

Assessment			
Methodologies	Competencies	Description	**Qualification**
Laboratory practice	B3 B1 B9 C1 C4	The student will perform three laboratory practices related to energy efficiency of conductive polymers .The skills acquired in the laboratory and the report submitted will be evaluated .	30
Supervised projects	A12 B3 B1 B9 B16 C1 C4	Students will do individual work on a topic related to conductive polymers to be delivered and presented to other students . Both will be evaluated.	70

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 (). ªSynthetic Metalsº: 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.