Course Guide
44424 Molecular electronics

COURSE DATA

Data Subject	
Código	44424
Name	Molecular electronics
Cycle	Master's degree
ECTS Credits	4.5

Study (s)

Degree	Center	Acad. year	Period
2208 - M.U. en Nanociencia y Nanotecnología Molecular	FACULTY OF CHEMISTRY	1	First term

Subject-matter

Degree	Subject-matter	Character
2208 - M.U. en Nanociencia y Nanotecnología Molecular	8 - Molecular electronics	Obligatory

Coordination

Name	Department
CORONADO MIRALLES, EUGENIO	320 - QUÍMICA INORGÁNICA

SUMMARY

The students will become familiar with the basic concepts of organic or molecular electronics and the most important applications of the molecular materials in this area.

The students will also get insights into the basic concepts, both experimental and theoretical, of the techniques used to measure the electronic properties of a single molecule deposited on a substrate or connected to metallic electrodes, and their potential applications in nanoelectronics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

There are no specified enrollment restrictions with other subjects of the curriculum.

OUTCOMES

2208 - M.U. en Nanociencia y Nanotecnología Molecular

- Students can apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
- Students are able to integrate knowledge and handle the complexity of formulating judgments based on information that, while being incomplete or limited, includes reflection on social and ethical responsibilities linked to the application of their knowledge and judgments.
- Students have the learning skills that will allow them to continue studying in a way that will be largely self-directed or autonomous.
- Students have the knowledge and understanding that provide a basis or an opportunity for originality in developing and/or applying ideas, often within a research context.
- To possess the necessary knowledge and abilities to continue with future studies in the PhD program in Nanoscience and Nanotechnology.
- For students from field of knowledge (e.g. chemistry) to be able to scientifically communicate and interact with colleagues from another field (e.g. physics) in the resolution of problems laid out by the Molecular Nanoscience and Nanotechnology.
- To know the methodological approaches used in Nanoscience.
- To acquire the basics knowledge in fundamentals, use and applications of microscopic and spectroscopic techniques used in nanotechnology.
- To assess the relationships and differences between the materials macroscopic properties and those of unimolecular systems and nanomaterials.
- To assess the molecules and hybrid materials relevance in electronics, spintronics and molecular nanomagnetism.
- To know the main biological and medical application in this area.
- To know the main molecular nanomaterials technological applications and to be able to put them in the Material Science general context.
- To know the technical and conceptual problems laid out by the physical properties measurement in single molecular systems (charge transport, optical properties, magnetic properties).
- To know the main applications of nanoparticles and nanostructured materials obtained or functionalised using a molecular approach- in magnetism, molecular electronics and biomedicine.

LEARNING OUTCOMES

The students will become familiar with the basic concepts of organic or molecular electronics and the most important applications of the molecular materials in this area.

The students will also get insights into the basic concepts, both experimental and theoretical, of the techniques used to measure the electronic properties of a single molecule deposited on a substrate or connected to metallic electrodes, and their potential applications in nanoelectronics.

DESCRIPTION OF CONTENTS

1. Molecular electronics.

1. Electronics based on molecular materials and unimolecular electronics: Introduction and basic concepts.
2. Molecular electronic devices: OFETs, OLEDs and photovoltaic cells; devices structure and types; operating physical basics; constituent materials; comparison with inorganic devices. Third generation solar cells such as DSSC, OPV and perovskite photovoltaic cells.
3. Unimolecular electronics: basic concepts of coherent electron transport through molecules; experimental techniques for measuring the quantum transport and for the fabrication of molecular nanodevices.
4. Quantum transport theoretical modelling.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	22.50	100
Seminars	7.50	100
Tutorials	6.00	100
Other activities	2.00	100
Preparation of evaluation activities	56.50	0
Preparing lectures	18.00	0
TOTAL	**112.50**	

TEACHING METHODOLOGY

- Theory classes, participatory lectures
- Articles discussion.
- Chaired debate or discussion.
- Practical cases or seminar problems discussion.
- Seminars.
- Problems.
- Laboratory practices and demonstracions and visit to installations.
- Experts conferences.
- Attendance to courses, conferences and round tables.

EVALUATION

Written exam about the subject basic contents	70-90%
Attendance and active participation in seminars.	0-10%
Questions answering	10-20%

REFERENCES

Basic

- - H.S. Nalwa Ed.: Handbook of Avanced Electronic and Photonic Materials and Devices, Academic Press, 2001.
  - D.M. Guldi, N. Martín Eds.: Fullerenes: From Synthesis to Optoelectronic Properties. Kluwer Academic Press, Dordrecht, Netherland, 2002.
  - M.C. Petty, M.R. Bryce, D. Bloor, Eds.: Introduction to Molecular Electronics, Oxford University Press, NY, 1995.
  - World Scientific Series in Nanoscience and Nanotechnology: Volume 1. Molecular Electronics. An Introduction to Theory and Experiment. Juan Carlos Cuevas (Universidad Autónoma de Madrid, Spain), Elke Scheer (Universität Konstanz, Germany)
  - Lessons from Nanoelectronics. A New Perspective on Transport. Supriyo Datta (Purdue University, USA) World Scientific, 2012