Syllabus

Course Description

Course Title	Plastic and Molecular Optoelectronics
Course Code	46087
Course Title Additional	
Scientific-Disciplinary Sector	FIS/01
Language	English
Degree Course	PhD Programme in Advanced-Systems Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Franco Cacialli, Franco.Cacialli@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/47601 dr. Manuela Ciocca, Manuela.Ciocca@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/44873
Teaching Assistant	
Semester	Second semester
Course Year/s	2025/2026
CP	3
Teaching Hours	30
Lab Hours	
Individual Study Hours	45
Planned Office Hours	7
Contents Summary	
Course Topics	1) Introduction - I. semiconductors, Organic semiconducting (macro)molecules, Pi-orbitals and conjugation ii. Excitations: excitons and polarons iii. Exciton spin: singlets and triplets

	iv. Synopsis electronic and optical processes v. Optical properties: a few examples vi. Summary of optical properties 2) Organic light-emitting diodes a. Structure b. Fundamental processes i. Charge injection ii. Charge transport iii. Exciton formation iv. Exciton decay c. Characterisation of OLEDs i. Relevant performance parameters ii. Characterising metal-semiconductor contacts: d. Practical implementations i. Anodes ii. Cathodes iii. Active materials iv. Fabrication technology: solution processability e. State-of-the-art devices and future prospects 3) Organic photovoltaic diodes (PVDs) - a. Fundamental process b. Characterisation of PVDs c. Examples of polymer-based PVDs d. State-of-the-art devices and future prospects 4) Supramolecular structures - a. Introduction to secondary (non covalent) interactions b. Threaded molecular wires (TMWs). 5) Near-infrared (NIR) emitting + absorbing materials a. Overview b. Challenges: the energy gap "rule" c. Materials not leveraging triplet-assisted photophysics d. Current state-of-the-art 6) Advanced bio-optoelectronic applications a. Role of conjugated polymers in advanced bio-optoelectronic applications

	i. Artificial retina technologies ii. Biohybrid interfaces iii. Bioprinting.
Keywords	Organic semiconductors, photophysics, OLEDs, PVDs, bioelectronics
Recommended Prerequisites	Physics I and II. Basic Electronics
Propaedeutic Courses	
Teaching Format	Lectures (online or in presence)
Mandatory Attendance	
Specific Educational Objectives and Learning Outcomes	
Specific Educational Objectives and Learning Outcomes (additional info.)	1. Knowledge and understanding Knowledge and understanding of: - the fundamental physical and chemical properties fof organic semiconductors (OS) - Understanding basic operation of organic light-emitting diodes (OLEDs) - Understanding basic operation of light-emitting electrochemical cells (LECs) - Understanding basic operation of organic solar cells 2. Applying knowledge and understanding 3. Ability to apply knowledge for solving given problems, including solving them with numerical data, approximating significant numbers, and taking care of the notation of units. Making judgements 4. Ability to judge plausibility of results. Communication skills 5. Maturing of technical-scientific terminology. Ability to learn 6. Learning skills to independently study and apply methods of physics for specific applications beyond topics covered in this lecture.
Assessment	Oral exam in which the students are expected to give a 20 minutes

	presentation on a topic of their choice among those treated during the course and of particular relevance to their PhD project. This will serve as a basis. Additional questions will be asked to test basic understanding and ability of the student to apply the concepts to relevant applications.
Evaluation Criteria	The grading will be based on: - Clarity and correctness of the presentation. - The correctness of the answers given to the questions, and of the terminology used.
Required Readings	Lecture notes.
Supplementary Readings	[1] Electronic Processes in Organic Crystals and Polymers, M Pope, C Swenberg, Oxford University Press, 2nd ed., Oxford, 1999 [2] *Organic Light-Emitting Devices*, K Müllen and U Scherf eds., Wiley-VCH, Weinheim, 2006 *[3] Organic Electronics: Foundations to Applications*, SR Forrest, Oxford University Press, Oxford, 2020
Further Information	
Sustainable Development Goals (SDGs)	Quality education