

Photonic Crystals

Prof. Massimo Gurioli, Università di Firenze

8 h (1 cfu) 31/1-1/2, 7-8/2/2019 14.30-16.30

1. Elements of electromagnetism
2. Eigenvalue problem in photonics and analogy with quantum mechanics
3. Photonics crystals and photonic bands
4. Negative refraction
5. Point and line defects (cavities and waveguides)
6. Photonics on membranes: high-Q cavities
7. Purcell effect and strong coupling in 3D microcavities
8. Thresholdless laser

Organic and hybrid materials for photonics and electronics

Prof. Luisa de Cola, University of Strasbourg

8 hours (1 cfu). 18-21/2/2019 14.30-16.30

The course will cover fundamentals on the design, synthesis, characterization, processing, and applications of organic molecules, polymers and inorganic materials.

In particular the course will be divided in 4 classes of 2 hours each discussing the following topics:

1. Design, synthesis, and characterization of materials. The first lecture will discuss the chemical structures/property relationship. Photophysics concepts such as light absorption, emission, photoinduced processes

2. Organic and hybrid photonic devices: OLED, Lighting. The second lecture will apply the concepts learnt in the first one for the construction of light emitting devices

3. Organic and inorganic systems for photovoltaics. The third lecture will address the different type of photovoltaic devices and the evolution of the materials used.

4. Nanomaterials for sensing, upconversion and imaging. The last lecture will cover new development in three areas where “nano” can be important.

Organic electronics and photovoltaics

Prof. Abderrahim Yassar, Université Paris-Saclay (F)

8 h (1 cfu) 4-8 March 2019, 14.30-16.30

1. Synthesis of organic semiconductors
2. General characteristic of organic semiconductors and charge transport
3. Organic field effect transistors
4. Organic light emitting diodes
5. Polymer solar cells
6. New donor and acceptor materials for polymer solar cells
7. Materials interface engineering for polymer solar cell
8. Tandem polymer solar cell

Ferroics: Materials and Phenomena

Dr. Silvia Picozzi, CNR-SPIN, Chieti

8 h (1 cfu), 19-20/3/2019; 26-27/3/2019 14.30-16.30

1. Energy levels in transition metal atoms: magnetic moment formation and spin-orbit coupling
2. Crystal structures, symmetries and chemical bonds in Transition Metal Oxides
3. Crystal field theory and Jahn-Teller effects
4. Spin, charge and orbital ordering, phase transitions and spontaneous symmetry breaking
5. Electronic basis of magnetism
6. Magnetism and exotic phases in complex oxides
7. Ferroelectrics
8. Multiferroics

Principles and applications of nano-biotechnologies

Profs. R. Grandori/M. Colombo/ F. Gelain/ D. Prospero, Università di Milano-Bicocca

8 ore (1 cfu) 7, 13, 14, 17, 18 June 2019

1. Synthesis and biofunctionalization of colloidal nanoparticles
2. Non-covalent interactions of proteins with nanoparticles
3. Nanostructured biomaterials for tissue regeneration
4. Protein-DNA interaction at single molecule level
5. Biomedical application of colloidal and biomimetic nanoparticles

Electrochemical energy storage and conversion

Prof. Fabio La Mantia, University of Bremen (D)

24 hours (3 cfu) 2-3-4-9-10-11-16-17-18-23-24-25/07/2019 14.30-16.30

Aims

Aims of the lectures are to supply the student with base knowledge about the physical chemistry of electrochemical systems and their application in the energy production and conversion.

Contents

Thermodynamics and kinetics in electrochemical systems. Transport in electrolytes. Electrified interfaces. Supercapacitors, lithium-ion batteries, post-lithium batteries, redox-flow batteries, fuel cells, electrolyzers.

Detailed program

Fundamentals of Electrochemistry: electrochemical thermodynamics and Nernst law; electrochemical potential; transport of charged species in solution and diffusion potential drop; double-layer theories and adsorption phenomena; electrochemical kinetics and overvoltage; heat generation in electrochemical systems.

Electrochemical energy storage and conversion: hydrogen economy; supercapacitors and pseudocapacitors; lithium-ion batteries; post-lithium-ion batteries; redox-flow batteries; polymer electrolyte membrane fuel cells; alkaline electrolyzers. Materials and configurations.