

Physics and Technology of Two-dimensional materials and devices – second semester (March – June)

Learning Objectives

The fundamental training objective consists in the acquisition of in-depth knowledge relating to the properties, preparation and stability of two-dimensional materials (semimetals, semiconductors and metals). At the end of the course the student will be able to understand and frame in a general context the most recent developments relating to synthesis, optical and transport properties in two-dimensional materials (giant Faraday rotation, anomalous Berry phase, Klein tunneling), focusing on the example of graphene and transition metal dichalcogenides.

Detailed Course Content

- 1) Introduction to graphene and two-dimensional materials: from 3D materials with Van der Waals bonds to two-dimensional materials. The example of graphene.
- 2) The electronic structure and the electrical and optical properties: transport of charge carriers in graphene. Graphene nanostructured films. Quantum phenomena originating in two-dimensional structures (quantum Hall effect and Faraday rotation).
- 3) Optical properties of 2D materials in the visible and near infrared.
- 4) Synthesis of two-dimensional materials: Mechanical exfoliation, Chemical vapor deposition, Solution Processing (Liquid phase, chemical routes), Nano-composites.
- 5) Nanostructured devices: junctions of 2D materials. Hybrid junctions and 1D-2D hybrid devices or quantum-dots / graphene. Field-effect transistor with 2D materials.
- 6) Transparent and conductive thin films: Comparison with TCO, applications in flexible and printed electronics.

Textbook Information

- 1) “Nanotechnology for Microelectronics and Optoelectronics”, J. M. Martinez-Duart, R. J. Martin-Palma, F.

Agullo-Rueda, Elsevier 2006

- 2) “Quantum Transport-Atom to transistor”, S. Datta, Cambridge University Press 2005
- 3) “The Physics of low-dimensional semiconductors-an introduction”, J. H. Davies, Cambridge University
- 4) “The Physics of graphene”, M. I. Katsnelshon, Cambridge University Press.