UE Elaboration of nanostructures / physics of 2D materials

Level
Baccalaureate +5

ECTS
3 credits

Component
UFR PhITEM (physique, ingénierie, terre, environnement, mécanique)

Semester
Automne

- **Teaching language(s):** English
- **Open to exchange students:** Yes
- **Code d'export Apogée:** PAX9NPAI

Presentation

Description

Part I: Epitaxy of semiconductor nanostructures
The goal of part is to introduce the crystal growth techniques of nanostructures, illustrated by examples taken in field of semiconductor nanostructures. After an introduction of the basics of the epitaxy, the elastic strain will be discussed in the case of planar heteroepitaxy leading to elastic or plastic deformations. Thus, the different ways to growth nanostructure from quantum wells to quantum dots will be presented. Additionally, last advances on nanostructures growth will be presented by introducing the selective area growth (SAG) and the Van Der Waals epitaxy (VDWE).
Chap. 1: Epitaxy basics and growth techniques.
Homoepitaxy, Vicinal surfaces, Physisorption/chemisorptions
Frank-Van der Merwe growth
Ehrlich Schwöbel barrier and surface morphology
Growth techniques: Molecular beam epitaxy and chemical vapor deposition
Chap. 2: Heteroepitaxy: from elastic strain to plastic relaxation.
Pseudomorphic/metamorphic growths
Elastic biaxial strain model
Plastic relaxation by misfit dislocation formation: importance of the critical thickness
Elastic relaxation: Stranski-Krastanow growth mode
Evolution of growth modes: Competition between surface energy and elastic energy

Chap. 3: Growth of semiconductor nanostructures
Epitaxial growth of quantum wells (2D) to quantum dots (0D)
Epitaxial of quantum nanowires (1D): catalyst and catalyst-free growths
Selective area growth (SAG)
Van der Waals epitaxy (VDWE) of 2D semiconductor material – Remote epitaxy
Hybrid growths
Part II: Electronic properties of graphene and 2D materials: transport and optical properties:
II.1 Conventional 2D electron gases (2DEG) in semiconductor heterostructures
II.2 Electronic properties of graphene heterostructures
- II.2.1 Introduction
- II.2.2 Material and tight binding band structure
- II.2.3 Hall bar devices and basic transport properties
- II.2.4 Quantum transport: integer quantum Hall effect
- II.2.5 Optical properties

II.3 Review of other 2D materials: twisted graphene bilayers, transition metal dichalcogenides, topological insulators.

Course parts

UE Elaboration of nanostructures / physics of 2D materials - CMTD	Lectures (CM) & Teaching Unit (UE)	24h

Period : Semester 9

Useful info

Campus

Grenoble - University campus