

# UE Elaboration of nanostructures / physics of 2D materials



Niveau d'étude  
Bac +5



ECTS  
3 crédits



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



Période de  
l'année  
Automne (sept.  
à dec./janv.)

- > **Langue(s) d'enseignement:** Anglais
- > **Ouvert aux étudiants en échange:** Oui
- > **Code d'export Apogée:** PAX9NPAI

## Présentation

### 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.

---

## Heures d'enseignement

UE Elaboration of nanostructures / physics of 2D materials -  
CM-TD

Cours magistral - Travaux dirigés

24h

**Période** : Semestre 9

## Infos pratiques

---

### Lieu(x) ville

> Grenoble

---

### Campus

> Grenoble - Domaine universitaire