

# Matériaux moléculaires et hybrides, nanomatériaux



Niveau  
d'étude  
BAC +5 /  
master



ECTS  
4 crédits



Composante  
Faculté des  
sciences

## En bref

- Langue(s) d'enseignement: Français
- Ouvert aux étudiants en échange: Oui

## Présentation

### Description

#### # 1. Conducting molecular materials :

Synthesis of molecular materials precursors: electroactive  $\pi$ -conjugated organic and organometallic molecules (several examples of donor and acceptors: TTF; bis(dithiolene) complexes of Ni, Pd, Pt, Au; TCNQ. Functionalization/ introduction of non-covalent interactions: hydrogen, halogen, chalcogen. Intermolecular interactions in the solid – Open shell molecules: – neutral radicals, stabilization, delocalization – two-stage redox systems (Würster, Weitz) – overlap interactions in the solid – mixed valence dimers – 1D materials – band structures – Peierls transition.

#### # 2. Magnetic molecular materials:

Introduction to fundamentals of magnetism of the transition metals. Magnetism of the essential lanthanide ions for our society. Single-Molecule Magnets as potential materials for high-density data storage applications.

#### # 3. Hybrid materials: The concept hybrid, definitions and synthetic strategies (sol-gel, grafting, self-assembly, intercalation, coordination)

Classification of hybrid organic-inorganic materials (classes 1 and 2). The main families of amorphous and crystalline hybrid materials (organo-mineral polymers, functionalized silica, coordination polymers (CPs or MOFs), hybrid polyoxometallates, halometallates, phosphonates). Crystalline structure-properties relationship (luminescence, photo- and electrochromism, ferroelectricity, multiferroics, semi-conductors).

#### # 4. Nanomaterials: Definition, history, classification.

Mechanism of formation and stabilization of nanoparticles (thermodynamic and kinetic aspects).

Synthesis of organic and inorganic nanoparticles. Properties (photophysics and plasmonics).

Functionalization and bio-conjugation.

Nanomedicine (delivery of the active principle and outcome in the body).

## Objectifs

This module aims at presenting the main families of functional hybrid organic-inorganic materials and nanomaterials, commonly encountered in applications of condensed matter physics (conducting and magnetic molecular materials), photonics (optical protection, surface plasmon resonance sensing) or in health, especially in nanomedicine (diagnosis, therapy). A particular focus will be dedicated to the fabrication of hybrid systems present in many areas thanks to the complementarity provided by the constituting organic and inorganic bricks. The main coupling methods of the complementary entities will be developed together with the experimental techniques to characterize the composition and structure of the hybrid architectures thus obtained.

## Heures d'enseignement

|    |                  |     |
|----|------------------|-----|
| CM | Cours magistral  | 30h |
| TD | Travaux dirigés  | 4h  |
| TP | Travaux pratique | 16h |

## Pré-requis obligatoires



## Compétences visées

- Know the characteristics and properties of PCPs (or MOFs).
- Apprehend the chemistry and optical and redox properties of polyoxometallates.
- Recognize the different interactions (weak or strong) in a hybrid organic-inorganic material.
- Synthesis of the main electroactive precursors.
- Analyze the band structures of molecular solids.
- Comprehend the basis of molecular magnetism of lanthanide complexes.
- Know how to define a synthetic strategy to prepare a nanoparticle system with specific properties.

## Infos pratiques

### Lieu(x)

➤ Angers

### Campus

➤ Campus Belle-beille