Molecular Materials, Hybrids and Nanomaterials

SCHOOL
Faculty of Science

CAMPUS
Belle-Beille

LEVEL
2nd year Master's degree

OPEN TO EXCHANGE STUDENTS
Yes

SEMESTER
Fall (S1)

- **Degree course:** Light, Molecules, Matter
- **Teaching unit:** UE5
- **Course language:** English
- **Duration (hours):** 50
- **ECTS:** 4
- **Teacher(s):** Narcis AVARVARI

Assessment:

- [x] Continuous assessment
- [ ] Final exam

Teaching methods:

[x] Lecture course	30	hours	[ ] Case study
[x] Tutorial course	4	hours	[ ] Project
[x] Practical work	16	hours	

COURSE DESCRİPTİON

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).

OBJECTİVES

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.