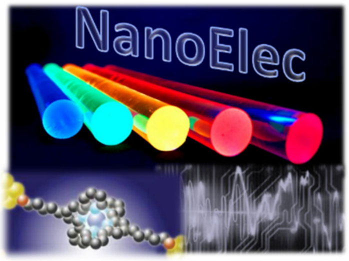
MASTER
Physique fondamentale et applications

M2 – SMNO-nanomat – NanoElec

Title:	Nanoelectronics and devices with molecules and nanoparticles (NanoElec)	
	Apogée code: MU5PYM08 **Number of credits:** 6 **Teaching hours:** 36h courses, 14h tutorial or project	

Responsible:	Olivier PLUCHERY INSP – Sorbonne Université olivier.pluchery@insp.jussieu.fr	Other teachers:	Emmanuel LHUILLIER (INSP, Sorbonne Univ) Florence Volatron (IPCM, Sorbonne Univ) Yvan BONNASSIEUX (LPICM, Ecole Polytechnique)

Objective	This courses establishes the bridge between fundamental concepts from physics and chemistry, and the most recent applications in electronics. The focus is placed on the "materials science" aspect of nanoelectronics, optoelectronics and organic electronics. It will lead the students from the quantum structure of solids and from the molecular architectures, to the the working principles of elementary devices such as organic field effect transistors (OFET), organic Light Emitting Devices (OLED), quantum dot (QD) based photodetectors, or a plasmonic activated photovoltaic cells. It will help the students understanding the "molecular electronic" revolution at play nowadays and help them find their place, either in academic research lab or in industrial R&D departments.
Content	(1) Revision of the fundamental concepts of semiconductor physics: doping, p-n junction, band diagrams, Schottky-Mott model, Shockley equation. (2) Molecular foundations for molecular electronics: atomic orbitals, HOMO-LUMO, Hückel method, frontier orbitals. (3) Molecular junctions: interface phenomena, band bending, surface dipoles. Experimental approaches. (4) Electrical current at the atomic and molecular scales: Ohm's law at the nanoscale, ballistic transport, Landauer formula. Break junction experiments. Coulomb blockade. (5) Semiconductor nanocrystals: synthesis methods, quantum confinement, photoluminescence and display application. Notion of color control in displays. Chromaticity diagrams. (6) Electrical current in nanocrystal arrays. Applications to the technology of infrared detectors (7) Metallic nanoparticles: synthesis methods, optical properties: plasmonics, optical nanoantenna (8) Review on the most important devices of the silicon industry: Field Effect Transistor (FET), Light Emitting Devices (LED), Photovoltaic cell (PV), optical detectors. (9) Recent breakthroughs in organic electronics: Organic LED, Organic display (AMOLED), printed electronics (e-paper), novel display technologies.
Prerequisites	A good background in **quantum physics** or **quantum chemistry** is necessary. Notions of **semiconductor physics** are recommended.
Examination	Final written exam 60% Home work 20% Oral presentation 20% (guided reading of a scientific articles)