Title : **Plasmas for materials, environment, biomedicine and agriculture**

Acronym :D2

UECoordinator :João SANTOS SOUSA

Teaching staff :João SANTOS SOUSA, Nicole BLIN-SIMIAND, Emmanuel ODIC, Mike KIRKPATRICK, Thierry DUFOUR

Pre-requisites : First year of MSc in Physics or Engineering Schools.

Credits : 3 ECTS

Language : French/English

Keywords :
Cold plasmas and processes. Low- and high-pressure non-equilibrium plasmas. Discharge physics, gas phase chemistry and surface chemistry. Physical and chemical diagnostics. Applications of plasmas to materials, environment, biomedicine and agriculture.

The objective is to present the physical principles, advances and technological barriers of the application of low- and high-pressure non-equilibrium plasmas to materials, environment, biomedicine and agriculture. Students will discover innovative applications of cold plasmas, and benefit from the expertise of researchers and professors recognized internationally for their scientific expertise.

The teaching unit is structured around seven themes, presented by five experts (researchers or professors) of the targeted fields:

– Kinetics and secondary reactivity at low- and high-pressure in non-equilibrium chemistry
– Physical diagnostics in post-discharge
– Plasma-Environment
– Plasma-Materials
– PlasmaandLiquids
– Plasma-Medicine
– Plasma-Agriculture

Kinetics and secondary reactivity at low and high pressure in non-equilibrium chemistry: secondary chemistry, production of secondary species, post-discharge physics, kinetic schemes and modeling of reactivity.

Post-discharge physical diagnostics: measurements of species and temperatures: short-lived and metastable species, gas temperatures, LIF diagnostics resolved in space and time, spatial profiles of radicals' density, optical diagnostics (emission, absorption, laser spectroscopy), mass spectrometry.

Overview of the different applications: synthesis of materials (e.g. nanoparticles) and surface treatment (etching, sputtering, deposition,...); depollution (DECOV, DeNOX, catalysis); biomedical (decontamination/sterilization, dermatology, oncology, in-vitro / in-vivo / clinical assays); agriculture (plant germination and growth,...).

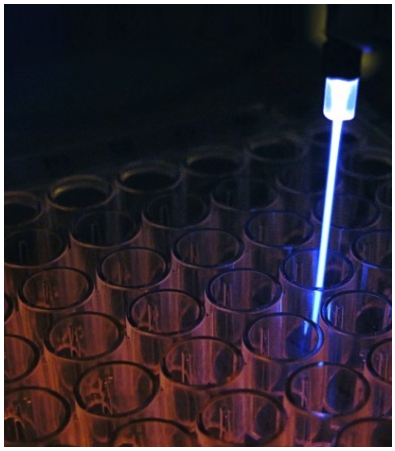
Physics of low pressure RF discharges: Physics of inductive heating and EH transitions - Global models - Radiofrequency sheaths: self-polarization, IEDF - Multi-frequency capacitive reactors - tailored waveforms - High frequency electromagnetic effects - Instabilities in industrial reactors - Modeling of a capacitive reactor - Modeling of an inductive RF thruster - Physics of helicon waves and HDLT and Vasimr thrusters - Physics of Hall effect thrusters.

Physics of high pressure pulsed discharges: Dielectric barrier discharges (DBD) - Role of the dielectric on the discharge - Different types of DBD - Calculation of current - Self-organization phenomena - Microplasmas (MHCD) - Plasma-jets and guided streamers.

Plasma physics (discharges) in liquids and induced chemistry in the liquid phase (by discharge in the liquid or in interaction with the liquid).

Plasmas and surface chemistry: Gas phase reactions (low and high pressure) - Collision mechanisms (electronic collisions, quenching, recombination,...) - Kinetic diagrams and modeling of reactivity.
Surface reactions: adsorption - heterogeneous catalysis and photo-catalysis - plasma/catalyst interaction - polymerization - spontaneous etching reactions - sputtering - neutral-ion synergy - inhibition layers - selectivity - transport by diffusion –gas heating in a high temperature source - Chantry model - pulse modulated plasmas: post-discharge kinetics - deposition - thin and nanostructuredfilms by PVD - transport of sputtered species to surfaces: weakly ionized plasma / high density plasma - control of the energy of deposition precursors - substrate polarization - effect of flux - effect of energy - examples of structuring of thin films (metallic / compound) - flexible and hard layers (adhesion of films, interfaces).

Chemical diagnostics (chromatography,...), **materials diagnostics** (SEM, TEM, XPS, AFM, etc.), **biological diagnostics** (in-vitro, ex-vivo, in-vivo models; survival curves; cell viability assays; clinical trials ,…).



Plasma seed treatment