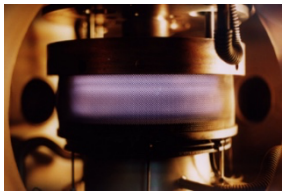
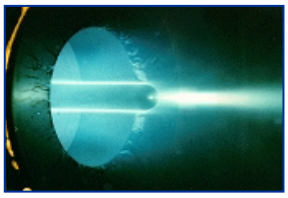
Title : **Low pressure cold plasmas**
Acronym : **O5**
EU Coordinator : Tiberiu MINEA, Laboratoire de Physique des Gaz et Plasmas (LPGP)
Teaching staff : Tiberiu MINEA, Jean-Luc RAIMBAUL
Pre-requisites : First year of MSc in Physics or Engineering Schools.
Credits : 3 ECTS
Language : French/English
Keywords : Low-pressure plasmas. Physics of discharges - Fundamental phenomena. Plasma-wall interaction in partly ionized plasmas. Magnetic confined plasmas. RF plasmas.

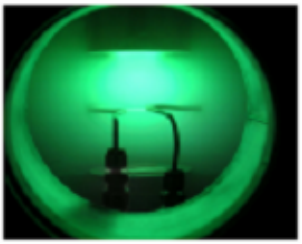




This module focuses on the production of low-pressure plasmas, their maintenance, the physical mechanisms involved during their operation, but also on the interaction of plasma species with surfaces - a phenomenon that is very important for the establishment of the steady state, but also for many applications. Discharge plasmas are intrinsically sources of species, charged or not, but also of photons. Without being exhaustive, this course presents different configurations of plasmas used as sources of charged particles for accelerators or synchrotron, space ion thrusters, ion beams (positive and negative as in the FIB - Focus Ion Beam or additional heating of tokamaks), reactive ion etching reactors, etc. The 'cold' reaction kinetics of heavy species in low-pressure plasmas is also addressed - a major issue in microelectronics, thin film deposition, but also light sources (gas lasers, specific and low consumption lamps, ...), environmental applications (isotope separation, destruction of pollutants, ...), biology and medicine, etc...

This lecture is structured in 4 chapters.





Chapter I: Introduction to cold plasmas gives the definitions and presents the fundamental concepts for the understanding of the phenomena governing low-pressure plasmas. The self-sustaining condition of a discharge is introduced as well as the laws of similarity allowing to compare different discharges.

Chapter II - Fluid models and kinetics of cold plasmas are common approaches to analytically describe charged and neutral species, involving free electrons and ions of the plasma. Typical approximations due to low pressure are detailed leading to specific forms of the conservation equations, explained through examples. Power and matter balances, as universal laws, allow to understand plasma formation and to open to specific configurations.

Chapter III - Plasma confined by walls is an issue of all low-pressure plasmas, because they are created in vacuum chambers to maintain the low pressure. Plasma-wall equilibrium in confined plasmas is treated in different situations - sheath models - as well as the transport of the charged particles to the walls at low pressure and the establishment of the self-bias voltage, for radio frequency (RF) excitation of the discharge.

Chapter IV - Power source/plasma coupling is the key to creating a plasma with the expected properties. Energy provided to the plasma, ionization and production of active species are presented from a fundamental point of view through examples of typical configurations:

- RF plasmas - capacitive, inductive, and helicon ;
- microwave plasmas.

The low pressure - high density plasmas constitute a specific research field using different forms of electron confinement (electrostatic, magnetostatic and mixed), which are detailed for the case of magnetrons and ion thrusters.