Avviso di Seminario

Lunedì 14 novembre – ore 16:30
Aula Multimediale Dipartimento Interateneo di Fisica

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"Hybrid" Discharges for Plasma Chemistry and Catalysis Applications

Characterization of Plasmas in Contact with Liquid Water

Control of energy partition in nonequilibrium gas discharge plasmas is critical for the energy-efficient plasma chemical conversion and plasma-enhanced catalysis. In many applications, high efficiency is achieved when the discharge is operated near the optimum excitation of vibrational and low-energy electronic states of major molecular species, such as N_2, H_2, O_2, and CO_2. This occurs in DC glow discharges, RF discharges, and microwave discharges. However, scaling these discharges to high pressures and large volumes is challenging, due to the plasma instability development. The use of high peak voltage, ns duration pulses generated at a high repetition rate extends the range of stable operation to significantly higher pressures and peak powers. On the other hand, this approach reduces the input energy fraction into the excitation of molecular vibrations, due to high peak reduced electric field. We employed a non-self-sustained "hybrid" discharge, where the ionization is generated by a ns pulse train and the energy is coupled to the plasma by a sub-breakdown RF waveform, using a single pair of electrodes external to the discharge cell. This approach suppresses the cathode layer instability and precludes the catalytic reactions on the electrodes. The plasma kinetics are quantified using the measurements of the electric field, vibrational level populations of the molecular species, and the yields of the plasma chemistry products, using a range of laser diagnostics. The hybrid plasmas are used for the selective vibrational excitation of N_2 and CO_2, to study the CO_2 dissociation and the plasma-catalytic ammonia generation. The results are used to isolate the effect of the targeted vibrational excitation on the process yield.

Measuring the electric field in plasmas in direct contact with liquid water, such as in plasma jets impinging on a water-covered substrate, is essential for understanding the plasma dynamics and chemistry. In our work, the electric field distribution over a microchannel array alumina ceramic surface, placed under an atmospheric pressure N_2-Ar plasma jet, is measured by ps Electric Field Induced Second Harmonic (EFISH) generation. The measurements are made both over the dry surface and the surface with the channels filled with liquid water. The results exhibit the enhancement of the electric field inside the channels, controlled by the propagation of the surface ionization wave. In a related experiment, hydroperoxyl radicals (HO_2) are measured in the plasma in contact with water, by Cavity Ring Down Spectroscopy. HO_2 is among the major product species in low-temperature plasmas containing water vapor and oxygen. Reactions between the HO_2 radicals result in the accumulation of H_2O_2, which induces apoptosis (programmed cell death) in the cell cultures in plasma-treated liquids. *In situ* measurements of the absolute, time-resolved concentrations of HO_2 in the plasma identify the dominant plasma chemical processes of their generation and decay. Since the objective of the plasma activation of water and aqueous solutions is introducing the long-lived reaction products (such as H_2O_2) into the liquid phase, these measurements are made near the liquid surface, using the water vapor as one of the key reactants.

Avviso di Seminario

Martedì 15 novembre – ore 16:30

Aula Multimediale Dipartimento Interateneo di Fisica

Prof. Ivo Furno

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Advancing the understanding of turbulent plasmas for fusion in basic plasma physic devices

Magnetic confinement fusion is one of the grand challenges of our century. The success of a future thermonuclear fusion reactor, such as ITER presently under contruction in the South of France, will depend on our understanding and mastering of plasma turbulence and its effects on the different plasma components, including the fusion-generated suprathermal alpha particles. Progress along these venues are achieved at the Swiss Plasma Center on the TCV tokamak and on basic plasma physics devices, which allow for detailed measurements of plasma turbulence in well controlled experimental setups. In this talk, I will present recent advances on the Toroidal Plasma Experiment (TORPEX) in the fundamental understanding of intermittently-generated plasma blobs, in methods to control their dynamics, and on the dynamic of fast ions interacting with plasma turbulence.