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MICROPLASMAS AND MICRO-JETS

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Abstract. Microplasmas are now widely investigated, one of their advantages being to generate a plasma at relatively high pressure close to the Paschen minimum (Schoenbach et al. 1997). Here, the microplasma is generated in a microhollow cathode type configuration made of a hole drilled through a metal/dielectric/metal sandwich (Schoenbach et al. 1997). One of the electrodes acts as the cathode (K) and the other as the anode (A1). The hole diameter ranges from 100 to 400 μm and the pressure ranges from 50 to 500 Torr. When a second electrode (A2) is added, a large volume of plasma plume may be generated between A1 and A2, at a low electric field (1-20Td depending upon the gas) (Stark et al. 1999). A microhollow cathode type discharge operates in three different regimes depending on the plasma current: abnormal, self-pulsing and normal regime. The self-pulsing regime is achieved in the range of 1-100 kHz, in argon, helium, nitrogen and oxygen. The self-pulsing frequency is controlled by the microplasma device capacitance, the gas breakdown voltage, and the average discharge current (Rousseau et al. 2006, Aubert et al. 2007).

i) First, in pure argon, the radial dependence of atoms excitation mechanisms and of the electronic density is studied inside the micro-hole. Imaging of the emission from the microplasma is performed with a spatial resolution of few μm. The electron density is estimated from the Stark broadening of the H_β-line. The radial distribution of the emission intensities of an Ar atomic line and an Ar^+ ionic line are used for the excitation study. Ar and Ar^+ lines are excited in the cathode sheath edge by beam electrons accelerated within the sheath. These two excitations show the decay of the energy of electrons in negative glow. The Ar line presents also production of excited atoms by recombination of argon ions with electrons at the center of the micro-hole.Work is in progress to evaluate the contribution of the static electric field on the strak broadening

ii) Second, in oxygen containing mixture, a flowing micro-jet is generated: the reactor used is separated in 2 rooms by the MHC. Thus, the gas is constrained to flow only through the microhole and the quantity of treated gas is well known. The gas flow is supersonic in most operating conditions at the exit of the microhole; despite a very large injected power density (typically 10^4 W cm^{-3}), the gas heating does not exceed few hundreds of degrees, so that the plasma is non equilibrium. Different measurements are realized on the plume in pure O_2 and in Air. O_3 concentration has been measured by UV absorption spectroscopy; NO and NO_2 have been measured by tuneable diode laser absorption spectroscopy (TDLAS) in the infrared region (Röpcke et al. 2006). The production of NO and NO_2 in air mixture scales as universal function of the injected power, independently of the working regime (continuous or self-pulsing).

References

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