DYNAMICS OF ATMOSPHERIC PRESSURE He/H_2O MICROPLASMAS: A NEW DOUBLE LAYER STRUCTURE

K. McKay, F. Iza and M. G. Kong
Electronic and Electrical Engineering, Loughborough University, LE11 3TU, UK

D. X. Liu and M. Z. Rong
State Key Lab. of Electrical Insulation for Power Equipment, Xi'an Jiaotong University, Xi'an 710049, China

Microplasmas have received growing attention in many application driven fields, such as plasma medicine. In this field, helium is often used as a buffer gas due to its excellent thermal properties and traces of oxygen and/or water vapor are typically introduced to the feed gas to create reactive oxygen species of interest for biomedical applications. Here we consider atmospheric pressure He+H_2O microplasmas sustained across gaps of different sizes. The observed plasma dynamics, however, are expected to occur also in other electronegative discharges such as in He+O_2 admixtures.

A 1-D fluid model of a parallel plate reactor is used to model the He+H_2O discharge. The model considers 31 species and 65 reactions. These have been chosen from a previous study where more than 500 reactions were screened to identify the main chemical processes at different concentrations of H_2O [1]. Due to the electronegativity of the discharge, double layers that confine the colder negatively charged species (anions) to the center of the discharge appear as the water concentration increases. Stratification of electrons and anions as well as other double layer structures have been found in many different types of plasma systems including magnetized and unmagnetized plasmas, collisionless and collisional regimes and electropositive and electronegative discharges.

In small gap microplasmas, a new type of double layer structure is observed. As in larger plasmas, negative ions remain confined to the central region of the discharge and due to their large inertia their spatial oscillation is negligible. On the other hand, the amplitude of the electron oscillations becomes larger than half the discharge gap, and therefore the electron ensemble is found to move across and beyond the discharge electronegative core. This results not only in stratification but actually in separation of electrons and anions. As a consequence the space charge density becomes strongly non-monotonous with "islands" of high positive space charge forming between the oscillating electron ensemble and the central electronegative core.

[1] D. X. Liu et al. "Global model of low-temperature atmospheric-pressure He+H_2O plasmas," *Plasma Sources Sci. Technol.* **19**, 025018 (2010)