PREDICTING SELF-ORGANIZATION IN DC GLOW MICRODISCHARGES IN DIFFERENT GASES WITH THE USE OF COMSOL MULTIPHYSICS

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Stationary self-organized patterns of cathodic spots have been observed in DC glow microdischarges in xenon[1]. Recently, such patterns have been obtained in the numerical modelling[2]: multiple steady-state solutions have been found for the same discharge current, some of these solutions describing modes with a normal spot and other describing modes with several spots, which are qualitatively similar to those observed in the experiments[1] and fit into the general pattern of self-organization in near-electrode regions[3].

A very interesting question is why the self-organization was observed in xenon but not in discharges with other plasma-producing gases, such as argon[1]. This question is dealt with in this work. The key feature of the modelling is the use of a stationary solver of COMSOL Multiphysics, which allows one to decouple questions of numerical and physical stability.

The modelling is performed for a parallel-plane discharge of the height of 0.5mm and radius of 0.5...1.5mm in argon or helium. For the pressure of 30 Torr, the discharge in Ar and He is obstructed (i.e., the current density-voltage characteristic is rising for all current densities), in contrast to that in Xe, the reason being different cross sections of elastic collisions of electrons with atoms. Unsurprisingly, no multiple solutions have been detected, which means that no self-organization is present. A falling section comparable to that in Xe at 30 Torr appears in the current density-voltage characteristics at the pressure of 75 Torr for Ar and 530 Torr for He. 2D and 3D modelling has shown that multiple solutions describing self-organized patterns indeed exist for these pressures and are similar to those found[2] in Xe at 30 Torr.

In summary, self-organization in microdischarges observed in Ref. 1 appears to be a general phenomenon. One should be able to observe it also in gases other than xenon provided that the experimental conditions, such as pressure, are right.

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* Work supported by FCT of Portugal through projects PTDC/FIS/68609/2006 and PEst-OE/MAT/UI0219/2011.