Study of radio frequency breakdown in a device with movable electrodes

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Radio frequency (RF) capacitively coupled plasmas represent an important part of the plasmas used in the laboratory for applications and basic studies. The issues of how breakdown of such plasmas takes place and of the related Paschen-like curves are of clear interest. Several authors have experimentally found that breakdown voltage curves as a function of pressure display a minimum, as in the DC case, and that on the low-pressure side of this minimum a multi-valued region occurs [1]. This has been associated to a transition from the γ regime, where secondary electron emission from the electrode plays an important role, to the α regime, where new electrons are originated only by ionization taking place in the bulk [2]. Beyond this dependence, the transition is also function of the electrode distance.

In this contribution we have studied Paschen-like curves for breakdown between plane parallel electrodes as a function of the gas pressure p and of the electrode distance d, for different RF frequencies (an example of the plasma produced in the device is shown in Fig. 1). This has allowed to build Paschen-like curves and to compare them with the Kihara equation [3, 4] and with the criterion proposed by Sato and Shoji [5]. The experimental data and the similarities and discrepancies with the theoretical curves have been discussed also in terms of the transition between γ and α modes, which turns out to be related both to the electrode distance and to the applied voltage frequency. The study has been performed for both helium and argon gases.

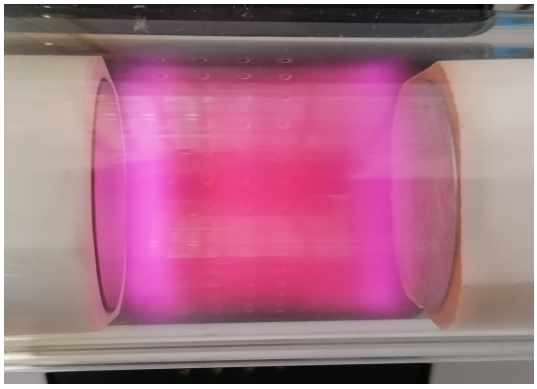

Figure 1: *Example of helium plasma produced between the electrodes, after breakdown.*

References

[1] V. A. Lisovskiy and V. D. Yegorenkov, J. Phys. D: Appl. Phys. **31**, 3349 (1998)

[2] M. U. Lee, J. Lee, J. K. Lee and G. S. Yun, Plasma Sources Sci. Technol. **26**, 034003 (2017).

[3] T. Kihara, Rev. Mod. Phys. **24**, 45 (1952)

[4] V. A. Lisovsky and V. D. Yegorenkov, J. Phys. D: Appl. Phys. **27**, 2340 (1994)

[5] M. Sato and M. Shoji, Jpn. J. Appl. Phys. **36**, 5729 (1997)