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2D numerical simulation of the electron dynamics in a micro-scale radio-frequency driven atmospheric pressure plasma jet

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The micro-scale radio-frequency driven atmospheric pressure plasma jet (μAPPJ) can provide high concentrations of various radicals at a low gas temperature [1], particularly for modification of sensitive surfaces, such as in biomedicine or for surface coatings.

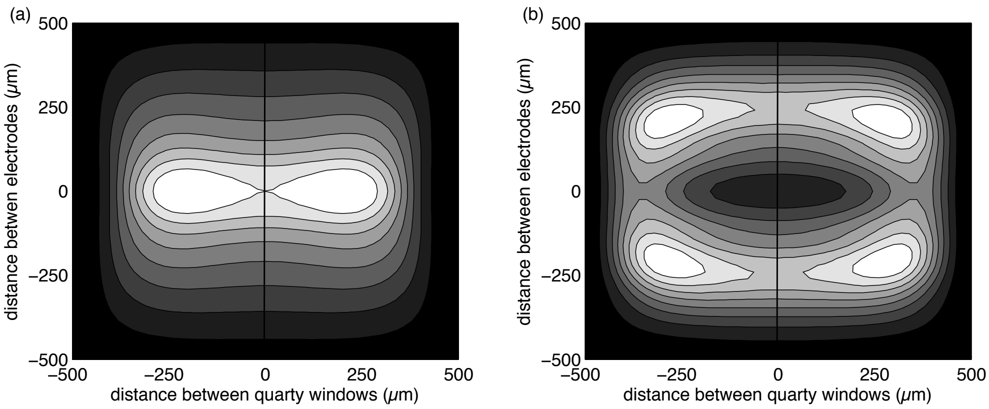

Fig. 1: Electron density (a) and electron impact excitation rate (b); time averaged over one RF cycle.

Here, the cross-section of the μAPPJ perpendicular to the gas channel is numerically simulated, using a fluid model with semi-kinetic treatment of the electrons benchmarked against optical measurements [2, 3]. The electrode spacing as well as the spacing of the guiding quartz windows is 1 mm, therefore the analysed cross section is quadratic as can be seen in fig. 1. Here, the time averaged electron density (a) as well as the time averaged electron-impact excitation of helium metastables (b) are shown on a linear greyscale. Light colours indicate high and dark colours low densities, respectively. Both, electron density and electron-impact excitation, exhibit maxima off centre with respect to the symmetry axis of the discharge (black line). This can be explained by surface charges infront of the quartz windows, which lead to additional excitation due to electric fields perpendicular to the symmetry axis, i.e. parallel to the electrodes. It can be shown that the electron impact excitation is rather dependent on the power coupled into individual electrons (j_eE/n_i) than on the total power coupled into electrons described by j_eE.

Reference

[1] V. Schulz-von der Gathen, L. Schaper, N. Knake, St. Reuter, K. Niemi, T. Gans, J. Winter 2008 J. Phys. D: Appl. Phys. **41** 194004

[2] K. Niemi, S. Reuter, L. M. Graham, J. Waskoenig, N. Knake, V. Schulz-von der Gathen, T. Gans 2010 J. Phys. D: Appl. Phys. **43** 124006

[3] J. Waskoenig, K. Niemi, N. Knake, L. M. Graham, S. Reuter, V. Schulz-von der Gathen, T. Gans 2010 PAC accepted