Measurement of electric field development in He plasma jet

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1. Introduction

In this contribution the results of the spatio-temporally resolved measurements of the electric field in the plume of the helium plasma jet are presented. The emission of the plasma jet is recorded with the finest spectral, temporal and spatial resolution. Using the method based on the Stark polarization spectroscopy the values of the electric field are obtained. The measurements are performed for two dielectric barrier discharge based plasma jet configurations.

2. Method for electric field measurement

The method we used is based on quantum mechanical perturbation principle for helium atom. Perturbation is due to the influence of the external electric field i.e. Stark effect. Moderate external field is sufficient to remove all restrictions with regard to changes in the orbital quantum number. This leads to the appearance of forbidden lines in the spectrum. Further, external electric field causes shifts of allowed and forbidden lines. Using perturbation theory, it is possible to calculate those displacements in dependence of the external electric field [1]. For the measurements presented here, helium He I (2^1P-4^1D) line at 491.19 nm and its forbidden counterpart (2^1P-4^1F) are used [2].

3. Results

Electric field strength development in plasma jet with the electrode grounded 2 cm downstream jet nozzle is presented in Fig. 1. Results are obtained from He I 492.1 nm line recordings made in 20–100 ns steps. It is found that electric field strength rises from the values of about 5 kV/cm at the tube exit, to the maximal value of about 20 kV/cm [3]. A few millimeters in the nearest vicinity of the instantaneous cathode, electric field reaches a plateau. Fig. 2 shows results of the electric field profile in the plasma bullet. The electric field in the bullet head has a narrow spatial distribution, which is in accordance with the theoretical predictions [4]. It is also found that the plasma bullet velocity rises with the rise of the electric field. As it is predicted by a model plasma bullet velocity doesn't depend only on the electric field, but also on bullet radius or jet current [5]. Those predictions are also plotted in Fig. 2.

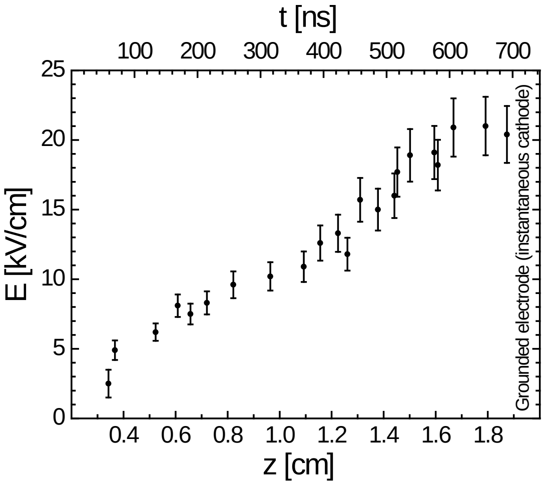

Fig. 1: *Electric field strength development in plasma jet with grounded electrode 2 cm downstream the nozzle.*

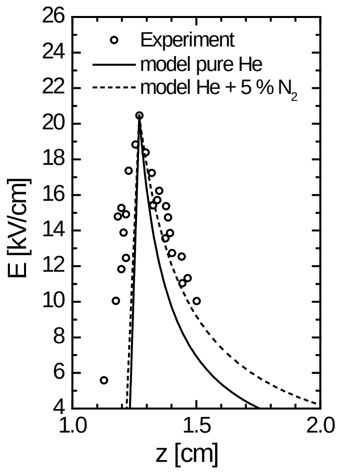

Fig. 2: *Distribution of the electric field along the z-axis obtained by experiment in comparison to the modelling predictions.*

References

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