Electric field measurements in DBD plasma jet using intensity ratio of helium lines

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In this paper a method is proposed and tested for electric field measurements in the streamer head of DBD helium plasma jet. The method uses intensity ratio of two helium singlet lines: He I 2^1P-3^1D at 667.8 nm and He I 2^1P-3^1S at 728.1 nm. The method is based on our earlier work in helium dielectric barrier discharge (DBD). Collisional-radiative model for the involved atomic levels is utilized to obtain the functional dependence of the line ratio on the local electric filed strength. The obtained values of the electric field are compared with the results obtained by Stark polarization spectroscopy.

1. Introduction

One of the most promising and patient friendly plasma devices for biomedical applications is non-thermal atmospheric pressure plasma jet. It can be found in various constructions and under various operation conditions. Non-thermal atmospheric pressure plasma jet requires noble gas as working media and AC or pulsed high voltage supply. It is a source of guided ionization waves, typically one ionization wave – streamer per one voltage half cycle. If discharge gets in contact with target, streamer becomes only one part of the entire discharge which transforms to transient glow discharge. The electric field strength is one the most important parameters of streamer discharges and the knowledge of the electric field in the streamer head can give information about other parameters, such as electron density and production of different active chemical species. The well-established Stark polarization spectroscopy method suffers from a low intensity of used helium lines, thus the new les demanding method would be of great interest [1,2]. Here we present preliminary results of the electric field measurements in the streamer head of DBD helium plasma jet using the intensity ratio of two helium singlet lines: He I 2^1P-3^1D at 667.8 nm and He I 2^1P-3^1S at 728.1 nm [3].

2. Experiment

Investigated DBD plasma jet consisted of quartz capillary of the inner diameter of 1 mm and outer diameter of 2 mm, with two metallic electrodes wrapped around it. The amplitude of applied sinusoidal voltage was 2.5 kV and the frequency was 10 kHz. Five millimetres downstream the exit tube copper grounded electrode was placed. High resolution spectrometer equipped with iCCD camera was used for all measurements.

3. Results

Figure 1 presents comparison of the results obtained by two methods. The preliminary results are promising and further studies should be preceded.

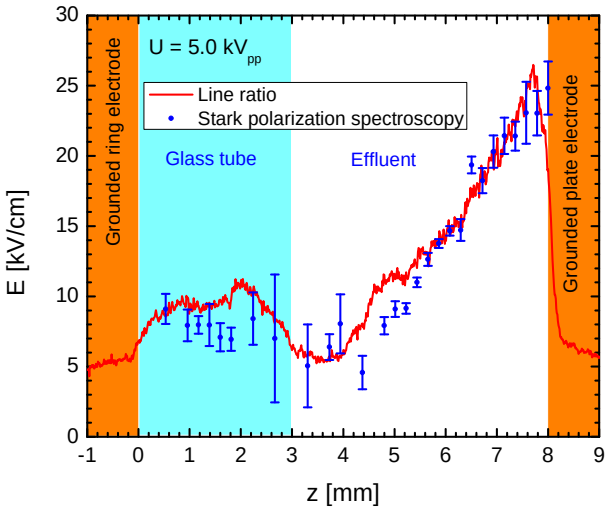

Figure 1: Comparison of the electric field strength inside the capillary of the plasma jet and in the effluent obtained by two independent methods.

4. References

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