Investigation of discharge development in an atmospheric pressure single dielectric barrier discharge in N_2/CO_2 mixture by Cross-correlation spectroscopy

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1. Introduction

Recently, there has been a tremendous interest in reduction of the greenhouse gases particularly carbon dioxide, since, it composes 85% of the greenhouse gases emitted annually [1]. Non-thermal plasmas have been suggested as an alternative technology for conversion of CO_2 to more valuable hydrocarbons or energy sources [1-2]. However, little is known about the mechanism of formation and plasma chemistry of discharges containing carbon dioxides. In this work, a novel technique of Cross Correlation Spectroscopy set-up has been used for investigation of discharge development in an atmospheric pressure dielectric barrier discharge in N_2/CO_2 mixture.

2. Description of the experiments

The experiments are carried out in a symmetrical single filament dielectric barrier discharge. The discharge cell consists of two metal electrodes, covered by alumina (Al_2O_3) with the thickness of 0.5 mm. The distance between the electrodes is 0.6 mm. A detailed description of the plasma source can be found in Höft et al. [3].

20% volume of CO_2 was chosen in order to compare the discharge development with air plasma, which contains the same amount of an electronegative gas (oxygen). The discharge was driven by a sinusoidal voltage with frequency of 7.27 kHz, and the voltage peak to peak amplitude was adjusted in the range of 13-14 kV in order to get only one single filament per every half period of the applied voltage.

Time correlated single photon counting (TC-SPC) technique has been used to investigate the discharge development. The principles of the TC-SPC technique are presented in Kozlov et al. [4].

3. Results and discussions

The spatio-temporal distribution of the single DBD luminosity for the spectral band of the second positive system of molecular nitrogen at the wavelength of 337 nm (0-0 transition) is shown in figure 1. The luminosity contains two intensive peaks located near the electrodes and both appear at approximately the same time. In addition, the development of the filament is clearly observed and it consists of a pre-phase at anode, followed by the propagation of the cathode directed ionization front and consequently a bulk plasma in front of anode. The whole discharge duration is less than 20 ns. The principal of development is comparable with that one in air. Besides, the specific of CO_2 instead of O_2 will be discussed in more detailed.

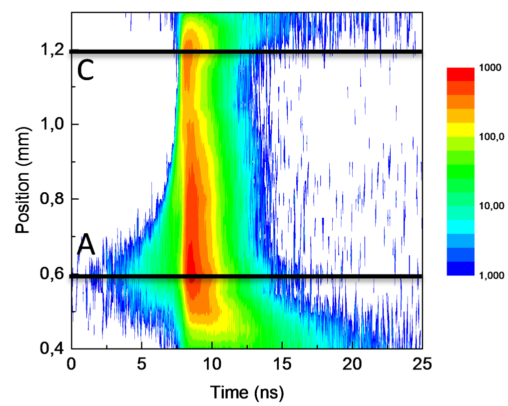

Fig. 1: *An example of the measured spatio-temporal distributions of the MD luminosity for the 0-0 transition of the second positive system of molecular nitrogen. The position of the electrodes has been shown by lines (A is Anode and C is the Cathode).*

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References

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