Study of electric field distribution in helium and hydrogen DBD at lower pressures

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The effect of pressure, voltage, electrode gap and surface on the electric field distribution in DBD in helium and hydrogen in the pressure range 5 – 100 mbar was investigated. It was found that the type of the discharge and its characteristic axial electric field distribution strongly depends on the distance between electrodes while influence of the pressure is mostly seen as a change of the field value. It was found that discharge in helium is a subnormal-like for 1 mm gap, and for 5 mm it is a glow-like. The discharge in hydrogen changes from a Townsend-like for 1 mm gap to a glow-like for 5 mm gap.

1. Introduction

Atmospheric dielectric barrier discharges (DBDs) have been widely studied over the last few decades mostly because of their broad application fields [1]. Ease of their implementation was demonstrated in different processes like surface modification, deposition, activation, gas purification, decontamination. Various discharge regimes have been observed and documented using high speed imaging, temporally and spatially resolved optical emission spectroscopy and simulations. In this paper we investigate DBD in helium and hydrogen in the pressure range 5 – 100 mbar. The effect of pressure, voltage, electrode gap and surface on the electrical characteristics of DBDs is investigated. We present the different regimes observed in the DBDs operation, depending on pressure observed trough the electric field distribution in the discharge. Stark polarization spectroscopy of hydrogen Balmer alpha line [2] was used for measurement. Using time-resolved spectroscopy, evolution of the electric field distribution was studied during the discharge development.

2. Experiment

In our experiment the discharge is formed between two parallel electrodes: one metal electrode (40 × 40 mm^2) is covered with alumina dielectric while the other electrode is made of steel mesh and covered with pyrex glass. The distance between the barriers is set at 1, 2 and 5 mm. The discharge chamber is firstly evacuated down to 10^{-2} mbar, and then the working gas is introduced up to 80 mbar pressure. The amplitude of the sine applied voltage was 1.1 and 1.75 kV at frequency of 19.7 kHz. Voltage is measured using high-voltage probe, and current is monitored using Rogowski coil. For time-space resolved measurement of emission spectra the 1–m spectrometer with ICCD detector was used.

3. Results

It was found that the type of the discharge and its characteristic axial electric field distribution strongly depends on the distance between the electrodes. Influence of the pressure is mainly observed as a change in the electric field strength, while its influence on the shape of the field distribution is minor. According to the measured electric field distributions, the discharge in hydrogen for 1 mm electrode gap is in the Townsend-like mode, for 2 mm it is in subnormal-like and for 5 mm in the glow-like mode. Figure 1 shows that discharge in helium is in subnormal-like mode for 1 mm electrode gap. While measurements for 2 mm and 5 mm gap have shown that discharge is in the glow-like mode.

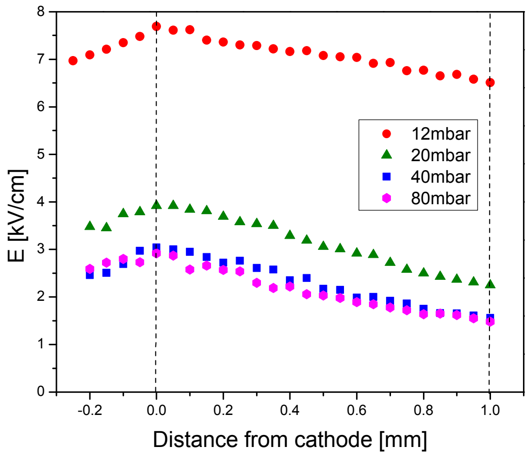

Fig. 1: Electric field distributions for the helium DBD at different pressures. Inter electrode gap is 1 mm.

4. References

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