Spatial distribution of light emission intensity of the surface discharge with multi-stripped electrode in dry Air and in Ar

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1. Introduction

Previous investigation of surface microdischarges in dry air from single electrode [1] has given information about spatial and temporal distribution of light emission of individual channels of the discharge. It has been shown that microdischarge channels develop at a certain distance from the dielectric barrier surface and their light emission structure resembles the one of a corona discharge in air. To be used in different plasma-chemical technologies a multichannel discharge must be analyzed. The aim of the present work was to investigate spatial structure of light emission of surface discharge from edges of a multistriped electrode, using a cross-correlation spectroscopy method.

2. Experimental

All experiments were carried out with a grounded multistriped electrode placed on one side of an Alumina plate of 1 mm of thickness while the other high voltage plate electrode was at the reverse side of the barrier (Fig.1). High 14 kHz sinusoidal voltage has been used its value being 3.2 kV for air and 1.1 kV for Ar. The surface of the barrier together with the discharge electrode has been covered by a thin layer of glass enamel (0.1 mm of thickness). The electrode system was placed in a specially developed discharge cell of Plexiglas with quartz windows.

Experimental device described in [1] has been used to measure light emission of the discharge. It consists of a lens, a monochromator with slits and a photomultiplier and permits to scan the light emission flow with steps in a micrometer range. It is possible to achieve the distribution of integral light emission of discharge channels that develop during whole period of the applied voltage or its half-period. The measurements for air were done for 337.1 or 391 nm wave lengths.

The discharge in a three electrode system has been investigated as well. The third plane electrode is placed at 1.2 cm distance from the dielectric barrier surface The DC voltage of different polarity could be up to 10 kV. A flow of dry air (humidity less than 0.7%) or slightly humid Ar (humidity 3.3%) was used (flow rate 30-70 l/h).

3. Experimental results

The measurements have shown that individual channels of the discharge in air appear from the electrode edge a distance about 1 mm between them, have their mean length about 1.6 mm, while the thickness of the plasma layer near the barrier surface (perpendicular to it) filled by microdischarge channels is in the range of 3.8 mm for the used conditions. The most intense emission is measured at a distance about 2.5-2.7 mm from the barrier surface and this distance increases slightly with higher values of the applied positive DC voltage at the third electrode. The light emission intensity increases about 20-25% with positive DC voltage. There is no visible influence of the negative DC voltage on the plasma layer thickness or the emission intensity. These results are in accordance with results achieved with a iCCD camera described in [2].

The same experimental procedure has been used to investigate the surface discharge in Ar. The measurements were done with 309 nm wave length that corresponds to chemically active spice OH. In this case it was found that an additional use of a positive DC voltage (up to 4 kV) decreases (more than 30%) the light emission from the discharge, while the negative 3 kV voltage switches off the discharge at all and it appears again only without the DC voltage. The highest value of emission of OH (without the DC voltage) is seen at a distance 1.5 mm from the barrier surface.

4. References