Publ. Astron. Obs. Belgrade No. 103 (2024), 154 - 157 *Poster*
https://doi.org/10.69646/aob103p154

INFLUENCE OF INTERELECTRODE DISTANCE ON THE CHARACTERISTICS OF THREE-ELECTRODE PULSED SDBD

V.V. VOEVODIN[1,2], O.I. KORZHOVA[1], V.Yu. KHOMICH[1], V.A. YAMSCHIKOV[1], N. Yu. LYSOV[2] and A.V. KLUBKOV[2]

[1] *Institute for Electrophysics and Electrical Power of the Russian Academy of Sciences, Dvortsovaya Naberezhnaya 18, Saint-Petersburg 191186, Russia*
E-mail vvvoevodin@ieeras.ru

[2] *Moscow Power Engineering Institute, National Research University, Krasnokazarmennaya str. 17, Moscow 111250, Russia*

Abstract. The distribution of extracted charge in the SDBD configuration with the third electrode is investigated. The amplitude of the ionic current is shown to depend on the polarity of the applied voltage and interelectrode distance

1. INTRODUCTION

In recent years, surface dielectric barrier discharge (SDBD) has attracted increased attention due to its potential for use in various technological applications. The SDBD electrode system typically consists of two electrodes: one exposed to the air and the other covered by a dielectric material. If the discharge is used as a source of ions or chemically active particles, a special electrode configuration can be used in which a third flat electrode is placed above the barrier surface to create a constant electric field. This electrode is referred to in the literature as an extraction electrode (Müller et al., 2007).

Since charge extraction occurs from the SDBD plasma, the width of the discharge region directly determines the area of ion extraction and the concentration of volume charge in the gap between the barrier and the third electrode. To increase the discharge region and the magnitude of ion current, several parallel plasma-generating electrodes located on the barrier at a certain distance *L* from each other are used. Studies show that as a result of the interaction of channels of the counter-developing discharge channels, the electrophysical characteristics of SDBD vary depending on *L* (Lazukin et al., 2022).

Using indirect measurements without time resolution, it was shown that, in the presence of a third electrode, the nature of the spatial distribution of the extracted charge varies with L (Krivov et al., 2020). However, there are no direct measurements in the existing literature of the spatial and temporal distribution of the extracted current produced by the charge carried out of the plasma during the SDBD development.

It seems relevant to carry out measurements of such a distribution using the previously created experimental setup with a sectioned third electrode when applying voltage pulses with nanosecond front duration to the electrode system (Khomich et al., 2022).

2. EXPERIMENTAL

In this work, two versions of the electrode system with a plane-parallel arrangement in atmospheric air with two parallel plasma-forming electrodes (exposed electrodes (1)) made of copper with the distance between them L=10 mm and L=5 mm were used. Geometrical parameters of the electrode system are shown in Figure 1.

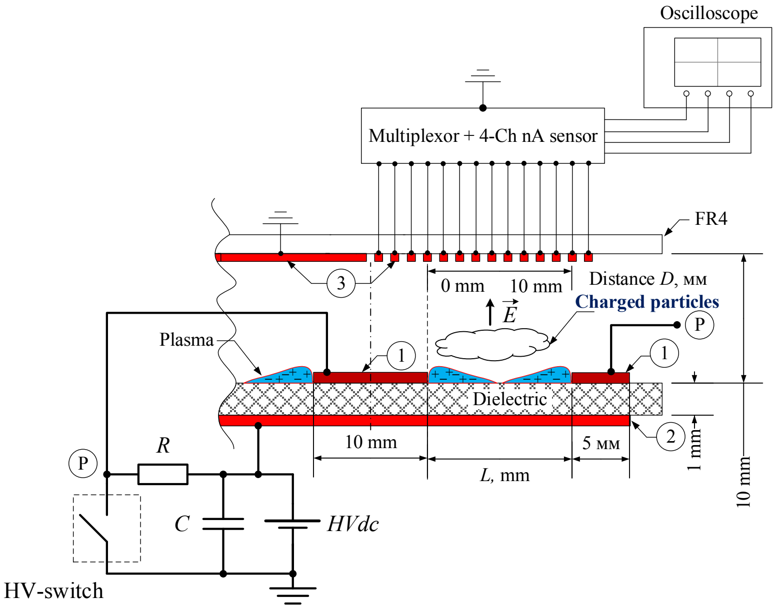

Figure 1: Scheme of the experimental setup and the electrode system: 1 – plasma generating electrodes, 2 – covered electrode, 3 – third sectioned electrode, P – pulsed voltage.

The distance from the surface of the 22XC alumina barrier (1 mm thickness) to the extraction electrode (3) consisting of 12 grounded and insulated copper strips (0.5 mm) was equal to 10 mm. A constant high potential HVdc was applied to the plasma generating electrode (exposed electrodes (1)) and the bottom electrode of the substrate (bottom electrode (2)) to create a field pushing ions towards the third electrode (3).

The voltage at the plasma-generating electrodes was created by a pulse generator by shorting them to ground for a time τ = 500 ns at a frequency f = 2 Hz, the voltage decay and recovery times were 50 and 400 ns, and the voltage was recorded using a Tektronix P6015A high-voltage probe. An electronic nanoamperemeter developed at the IEE RAS (Khomich et al., 2022) was used to measure the spatial and temporal distribution of the extracted current.

The sections of the third electrode, located directly above the area of counter development of discharges, were grounded through the measuring channels of the nanoamperemeter. The edge of the first plasma-generating electrode was taken as the reference point for the horizontal distance D from each section. Signals from the nanoamperemeter were recorded and displayed on a LeCroy Waverunner 104Xi-A oscilloscope. The experiments were carried out in atmospheric air at a relative humidity of 30±4% and a temperature of 22±3°C.

3. RESULTS AND DISCUSSION

An important characteristic of the surface dielectric barrier discharge, on which the values of the extracted current depended, was the extracted charge magnitude. Figure 2 shows the charge distribution by sections depending on the polarity and amplitude of the applied voltage *HVdc*, as well as on the distance *L* between the plasma-generating electrodes on the barrier surface, calculated by formula 1:

$$q_D = \int_{t_0}^{t_{end}} i(t)dt \quad (1)$$

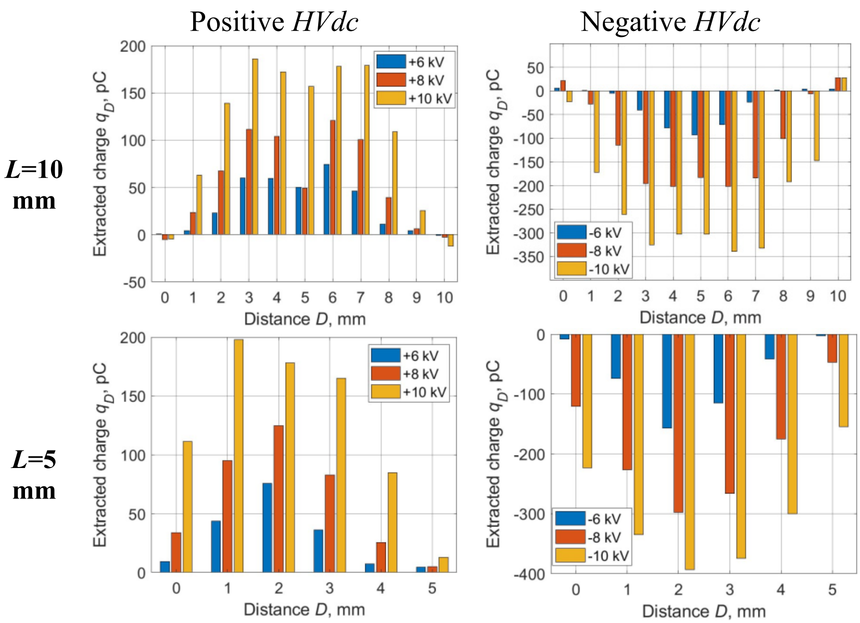

Figure 2: Distribution of the total extracted charge q_D over the measuring electrodes located at different horizontal distances *D* from the edge of the exposed electrode: A—positive, B—negative polarity of *HVdc* voltage.

The total extracted charge Q_Σ in a three-electrode system was calculated as the sum of the charges that arrived to all measuring sections q_D according to formula 2.

$$Q_\Sigma = \sum_{D=0}^{11} q_D \quad (2)$$

HVdc, kV	*E*, kV cm^{-1}	Total charge Q_Σ, pC	
		L=10 mm	*L*=5 mm
+6	6	333	177
– 6	6	–293	–398
+8	8	611	367
–8	8	–1142	–1133
+10	10	1180	750
–10	10	–2323	–1781

Table 1: Dependence of the total extracted charge Q_Σ on the *HVdc* amplitude and polarity for different horizontal distance D from the exposed electrode.

Based on Table 1, we can conclude that the total charge extracted at negative polarity *HVdc* was an order of magnitude higher than at positive polarity, practically at any values of amplitude and distance between plasma-generating electrodes. The charge distribution over the sections of the third electrode remains non-uniform at any voltage polarity and distance *L*. The obtained result may be useful for the use of discharge in plasma technologies.

This work was financially supported by the Ministry of Science and Higher Education of the Russian Federation, Agreement No. 075-15-2024-543 dated 24.04.2024.

References

Khomich V.Yu., Rebrov I.E., Voevodin V.V., Yamshchikov V.A., Zharkov Ya.E. : 2022, *J. Phys. D. Appl. Phys.*, **55**, 275204.

Krivov S.A., Moralev I.A., Lazukin A.V., Selivonin I.V. : 2020, IEEE Trans. Plasma Sci., **48** (7), 2442.

Lazukin A.V., Nikitin A.M., Romanov G.A. : 2022, *Technical Physics Letters,* **48**, 34.

Müller S., Zahn R.-J., Grundmann J. : 2007, *Plasma Process. Polym.*, **4** , S1004.