

Effect of polarity of the voltage pulse on the appearance of the discharge at the breakdown in the nonuniform electric field

Abstract - At the pressures 0.5-3 atm of the air, nitrogen, argon and sulfur hexafluoride (SF₆) an appearance of the nanosecond discharge in the nonuniform electric field is investigated. It is seen, that formation of the bright spots on the flat electrode at the negative polarity of the electrode with small radius of curvature is observed during the changing of the discharge current polarity.

Formation of the diffuse discharge in the nonuniform electric field without using of additional sources of the preionization during the breakdown in the atmospheric air was shown to be due to the generation of the runaway electrons and x-ray [1]. Using of electrode with small radius of curvature allows to obtain runaway electrons in the various gases at the high pressures. It was shown [2], that diffuse discharge formation due to the applying of the high-voltage nanosecond pulses to the gap occurs for the both negative and positive polarity of the electrode with a small radius of curvature. Runaway electrons preionized diffuse discharge (REP DD) was obtained for the both in single shot [2, 3] and repetition rate [4] modes. We consider that formation of REP DD at the positive polarity of the electrode with a small radius of curvature is related with generation of runaway electrons and x-ray as well.

The aim of this paper is to investigate effect of the voltage pulse polarity on the appearance of REP DD in the SF₆, nitrogen, argon and air at the pressures 0.5-3 atm. High-voltage pulses of the both negative and positive polarities from the pulser RADAN-220 applied across the gap. The pulser has an impedance of 20 Ω and produced high-voltage pulses with a FWHM of ~ 2 ns (with a matched load) in the discharge gap at rise time ~ 0.5 ns. Amplitude of the voltage pulse depended on pressure and sort of the gas. Its value varies from 150 to 340 kV in these experiments. The potential tubular electrode of 6 mm in diameter was made of 100 μ m thickness stainless steel foil. The plane electrode was an Al foil which was connected with the chamber case by means of current shunt made of chip-resistors. Measurements of the supershort avalanche electron beam (SAEB) amplitude were carried out

with the collector located behind the Al foil. The interelectrode distance was of 8 or 13 mm.

Integrated images of REP DD plasma glowing are presented on Figure 1. All images for interelectrode distance 13 mm demonstrate diffuse discharge forming due to the propagation of the ionization wave bridged the gap in time less than 1 ns [3]. There are cathode and anode spots on the electrodes (images c, e, f, i, k). These spots may be absent on the flat electrode. As well as a spark leaders (a, g) and spark breakdown (d) can be observed on the background of the diffuse discharge. At the small repetition rate (1 Hz) the following regularities of REP DD formation were established. Discharge appearance in some pulses can vary, but the probability of such deviations was small. Most easily REP DD is formed in the nitrogen and SF₆ at the negative polarity of the tubular electrode (e, i, k). When the polarity of the tubular electrode is positive, bright spots are appeared on the flat electrode (b, d, h, j, l). At the pressure 3 atm of the nitrogen only spots on the flat electrode were out (f). Bright spots on the flat electrode were appeared at the gap distance decreasing. As well as, bright spots on the flat electrode at the negative polarity of the tubular electrode are observed when gas pressure decrease (a). At the gas pressure and (or) interelectrode distance decreasing the impedance of the discharge gap decreases and oscillatory mode is observed. In argon, bright spots on the flat electrode were observed at the both polarities of the voltage pulse (g, h) and throughout gas pressures range. It is related with less impedance of the discharge plasma and oscillatory mode of discharge in the argon, because of step ionization effect. In all gases at the negative polarity of the voltage pulses, SAEB and x-ray were registered. Attempts to register SAEB and x-ray in these conditions at the positive polarity of the tubular electrode failed. However, we consider that generation of the SAEB and x-ray at the positive polarity of the voltage pulses is occurred in all gases. Preionization of the discharge gap at the positive polarity of the electrode with a small radius of curvature takes place owing to characteristic radiation [5].

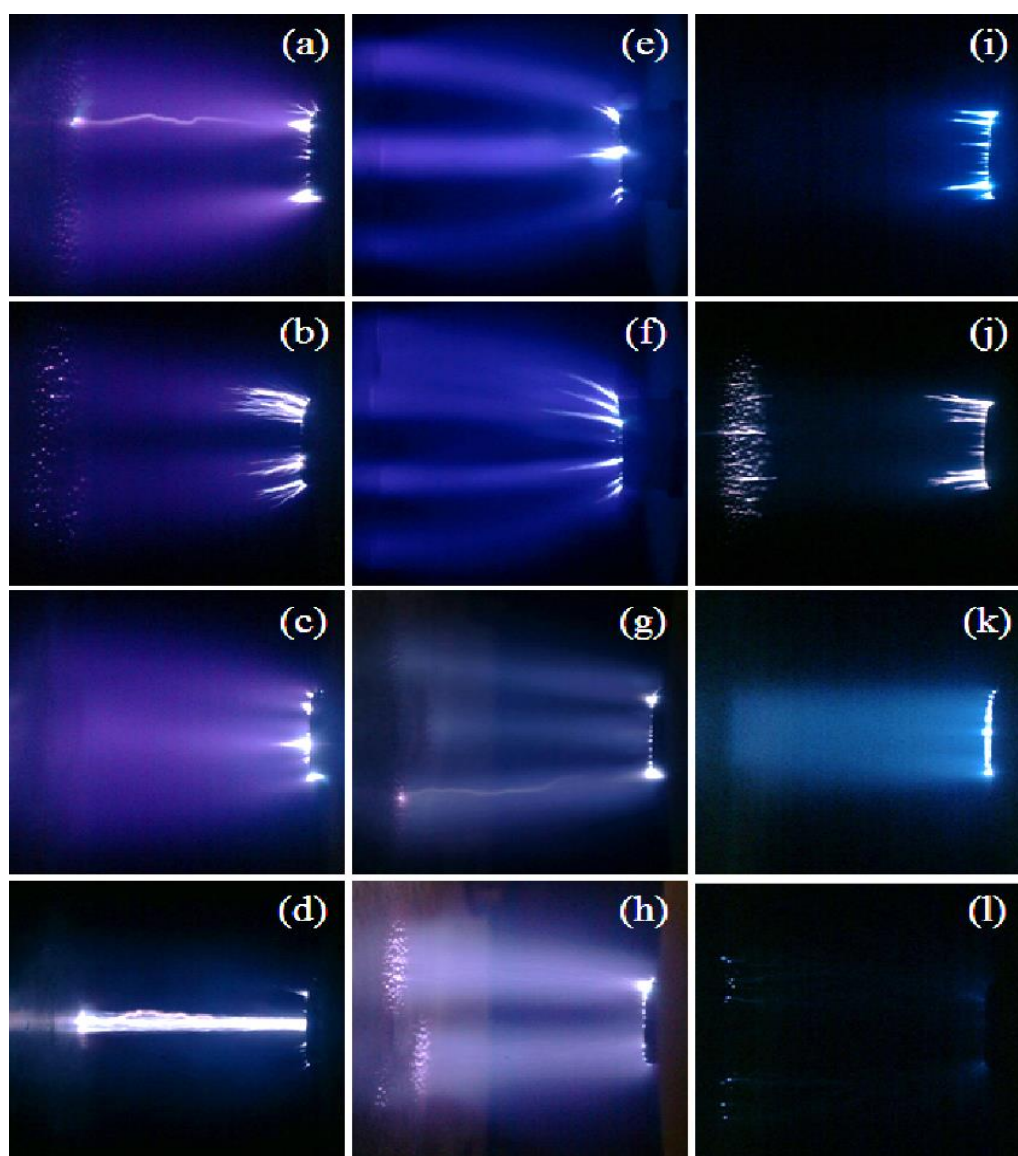


Fig. 1. Discharge glowing in: air at pressure of 0.5 atm (a, b), 2 atm (c, d); nitrogen at pressure of 3 atm (e, f); argon at pressure of 1 atm (g, h); SF₆ at pressure of 0.5 atm (i, j), 1.5 atm (k, l). Polarity of potential tubular (right) electrode is negative (a, c, e, g, i, k), positive (b, d, f, h, j, l).

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