THE EFFECT OF POLARITY ON THE FORMATION OF STREAMERS IN AN INHOMOGENEOUS ELECTRIC FIELD*

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It is well known that the polarity of voltage pulses affects the formation dynamics and parameters of a streamer. The effect of polarity is especially pronounced in the gaps with asymmetric distribution of the electric field strength. Breakdown voltage at positive polarity is less than at negative one (polarity effect) in conditions of slowly varying electric fields [1]. A negative electrode is the shielded by a cloud of immobile positive ions. As a result, higher electric field is required for the development of a negative streamer. Furthermore, with low overvoltage, a positive streamer develops faster than the negative one. In nanosecond discharges with high overvoltage levels, the inversion of polarity effect is observed: breakdown voltage at positive polarity becomes higher than at negative one [2–4]. In recent paper it was shown that at subnanosecond breakdown of a 1-cm tube-to-plane gap, the positive streamer appears later than the negative one [5]. As a result, the voltage at positive polarity increases to large values. However, the effect of polarity on a streamer velocity has not been studied in [5].

This paper presents the results of experimental studies of the effect of polarity on the streamer velocity at various voltage amplitudes. In the experiments, nanosecond voltage pulses were applied across an 8.5 mm point-to-plane gap filled with air and nitrogen at a pressure of 100 kPa. The formation of positive and negative streamers has been experimentally studied using a HSFC-PRO four-channel ICCD camera. Waveforms of voltage and discharge current pulses were also recorded. The propagation velocity of streamers was estimated by a dynamic displacement current (DDC) [6]. It was found that the negative streamer crosses the gap faster than the positive one (Fig. 1). This may be due to the features of the streamer shape near the pointed electrode, as well as the mechanism of gas pre-ionization before the streamer front.

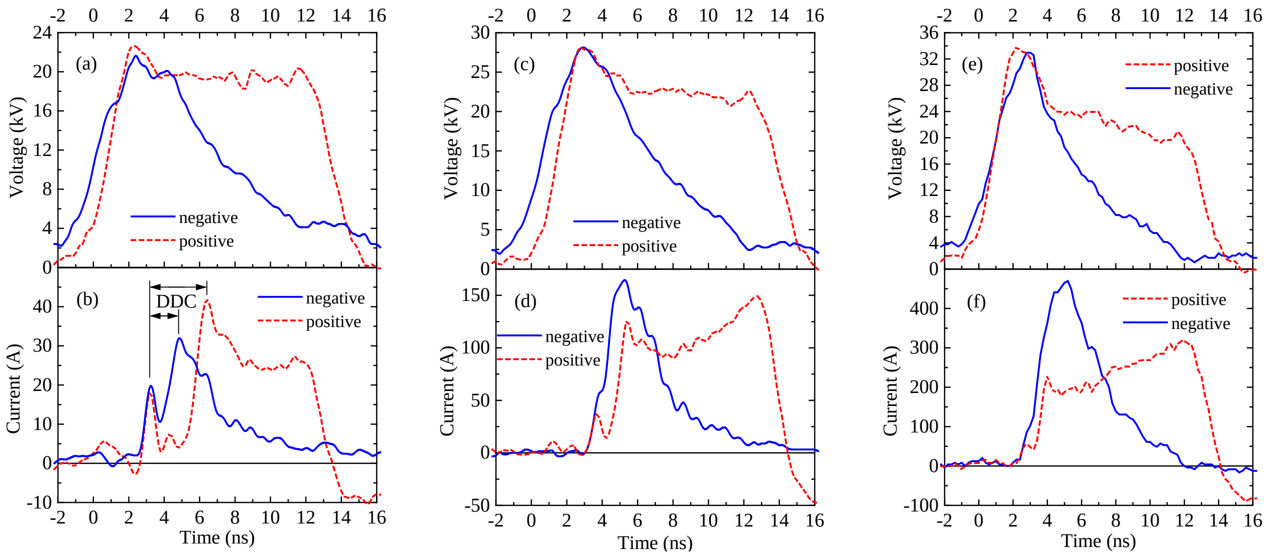

Fig. 1. Waveforms of (a, c, e) voltage and (b, d, f) current during discharge in atmospheric pressure air at different voltage amplitudes and polarities.

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