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QUASI-VOLUME IONIZATION AT THE FINAL STAGE OF STREAMER DEVELOPMENT IN A SHARPLY INHOMOGENEOUS ELECTRIC FIELD*

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Streamer discharges have been studied for a very long time [1, 2]. They are formed at high gas pressures, in particular at atmospheric pressure. Studies of the initial stage of nanosecond diffuse discharges in an inhomogeneous electric field by high-speed methods have shown that a large diameter streamer develops in the discharge gap. It was shown that the streamer velocity changes as it develops and is associated with a change in its diameter and a reduction in the distance to the opposite electrode [3]. It was found that in the final stage, the streamer velocity rises sharply. Uunder some conditions, the propagation velocity of the streamer front can reach practically the light speed [4]. In this work, we studied in the details this stage of the streamer development in air and nitrogen (to exclude the photoionization) at different pressures using a streak camera and an original technique based on measuring a displacement current caused by the streamer. Under these conditions, the initiation of the streamer occurred during the generation of runaway electron (RE) beam with a duration of tens of picoseconds. The waveforms of electrical parameters were accurately synchronized with the streak images. It is shown that REs are generated at the start of the ionization processes in the vicinity of the pointed electrode. The RE current is detected even if the streamer stops somewhere in the middle of the gap. It was found that a quasi-volume ionization (QVI) is observed at the final stage of streamer development. The size of the QVI region depends on the gas pressure. It is assumed that the reasons for the change in the nature of the breakdown are the development of a large-diameter streamer (on the order of the gap length) and the preliminary ionization of the gas by REs.

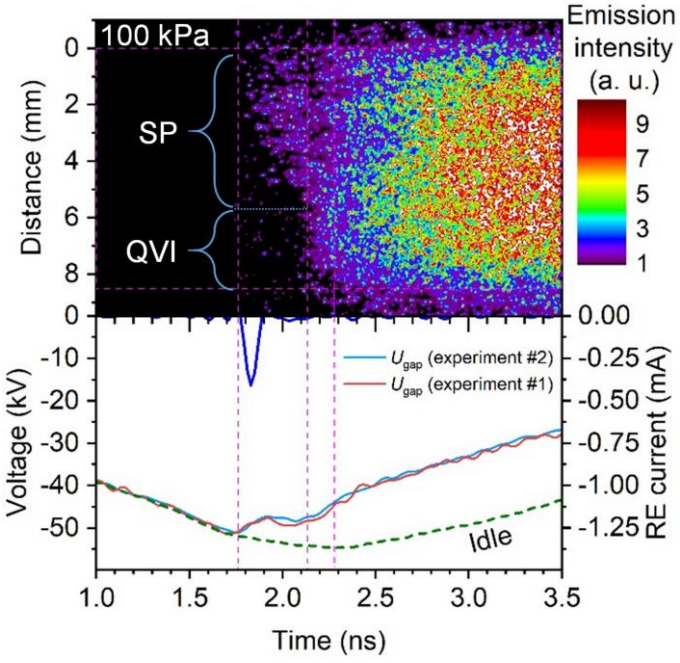

Fig.1. Streak-image of the discharge formation in nitrogen and corresponding waveforms of voltage and runaway electron current.

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