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Propagation process of streamers and time history of reduced electric field during nanosecond pulsed discharge in coaxial electrode in atmospheric air

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Pulsed discharge plasmas which are one of the non-thermal plasma have been actively studied for industrial and environmental applications. The observation of discharge plasma formation is beneficial for better understanding of the plasma physics of this growing field. Generally, a pulsed discharge with time duration of 100s ns is divided into two phases, primary streamer and secondary streamer discharges. The primary streamer discharge has streamer head with the largest electric field among entire discharge phases and thereby produces a variety of radical species with high efficiency. Meanwhile, secondary streamer discharge is capable to produce many radicals by high density electron, however, causes much larger heating loss. Therefore, pulse duration of the applied high-voltage pulse has a strong influence on the energy efficiency of the plasma processes. In the recent study, a nanosecond (ns) pulsed power generator which can generate a pulsed voltage with 5 ns of duration was developed and achieved the higher efficiency on several applications (e.g. ozone generation, NO removal, and water cleaning). However, the fundamental mechanisms of these high efficiencies are not very well studied and understood. Therefore, the present study focused on obtaining the propagation process of streamers and time history of reduced electric field by measuring the intensity ratio of spectral bands of molecular nitrogen during ns pulsed discharge in atmospheric pressure air. In the experiment, the discharge propagation process and time history of reduced electric field in the vicinity of coaxial electrode were observed by using a high-speed gated emICCD camera and time-resolved spectroscopy, respectively. As the result, the reduced electric field of ns primary streamer near the high voltage inner electrode was estimated more than 1000 Td. This can be explained from the effect of significantly fast pulse rise rate of ns pulse voltage with exceeding 10 kV/ns.

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