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Effects of voltage rise rate on pulsed streamer discharge

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Pulsed streamer discharge plasma, a type of non-thermal plasma, is known to generate various chemically active species therefore widely applied to many fields such as water quality improvement and ozone generation. However, detailed physical properties of streamer discharge remain unclear. Thus, basic research on pulsed streamer discharge is necessary.

Some studies report the streamer discharge observation, but mostly based on the unfixed peak voltage. In this study, discharge propagation phenomena were investigated at a fixed peak voltage under various voltage rise rates using an ICCD camera.

In the experiment, a pulsed voltage with a duration of 100 ns was created using Blumlein lines generator and applied to a needle-hemisphere electrodes. The applied peak voltage was about 71 kV with the electrode gap set at 24 mm as measured from the top of the needle to hemisphere surface.

To adjust the voltage rise rates, an inductor was employed in the generator with changing its winding number. A decrease in the number of winding from 5 to 0 resulted in a pulsed voltage rise rate increased from 0.61 to 1.21 kV/ns. Important results are as follows: (1) The ending time of streamer head propagation was delayed, and the voltage at that time increased from 53.1 to 61.0 kV; (2) Streamer head velocity on average increased from 0.45 to 0.58 mm/ns; (3) Brightness value increased at the end of streamer head propagation.

The experimental results elucidate the relationship of pulsed voltage rise rate to various streamer discharge parameters. It can be concluded that pulsed voltage rise rate has a great influence on the physical characteristics of streamer discharge.

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