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Spatial resolved observation of repetitive nanosecond volume discharges under airflows

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Repetitive nanosecond discharges have received considerable attentions for their wide industrial applications. Among these plasma applications, a large volume discharge in atmospheric pressure is currently one of the most widely proposed methods. This paper presents nanosecond volume discharge behaviors under high-speed airflows. ICCD pictures and discharge electrical characteristics are obtained and used to study the effects of airflows on the volume discharges.

The experimental system includes a subsonic air wind tunnel, a nanosecond pulse generator, discharge systems, and measurement systems. The airflow speed can be adjusted with a maximum value of up to 250m/s. The plate-plate electrodes separated by a 6 mm vertical distance are set in a horizontal and parallel manner. The two electrodes are composed of stainless steel plates with the sizes of 40 mm ×100 mm and a thickness of 2 mm. The discharge system is installed at the downstream of the wind tunnel exit, and with the flow direction perpendicular to the electrode surface. The voltage and current are measured by a capacitive divider (bandwidth: 200 MHz, divider ratio: 2200) and a Pearson current probe (Pearson 6585). Both the waveforms are recorded by an oscilloscope (DPO 3014 2.5 GHz). A high resolution ICCD is used to observe discharge development and discharge mode details.

The ICCD plasma images indicate that the volume discharge modes vary with airflow speeds, and a diffuse and homogeneous volume discharge occurs at the speed of more than 50m/s. With different ICCD exposure times, the discharge modes have detailed definition as filament discharge or diffuse discharge. The role of airflows provides different effects on the 2-stage pulse discharges. The 1st pulse currents maintain consistency with airflow speeds, and the 2nd pulse currents always first decrease and then increase. The inhibited effect caused by airflows begins to dominate at higher flow speeds. The pulse repetitive frequency should be high enough to generate stable plasma for high-speed airflow applications.

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