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The discharge propagation and the evolution of electric field and surface charge in nanosecond-pulse surface dielectric barrier discharge

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Abstract: Surface dielectric barrier discharge (SDBD) actuators driven by a nanosecond pulsed power source are considered to have great development prospects because of its fast response and low energy consumption [1]. Meanwhile, rapid gas heat transferred from the electric power and electron energy is significant in SDBD actuators [2]. The time-resolved temperature distribution after the discharge pulse can be influenced by the behavior of surface charges on the dielectric surface. In this paper, a SDBD actuator with a multi-grounded electrode configuration is used to investigate the discharge propagation along the dielectric surface. The currents flowing each grounded electrode are measured to study the discharge propagation and the evolution of surface charge in SDBD actuator. During the voltage rising edge, two current peaks appear on each ground electrode, which indicates two propagation processes of the surface ionization wave (SIW). The primary SIW has a higher velocity while it has a stronger attenuation away from the HV electrode, compared with the secondary SIW. During the voltage falling edge, the polarity of the current is reversed and the surface charge decays much faster near the HV electrode. A non-intrusive laser diagnostic technique, second harmonic generation (SHG), is used to measure the electric field distribution in the nanosecond-pulsed SDBD actuator. A clear SIW propagation process is shown, as the peak of the electric field comes later when the measurement position is away from the HV electrode. During the voltage rising edge, the peak electric field decreases away from the HV electrode. However, during the voltage falling edge, the distribution of the electric field flips with a higher value away from the HV electrode. indicating the accumulation of surface charges on the dielectric surface. This phenomenon is consistent with the measured currents mentioned above. The investigation of the work confirms that an isolated surface charge appears far away from the HV electrode in nanosecond-pulsed SDBD.

Reference

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