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(G*) Streamer Propagation at Water Surface: Influence of Gap Distance and Quantification of Injected Charge.

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A streamer discharge is a highly reactive and dynamic non-thermal plasma. It has been used in many applications, including environmental remediation, medicine, and material processing. Although the physics of streamer discharges in gaseous media is well understood, its interaction with a solid and liquid dielectric surface remains under investigation, in particular when quantitative data are searched for. Here, we investigate the propagation of pulsed discharge at the surface of distilled water, in pin-to-plate geometry and under various experimental conditions of gap distance and applied voltage. The former has been adjusted between 10 and 1000 µm, while the latter was adjusted from 8 to 20 kV; the pulse width was 100 ns. The discharge was characterized electrically, using high voltage and current probes, and optically, using time resolved imaging technique (ICCD camera with temporal resolution of 1 ns).

The results have showed that the discharge is ignited at the anode tip and propagates towards the water surface. Initially, it has a disk-like shape that evolves (after a few nanoseconds) to a ring. Another few nanoseconds later, the ring breaks into dots that propagate on the water surface. Because of its stochastic nature, a large number of discharges was performed to address the influence of the applied voltage and the gap distance on the number of plasma dots produced, as well on the injected charge. As expected, for a given applied voltage, the breakdown voltage is found to increase with the gap distance. Moreover, the total injected charge decays linearly with a rate of ˜8-9 nC by 200 µm of gap distance increase, while the number of dots decreases linearly with the gap distance at the rate of ˜1 dot by 200 µm of gap distance increase. Based on the measurement of the propagation velocity of the plasma dots and on the estimation of the electric field in the medium, an average mobility of plasma dots of ˜1.5 cm2/Vs is evaluated. From both, this value and the instantaneous measured propagation velocity, the temporal evolution of the charge per dot is determined. The observations reported here are of interest for fundamental studies as well as for applications where well-controlled charge transfer to surfaces is crucial.

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