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Observation of Two Consecutive Pulsed Discharge Over Water Surface

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Abstract
Two consecutive pulsed discharges generated over a stationary water surface in argon are observed to understand the post-discharge phenomena. Two ICCD cameras are used to take images of the propagation of the first and the second pulse discharges. A cylindrical vessel filled with argon gas and containing a purified water is used. The pulses with an interval time ranging from 1 to 1000 ms are generated by a pulsed power generator consisting of two MOSFET. When the interval between two pulses is less than approximately 20 ms, the development of the discharge of the second pulse enhanced, and the propagation velocity of the discharge and the charge quantity of the second pulse are higher than those of the first pulse. The maximum discharge velocity estimated from the time change of the discharge length of the first and second pulses are 0.35 and 0.52×10^6 m/s, respectively.

1. Introduction
Pulsed discharge in contact with water has recently been attracting significant attention as a promising technology for various fields such as environmental remediation and agriculture applications, which have been extensively investigated. The discharge enables the instantaneous production of oxidants, with very high oxidation potential, such as hydroxyl radicals, inside the discharge channel at the water surface [1]. However, details of the propagation process of the discharge with a time duration on the order of nanoseconds and its relationship with the chemical reactions occurring at the gas-liquid interface remain open questions. In this study, the post discharge relaxation phenomena of two consecutive pulsed discharges generated over stationary water surface are observed. Two ICCD cameras are used to take images of the propagation of the first and the second pulse discharges. A cylindrical vessel filled with argon gas and containing a purified water. A pulsed power generator consisting of two MOSFETs is used to generate high voltage pulses with a discharge interval.

2. Experiment
Figure 1 shows schematic diagram of the discharge. The reactor consists of a cylindrical acrylic vessel (134 mm in a diameter and 100 mm in a height) covered with a quartz glass disc. The inside of the reactor is filled with an argon gas. A stainless-steel disc is placed on the bottom of the reactor and used as a grounded electrode. A 50 mL of purified water is added to the vessel. A tungsten wire (0.5 mm in a diameter) is placed above the

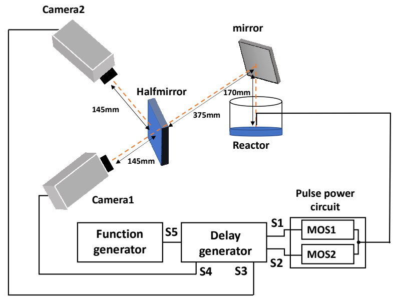

Fig.1 Schematic diagram of the discharge system

water surface with a gap length of 3 mm and used as a high-voltage electrode. The two consequent pulse voltage with an amplitude of 7 kV, a pulse width of 500 ns applied to the high voltage electrode, generated by the pulsed power generator driven by 2 MOSFETs. The pulse duration was varied from 1 ms to 5 ms. The discharge propagation is observed using two ICCD cameras

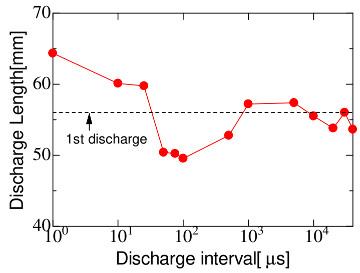

Fig.2 Discharge length of second pulse discharge as a function of discharge interval

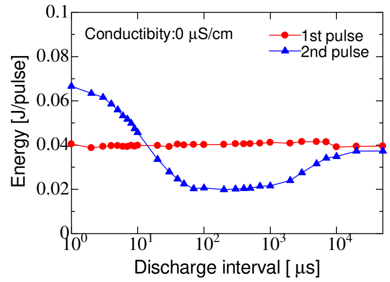

Fig.3 Energy per a pulse of the second pulse discharge as a function of discharge interval

3. Results and discussion

Figure 2 shows the discharge length of the second pulse as a function of the interval time. The discharge length of the first pulse is approximately 57 mm. When the discharge length is less than 20 µs, the discharge length of the second pulse is longer than that of the first pulse. The maximum discharge velocity estimated from the time change of the discharge length of the first and second pulses are 0.35 and 0.52 × 10^6 m/s, respectively. The first and second discharges propagate along the same path when the interval time is less than 20 µs, and the correlation of the path decreases as the interval time increases. Figure 3 shows the energy per a pulse as a function of the pulse interval time. The energy of the second pulse is higher than that of the first pulse of approximately 0.04 J for an interval time of less than 20 µs. These results show that the second pulse discharge can be enhanced by the effect of the first pulse discharge within the post discharge period of less than several µs to 20 µs. The discharge channel increases the gas temperature and the reduced electric field, leading to an enhancement of the ionization. On the other hand, as shown in figure 2, the discharge length of the second pulse is shorter than that of the fist pulse with an interval time from 20 µs to several ms. The charges on the water surface reduce the electric field, which suppress the development of the second pulse discharge.

4. Conclusions

The propagation of two consecutive pulsed discharges generated over stationary water surface in argon is observed to understand the post discharge phenomena. When the interval between two pulses is less than 20 ms, the development of the second pulse discharge is enhanced, and the discharge propagation velocity and the charge quantity of the second pulse are higher than those of the first pulse. The maximum discharge velocity estimated from the time change of the discharge length of the first and second pulses is 0.35 and 0.52 × 10^6 m/s, respectively.

Acknowledgments

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