Time- and space-resolved optical emission spectroscopy on dielectric barrier discharge of helium gas in contact with water

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We have performed time- and space-resolved optical emission spectroscopy on a dielectric barrier discharge of helium gas in a system consisting of a top metal syringe on a water surface. We have observed streamer propagation from positive to negative electrodes for both polarities of applied pulse voltages. After the streamer reaches the counter electrode, the discharge area has shown glow-like structure, which is composed of a positive column, a Faraday dark, and a negative glow, for both polarities. However, the negative glow formed on the water shows weaker emission intensity than the positive column, as opposed to the fact that a negative glow should show higher emission intensity than a positive column in the case of conventional glow-discharges in contact with a solid electrode. This can be attributed to electron attachment by dense water vapor on the water surface.

1. Introduction

Plasma in contact with liquid has attracted much attention because of its various potential applications [1]. However, characteristics of plasma in contact with liquid have not yet fully understood. Shirai and others have revealed static structure in a DC discharge on water [2]. In this paper, we report time evolution of structure in a DBD on water, which is observed by using time- and space-resolved optical emission spectroscopy (OES).

2. Experimental Setup

We applied time- and space-resolved OES on a DBD of helium gas on a water surface. The top electrode was a metal syringe to feed helium gas, and the bottom electrode was a planar surface of deionized water in a glass petri dish. The gas gap between them was 3 mm. Applied voltage was bipolar pulsed voltage (amplitude 1.2 kV, frequency 10 kHz, pulse width 4 µs).

3. Results and discussion

Figures 1(a) and 1(b) show the time- and space-resolved OES profiles for helium (587 nm) when positive and negative pulses are applied on the top electrode, respectively, in which a streamer propagates from the positive electrode to negative one. After the streamer reaches the counter electrode, the discharge area exhibits a glow-discharge-like structure composed of a positive column, Faraday dark, and negative glow. These are common features for both positive and negative polarity. However, the negative glow formed on the water surface shown in Fig. 1(a) has weaker emission intensity than the positive column as opposed to a conventional discharge on a metal electrode. This can be attributed to electron attachment by dense water vapor near the water surface.

Acknowledgements

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References

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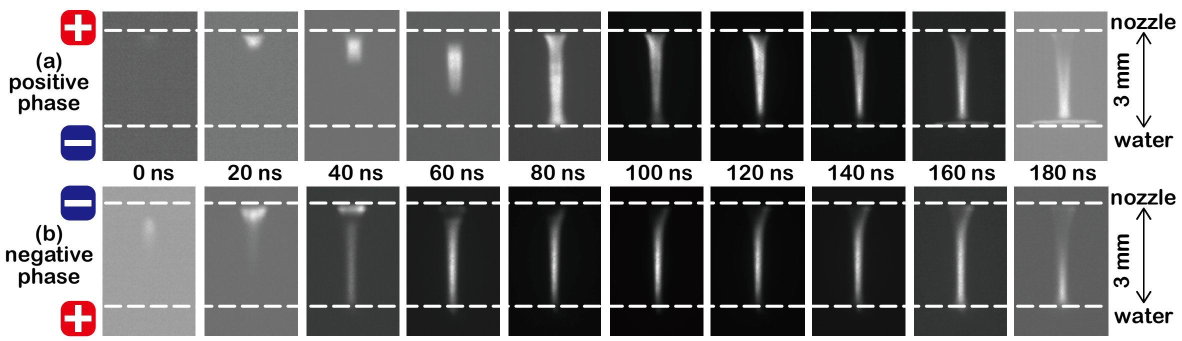

Fig. 1 Time- and space resolved OES profiles on a He plasma jet on water.