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Generation and Application of Broad Type Atmospheric Pressure Plasma Jet
幅広型大気圧プラズマジェットの生成と応用

Hiroshi Akamatsu
赤松 浩

Kobe City College of Technology
8-3, Gakuenhigashimachi, Nishi-ku, Kobe 651-2194, Japan
神戸市立工業高等専門学校 〒651-2194 神戸市西区学園東町8-3

A broad type atmospheric pressure plasma device has been experimentally developed with a funnel nozzle. An atmospheric pressure plasma was generated with helium gas of 5.0 l/min, applied voltage of -8 kV and frequency of 12.5 kHz. A broad type plasma was formed in the funnel by blocking the funnel end with a quartz tube while a plasma plume, which is ordinary formed by a capillary nozzle, was observed without the quartz tube at the funnel end.

1. Introduction

Atmospheric pressure plasma jets, which have highly reactive species such as hydroxyl radical, reactive oxygen species, and reactive nitrogen species, are widely used in material surface modification, decontamination and sterilization applications. Typically atmospheric pressure plasma jets have a single driven electrode configuration [1-6]. In the case of a capillary tube plasma jet design, the diameter of the capillary tube is a few millimeters. Therefore the area irradiated by plasma jet is limited and they are not applicable for large area processing.

Recently, atmospheric pressure plasma jet arrays [7-9] or sheet-type plasma jets [10-11] have been studying by several group. However, it is difficult to generate uniform plasma over a wide area above several 10 millimeters.

In this study, a broad type atmospheric pressure plasma jet device has been developed experimentally. In the device, a funnel was used for a plasma jet nozzle, resulting in generation of wide plasma with a diameter of 45 mm. In this paper, the generation of broad type plasma and observation of the plasma is reported.

2. Experimental Setup

Figure 1 shows a schematic diagram of broad type atmospheric pressure plasma generation. A glass funnel with opening diameter of 45 mm was used as a plasma jet nozzle. A metallic rod with a diameter of 3 mm was inserted in a T-shaped coupling. High voltage pulses generated by a blocking oscillator circuit (ND-600) was applied on the rod electrode. Helium gas, regulated by a flow meter (RK-1650, KOFLOC) was introduced into the coupling. An atmospheric pressure plasma

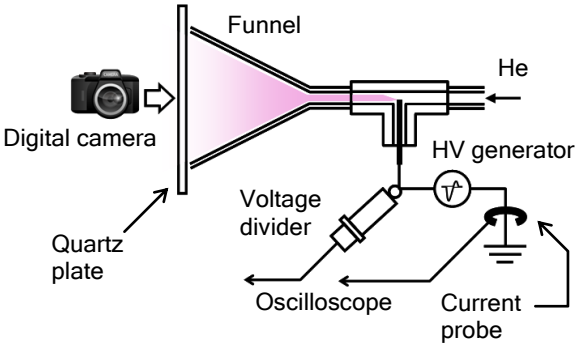

Fig.1. Scheme of broad type atmospheric pressure plasma jet

generated at the rod electrode spread to the end of funnel. The plasma fills in the funnel because a quartz plate with 50 mm x 50 mm was at the end of the funnel. The voltage was measured with a voltage divider (HV-P30, IWATSU) and a digital oscilloscope (TDS2024C, Tectronix). Current with discharge was measured with a current probe (A621, Textronix) and the digital oscilloscope.

A probe of an optical emission spectrometer (SEC2000, BAS) was set to the side opposite to the funnel nozzle. The axis of the probe conformed to the central axis of the funnel nozzle. The probe also was movable to the radial direction of the funnel bottom.

The plasma generated by the funnel nozzle was observed by a digital camera (D60, Nikon).

3. Result

Figure 2 shows typical temporal evolution of voltage and current applied on the electrode. Negative high voltage pulses with the amplitude of -8 kV and frequency of 12.5 kHz were applied on the electrode.

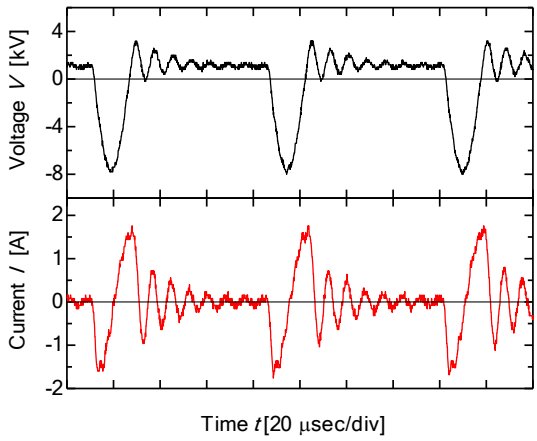

Fig.2. Typical temporal evolution of voltage and current applied on HV electrode

Figure 3 shows photographs of atmospheric pressure plasma jet (a) without and (b) with a plate at the front of the funnel end. As shown in Fig. 3(a), a plasma plume, which is generally formed by capillary nozzle, can be observed in the funnel. On the other hand, the plasma fills in the funnel by blocking the funnel end with the plate.

Figure 4 shows a photograph of the plasma, taken at the end of funnel. As shown in Fig. 4, uniform plasma was formed in the funnel.

4. Conclusion

A broad type atmospheric pressure plasma has been experimentally generated with a funnel nozzle. The plasma was generated with helium gas of 5.0 l/min, applied voltage of -8 kV and frequency of 12.5 kHz. The broad type plasma was formed in the funnel by blocking the funnel end with a quartz tube.

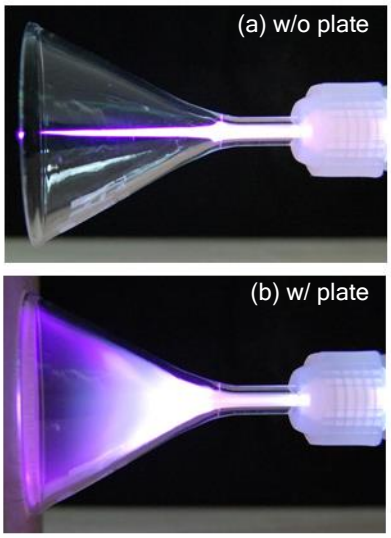

Fig.3. Comparison of atmospheric pressure plasma generated by funnel nozzle (a) without (b) with a plate at the funnel end

Fig.4. Observation of atmospheric pressure plasma taken at the end of funnel

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