9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Self-organized luminescent patterns observed in direct current glow discharge from low pressure to atmospheric pressure

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Introduction

There have been numerous reports of self-organization phenomena involving luminescence at the anode surface in atmospheric pressure DC plasma using liquid electrodes, but the details remain unclear. We have previously reported that pattern formation is influenced by oxygen gas and that a liquid anode is not always necessary[1,2]. To investigate the detailed plasma state, we generated plasma in a helium atmosphere using a discharge capacitor and examined its characteristics.

Experimental procedure

Figure 1 shows an overview of the experimental setup. In this work, the chamber with approximately 3 L volume was used, as shown in Fig. 1. The chamber was evacuated using a diaphragm pump until the pressure inside the chamber reached a few Torr, and then helium gas was introduced into the chamber to fill the chamber with helium gas and achieve the desired pressure, which was checked using a baratron gauge. The power supply was used in CC mode. The voltage-current characteristic was obtained by reading the set current (mA) and voltage (kV) values displayed on the power supply and calculating the voltage at the discharge section by subtracting the voltage across the 50 kΩ resistor. The gas pressure inside the chamber, discharge current, and distance between electrodes were varied in the range of 0.1-1.0 atm, 1-12 mm, and 1-80 mA, respectively, to investigate the experimental conditions under which the patterns were formed.

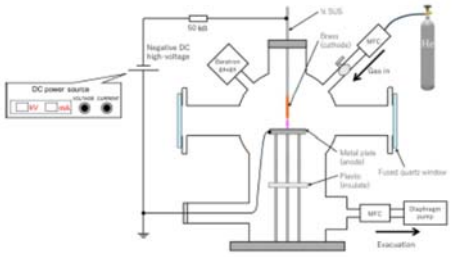

Figure 1 Experimental setup for generating pin-tp-plate DC glow discharge in the chamber.

Results and Discussion

Figure 2 shows discharge photographs taken with a current of 40 mA between electrodes in a helium atmosphere. Self-organizing patterns were observed in all cases where the atmospheric pressure was changed. Figure 2 shows discharge photographs taken with a helium atmosphere and a current of 40 mA, while varying the electrode spacing. Self-organizing patterns were observed in all cases where the pressure was varied. Pattern formation can be explained by the relationship between the product of pressure p and electrode spacing d (pd) and the discharge voltage.

References

[1] N. Shirai et al., Plasma Sources Sci Technol.23 054010 2014
[2] T. Miyazaki et al, Plasma Sources Sci Technol. 33 115007 2024

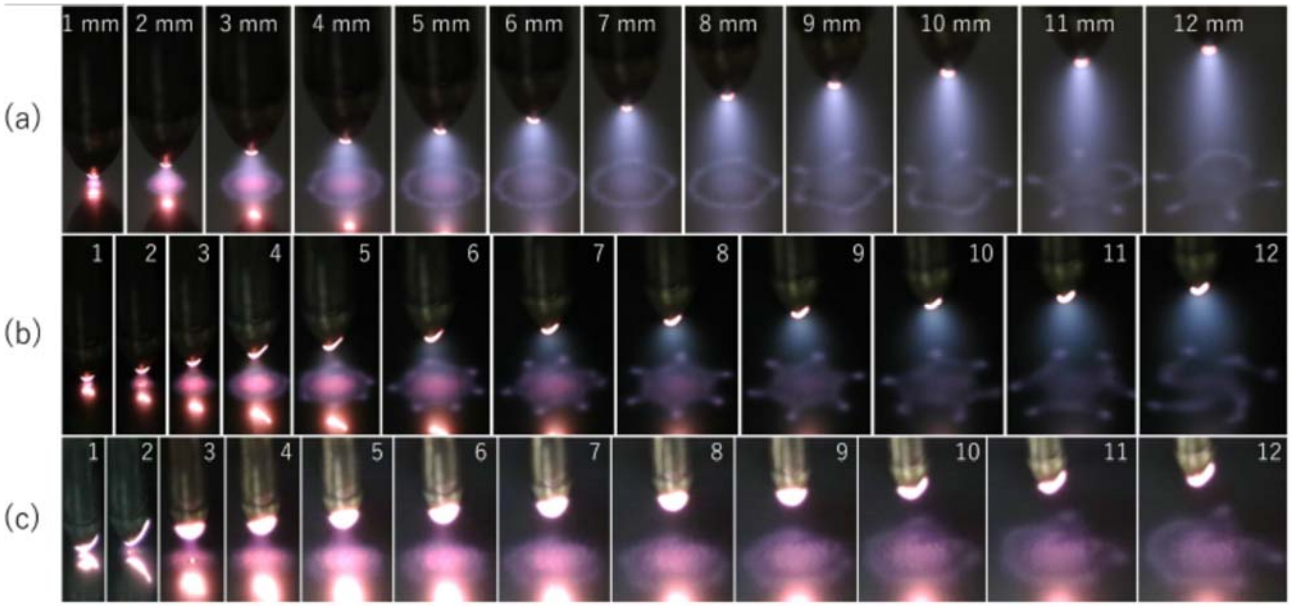

Figure2 Images of the discharge and the pattern formation at the gas pressure of(a)1.0 atm, (b)0.6 atm, and (c),0.2 atm. The discharge current was 5mA. The distance between electrodes varied between 1-12 mm.