Production of Atmospheric Pressure Plasma in a Localized Static Magnetic Field

局所静磁場中の大気圧プラズマ生成

Yosuke Fujita, Kota Oura, Toshiro Kasuya and Motoi Wada
藤田陽資,大浦功太,粕谷俊郎,和田元

Graduate School of Science and Engineering, Doshisha University,
Kyotanabe, Kyoto 610-0321, Japan.
同志社大学理工学研究科　〒 610-0321 京都府京田辺市多々羅都谷1-3

1. Introduction

Atmospheric pressure plasma can be produced by high frequency electromagnetic waves of various frequency like plasma sources operated at reduced pressure condition. However, not many attempts have been made to actively use a localized static magnetic field. For example, Hall thruster is effective in giving a directional flow in plasma by using Lorentz force in strong magnetic field under reduced pressure. Nevertheless, under atmospheric pressure, the mean free pass should be less than about 1 μm. This short mean free path forbids ions and electrons to complete gyro-motion and collective drift of the plasma. Namely, the Hall thruster field geometry may not realize directional plasma flow.

In the present study, we experimentally investigate on atmospheric pressure plasma in a localized static magnetic field.

2. Experimental apparatus

Figure 1 shows the schematic diagram illustrating the structure of the atmospheric pressure plasma source. It consists of three parts: magnetic circuits, coils, and electrodes. The device width is 80 mm, and its height is 66 mm.

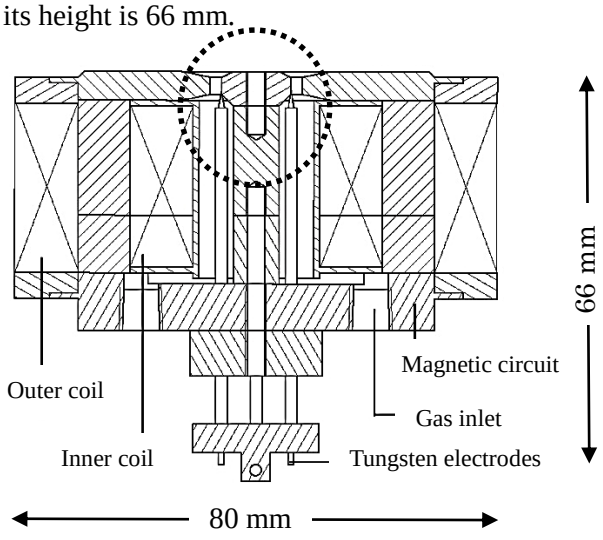
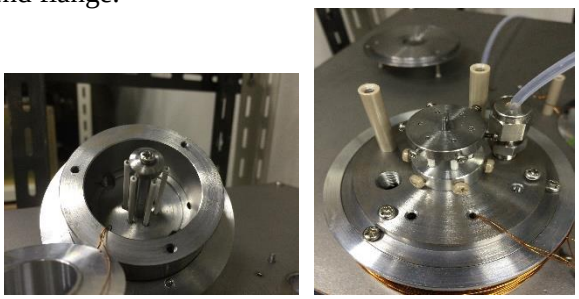


Fig.1 The schematic diagram of the atmospheric pressure plasma source

The magnetic circuit is made of iron, and is designed to form magnetic field structure required for Hall thruster geometry. The magnetic flux density for making Lamor radius to be comparable to the mean free path for 2000 K electron is 1.1 T, and this has been made as the target value calculated from the mean free pass, the electron velocity, and Larmor radius is 1.1 T.

The apparatus has six Tungsten electrodes ($\varphi = 1$) along the discharging part, and they are covered with the insulating tubes made of alumina. Figure 2(a) shows its photo. The discharge gas is supplied to the apparatus from the back end plate to push out produced plasma threads. Figure 2(b) shows the back end flange.



(a) (b)

Fig.2 The photo of the electrodes (a)
The photo of the gas inlet (b)

The two coils, outer and inner shown in Fig.1 are used as electromagnets. In order to see whether enough magnetic field is produced, we conducted magnetic field analysis using MAGNUM: a software for magnetic field analysis. Both coils have 1200 turns of the enameled wire, and the supply current is 4 A. Figure 3 shows the result. The magnetic flux density as large as 0.9 T is obtained.

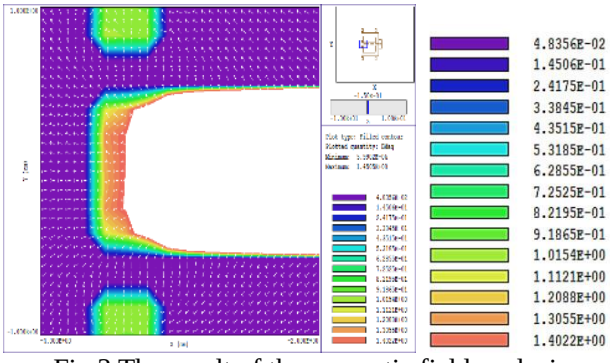


Fig.3 The result of the magnetic field analysis