§8. Potential Difference Formation between Two Floating Electrodes Due to Plasma Flow

Saitou, Y. (Grad. Sch. Eng., Utsunomiya Univ.),
Tsushima, A. (Grad. Sch. Eng., Yokohama National Univ.),
Yoshimura, S.,
Tanaka, M.Y. (Grad. Sch. Sci. Eng., Kyushu Univ.)

A pair of face-to-face electrodes is set in a plasma flow along the external magnetic field line. The back side of each electrode is covered by an insulator to prevent a direct collection of charged particles along the magnetic field line. Under the situation, it is expected that a potential difference of the two electrodes depends on the flow velocity of the ambient plasma. The Face-to-face Double Probe (FDP) is a method to measure a Mach number, M, of the plasma flow by the potential difference, V_0, that is, $M \propto eV_0 / k_B T_{e,in}$, where existence of diffused plasma of the electron temperature, $T_{e,in}$, between the electrodes is assumed[1,2]. This means that a distance of the electrodes should, at least, have to be several times larger than the Debye length when the method is applied to experiments. In the case that the plasma density is very thin, a size of the probe becomes considerably large. In general, probes to measure plasmas have to be as small as possible not to disturb the plasmas. It is worth examining how much a distance of the electrodes of the FDP can be decreased to keep the potential difference of the two electrodes by a plasma flow.

This experiment was performed in HYPER-I device with the radius of 15 cm, where existence of the plasma flow was confirmed using a directional probe[3]. A shape of the FDP is shown in Fig. 1. The size of the FDP inserted in the device was as follows: the boron-nitride (denoted as "BN" in Fig. 1) insulator of 12 mm in diameter and 50 mm in length; A concentric hole of 5.5 mm in diameter is open on top of the insulator and two electrodes of tungsten rod whose diameter is 0.7 mm and length is 4 mm are installed in the hole, that is, a separation of the electrodes is 5.5 mm. This shape of the FDP has an advantage in preventing the collection even if charged particles coming from a side of the electrodes due to $\boldsymbol{E}\times\boldsymbol{B}$ drift *etc.* The FDP is placed at z = 117.5 (cm) and r = 0 (cm). The developed potential difference was estimated by measuring the *V-I* characteristic curves of the FDP.

In the experiments, argon gas was used under the pressure ranged from 7×10^{-4} to 4×10^{-3}Torr. The plasma is generated by the ECR with a microwave of 2.45 GHz, whose power was $3 \le P_w \le 11$ (kW). The strength of the external magnetic field $|B|$ was approximately 1 kG. The density profile along the radial direction was almost uniform. It is found that the electron temperature is almost constant and the electron density has a trend to increases gradually with increasing microwave power.

Figure 2 shows the developed potential difference of the two electrodes due to the plasma flow. In the figure, the potential difference is shown as a function of the injected microwave power. It is found that the magnitude of the potential difference is almost linearly decreased with increasing microwave power. From previous experiments on Mach numbers in HYPER-I using the Mach probe, it is known that the Mach number of the plasma flow is approximately 0.3 when P_w = 5 (kW) and $|B|$ = 1 (kG). It is estimated that there exists a plasma flow under the other microwave power and the potential difference may be induced by the flow.

In summary, it is found that the potential difference of the two electrodes was formed. It is considered that the difference was induced by the plasma flow. To confirm this in detail, it has to be examined how the plasma flow depends on the microwave power as a future work.

1) Y. Saitou and A. Tsushima: Jpn. J. Appl. Phys., **40** (2001) L1387.
2) Y. Saitou and A. Tsushima: J. Phys. Soc. Jpn., **70** (2001) 3201.
3) K. Nagaoka, A. Okamoto, S. Yoshimura, and M. Y. Tanaka: J. Phys. Soc. Jpn.**70** (2001) 131.

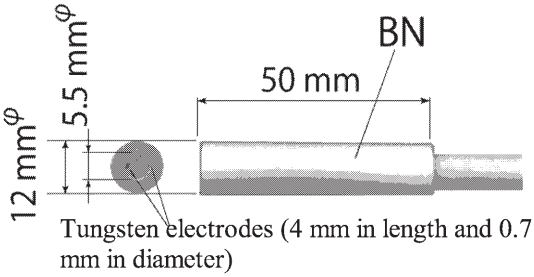

Fig. 1 A picture of the Face-to-face Double Probe with its size.

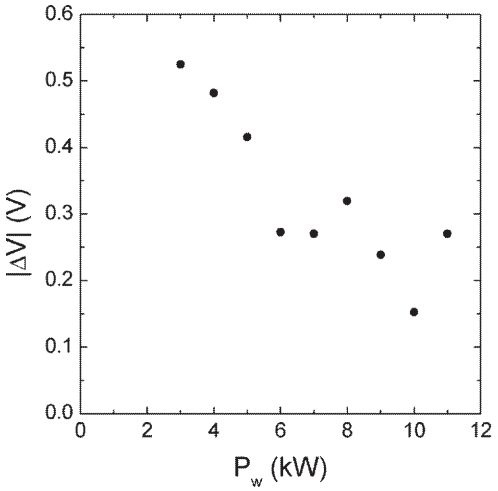

Fig. 2 Developed potential differences by the injected microwave power.