§5. Evaluation of Ion Temperature using Ion Sensitive Probe in HYPER 1 M

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Ion sensitive probe consists of a disk-shape electrode and a cylindrical electrode, which are surrounded by a cylindrical insulator, as illustrated in Fig. 1. A distance, or a height, of the top of the cylindrical electrode from the surface of the disk-shape electrode is set to be comparable of a radius of ion gyro-motion and extremely larger than a radius of electron gyro-motion in a magnetic field. Then, the cylindrical electrode keeps electrons from the disk-shape electrode and the disk-shape electrode collects ions. Thus, the disk-shape electrode and the cylindrical electrode are called "ion collector" and "electron guard", respectively. In result, ion temperature, T_i, is evaluated from the V-I characteristics of the ion collector by assuming the relation of

$$I \propto exp(-eV/k_BT_i) ,$$

where e is the elementary charge and k_B is the Boltzmann constant. Such the probe was first used in a small torus device[1] and its performance is described by Katsumata.[2] However, the relation has not been investigated until recently.

In boundary plasma of the JFT-2M tokamak, an ion sensitive probe with variable height, H, of electron guard, on which current into an ion collector, I, depends, is used and measured so-called H-I characteristics are compared with numerically obtained H-I characteristics for evaluation of ion temperature.[3] Subsequently, the dependence of V-I characteristics with radius, R, and height, H, of an electron guard is numerically investigated by assuming the relation of

$$I \propto exp(-c\, eV/k_BT_i) ,$$

where c is a correction factor, depending on R and H.[4]

In this study, with consideration of the correction factor, c, we evaluate ion temperatures of ECR plasmas with a microwave frequency of 2.15 GHz in the HYPER 1M from the V-I characteristics measured by an ion sensitive probe, the dimensions of which are shown in Fig. 1. The height, 2 mm, of an electron guard is less than the radius of ion gyro-motion, 3.4 mm for a helium ion with 1 eV and 11 mm for an argon ion with 1 eV with magnetic intensity of 846 G., while it is much larger than the radius of electron gyro-motion. The ion sensitive probe was inserted radially from a side port of a cylindrical vacuum vessel and its top was placed at 100 mm from the axis of the device, or 50 mm from the radial wall of the vacuum vessel. The results of the ion temperature evaluation are seen in Table 1 in the case of helium plasma with a gas pressure of 1.6 x 10^{-3} Torr and in the case of argon plasma with a gas pressure of 4.3 x 10^{-4} Torr for various ECR microwave power, P_μ, where the correction factor of 0.95 is used for helium plasma and that of 0.85 for argon plasma. Note that the ion temperatures evaluated are affected by ExB drift motion.

References

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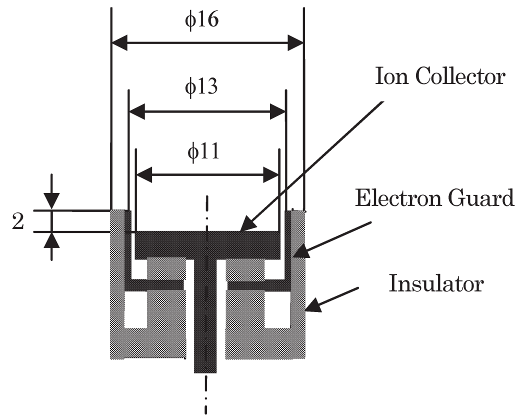

Fig. 1 Schematics of ion sensitive probe, which consists of central electrode and electron guard surrounded by cylindrical insulator.

Power P_μ (kW)	Helim Plasma T_i (eV)	Argon Plasma T_i (eV)
1	4.2	4.9
2	4.8	9.4
3	6.6	7.6

Table 1 Evaluation of ion temperatures, T_i (eV), for helium plasma with 1.6 x 10^{-3} Torr and argon plasma with 4.3 x 10^{-4} Torr for various microwave power, P_μ (kW).