Enhanced Production of ECR Plasma by Exciting Selective Microwave Mode on a Large-Bore ECRIS with Permanent Magnets

Daiju Kimura, Yosuke Kurisu, Keisuke Yano, Sho Kumakura, Youta Imai, Fuminobu Sato, Yushi Kato, and Toshiyuki Iida

Division of Electrical, Electronic and Information Engineering, Graduate School of Engineering, Osaka University, 2-1 Yamada-oka, Suita-shi, Osaka 565-0871, Japan.

§ 1. Introduction

- We have been constructing a tandem type ECRIS. The first stage of the ECRIS is a large bore one, using cylindrical comb-shaped permanent magnets and has an also large bore extractor. The magnetic field configuration is fixed and variable frequency microwaves are fed in the first stage. On the first stage, 2.45GHz and 11-13GHz microwaves can be supplied to plasma chamber individually and simultaneously. The resonance zones of 2.45GHz and 11-13GHz microwaves are located the center and the peripheral regions of the chamber, respectively.

- A mobile plate tuner is used to optimize the beam current. In general, beam current changes by the position of the mobile plate tuner as similar to biased disk. It is known that the beam current is affected by the position of the mobile plate tuner in the vacuum chamber as like a circular cavity resonator. Similar effects are also observed on the first stage.

§ 2. Object

- We use the mobile plate tuner for the optimization of the 2.45GHz and 11-13GHz microwaves.

- We observe the standing wave patterns in the number of efficient microwave mode and obtain the standing wave patterns in the microwave field of the tandem type ECRIS.

- We measure the beam current and the ion saturation current by using a new mobile plate tuner, and obtain excitation of selective microwave modes to enhance ECRIS performance for 2.45GHz.

- We use two different shape mobile plate tuners: One is a multistage cylindrical comb-shaped magnetic field, and the other is a multistage circular comb-shaped magnetic field. The A-type is used in 2.45GHz and 11-13GHz microwaves and the B-type is used in 2.45GHz microwave. The A-type and the B-type are arranged at 0°~145° and 178°~238°, respectively.

- We achieve to excite the selective microwave mode in the 11.3GHz.

- The beam current and the ion saturation current are enhanced by using the mobile plate tuner.

- The variation of the mobile plate tuner affects the A_r and T_r profiles.

§ 3. Experimental setup

- **Tandem type ECRIS**

- **The first stage**

- **Mobile plate tuners of two different shapes**

- **Magnetic field lines of comb-shaped magnetic field**

- **Cylindrically comb-shaped permanent magnetic field**

- **The standing wave pattern of each TE_{m1} mode**

- **Design of the new mobile plate tuner to excite efficient modes selectively**

- **Absorbed power of each TE_{m1} mode**

- **5th Experimental result**

- **Correlation between the beam current and the ion saturation current**

- **Experimental result of excitation of selective mode**

- **B_r & T_r profiles at the maximum & the minimum beam currents obtained by the B-type of mobile plate tuner (2.45GHz)**

§ 4. Conclusion

- The A_r and T_r had peaks near the mobile plate tuner position where the standing wave of standing waves are formed.

- We obtained the dependence on the A_r, against the L_r.

- At the first stage, the efficient modes are TE_{m1} and TE_{m2} in the case of 11GHz and TE_{m1} in the case of 2.45GHz. They are defined by calculating the S_m for each microwave mode.

- We made a new mobile plate tuner to excite a specific mode for 2.45GHz. In the experimental result, we obtained the excitation of the selective modes, i.e., the standing waves of TE_{m1} and TE_{m2} match to the peaks of the A_r and the L_r.

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