§12. Production of Ions and Radicals in H_2 ECR Plasma with Controlled Electron Temperature

Muta, H., Kishida, S., Tanaka, M. (Interdisciplinary Graduate School of Engineering Sciences, Kyushu Univ.), Yoshimura, S.

1. Introduction

Hydrogen (H_2) plasma is widely used for scientific and industrial field. For instance, negative ion in H_2 plasma is used as a negative ion source for the NBI heating of fusion plasma. On the other hand, atomic hydrogen in silane and methane plasma with a large amount of hydrogen dilution plays an important role for the thin film growth of silicon and carbon, respectively. In these applications, there are strong requirements for selective production of ions and radicals in H_2 plasma.

In this study, we focused on the positive ions (H^+, H_2^+, H_3^+) and investigated how the composition and energy distribution of them depend on external experimental conditions [1].

2. Experimental

Temperature and density of the electrons were measured by Langmuir probe. The composition and energy distribution of ions were measured by a quadrupole mass spectrometer (Q-mass, HIDEN EQP-500). The measuring point was z=500 mm. Figure 1 shows the magnetic filed configurations used in this study. Gas pressure, gas flow rate and microwave power dependences were examined for the three types of the magnetic field.

3. Results and discussion

Figures 2 show the composition ratio of the positive ions for 3 mTorr and 5 mTorr. H^+ was great majority in the case of A, B-type. On the other hand, the increase of H_3^+ was remarkable with increasing the gas pressure in the case of C-type.

Figure 3 shows the dependence of electron temperature on gas pressure. There seems little difference among the three types of the magnetic field over the pressure range. Therefore, it is unlikely that the electron temperature directly influenced on the change of the positive ion composition. Next, the microwave propagation in the axial direction was measured by interferometry. There seems big difference between A, B-type and C-type. Namely, the microwave propagated until the ECR region at least in the case of A, B-type. In the C-type, the microwave damped exponentially within the skin depth. Judging from the fact that the electron density of the C-type was almost equal to that of the A, B-type, it is considered that surface waves were excited in the case of C-type. At any rate, we cannot explain the reason that H_3^+ increases drastically in the case of C-type at the present stage. More work is necessary.

4. Conclusion

It was found that ion composition is considerably controlled by adjusting the magnetic field and the gas pressure.

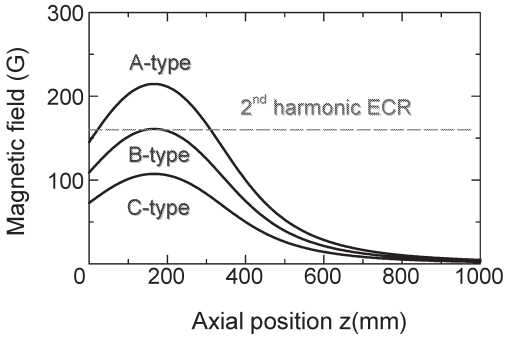

Fig. 1. The magnetic field configurations.

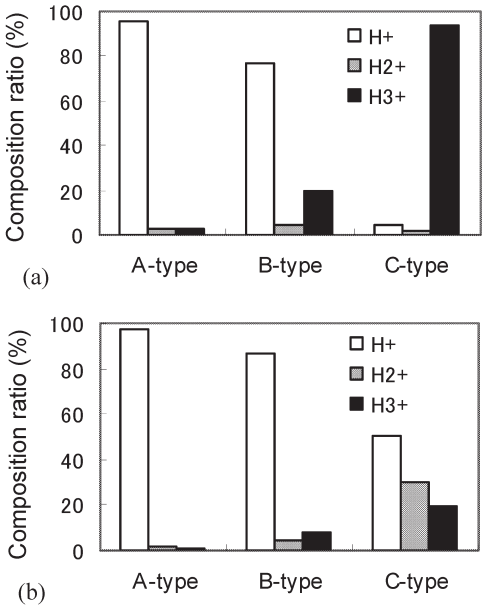

Fig. 2. The composition of positive ions.
((a) 3 mTorr (b) 5 mTorr)

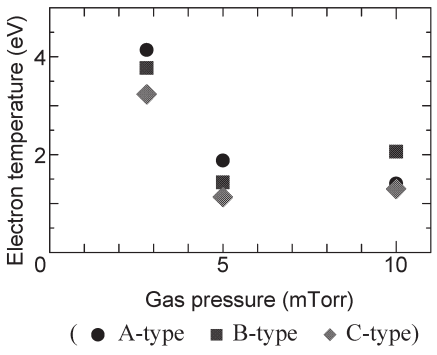

Fig. 3. The dependence of electron temperature on pressure.

Reference

1) Muta, H., Tanaka, M. and Kawai, Y. "Investigation of Composition of Ions in 915 MHz H_2 ECR Plasma" The 8th APCPST & 19th SPSM (Cairns, July 2006).