§ 22. Basic Process of Solid Hydrogen Ablation by Plasma

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From the viewpoint of performance of nuclear fusion plasmas, pellet injection experiments have been actively carried out in many toroidal devices in the sense of the control of density profile, obtaining high density or improved confinement, and diagnostic purposes. However, there exists, so far, only an empirical scaling and the essential part of solid hydrogen ablation by plasmas, such as the interaction between pellet and plasma, have not been clarified until now. For instance, observation of so-called "Tail Mode" phenomena, which may be the result of charge exchange equilibrium state and the plasma rotation by the potential, can be affected by the density profile of the edge plasma [1]. Thus, the study of interaction between plasma and solid is one of the most interesting issues to be investigated in the sense of fundamental plasma science.

In this research, an accumulation of data on the interaction between plasma and solid hydrogen is planned by measuring the fundamental process of pellet injection into an inductively coupled plasma (ICP) and/or an electron cyclotron resonance (ECR) plasma. Both ICP and ECR plasmas are possible to get high-density of 10^{12} cm^{-3} and uniform density profile at low pressure of a few mTorr. These plasmas are considered to be utilized as target plasmas to simulate edge plasmas.

In this year, the ICP discharge is realized at a low pressure (a few mTorr) and a radio frequency (RF: 13.56MHz) power using a helical antenna. We report the experimental results on the fundamental characteristics of ICP as simulated target plasma for solid hydrogen pellet injection.

Figure 1 shows the ICP experimental apparatus. The effect of magnetic configurations on plasma characteristics has been examined in the ICP. Figure 2 shows axial profile of electron density at Ar gas pressure of 15 mTorr and RF power of 150W at various magnetic field configurations shown in Fig. 1. Here, Z=0 denotes the distance from the end plate as shown in Fig.1. It is seen that electron densities at all type magnetic field configurations increase gradually with away from the end plate. Electron density at Type 3 is the lowest in three type magnetic field configurations because a magnetic confinement of electrons is weak owing to the low magnetic flux density. On the other hand, electron density at Type 1 is about two times higher than that at Type 2 whereas the magnetic flux densities of both Type 1 and Type 2 are almost the same values.

In the future work, we will include the effect of magnetic field on the pellet injection through the comparison of these results. Thus, the detailed data will be accumulated by practical experiments. Furthermore, the pellet injections into these two plasma devices are expected to be effective because these plasmas are uniform in density profile and those densities are possible to be controlled with wide range. As the next step, the pellet injection into "HYPER-I" device (n_e=10^{11}-10^{13} cm^{-3}, diameter L=30cm) will be prepared.

References
[1] K.H.Finken and K.N.Sato: American Inst. Of Phys. No.345, p172 (1995).

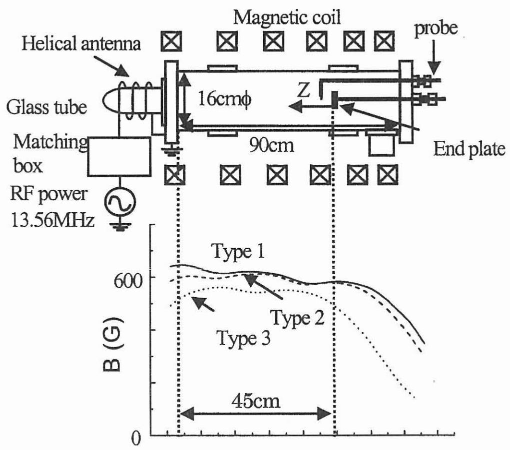

Fig.1 Experimental apparatus.

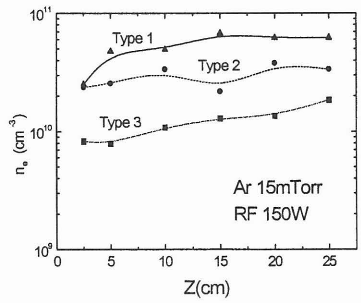

Fig.2 Axial profile of electron density at various magnetic field configurations.