§20. Basic Process of Solid Hydrogen Ablation by Plasma

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Interaction between plasma and solid is one of the important themes, which should be studied in the sense of plasma science. On the other hand, from the viewpoint of performance of nuclear fusion plasmas, pellet injection experiments have been actively carried out in many toroidal studies in the sense of the control of density profile, obtaining high density or improved confinement, and diagnostic purposes. An ablation study has been performed with the international cooperation, constructing IPAD (International Pellet Ablation Database)[1]. However, it is, so far, an empirical scaling and the essential part of solid hydrogen ablation by plasmas, such as the interaction between pellet and plasma, has not been clarified. For instance, observation of so-called Tail Mode , which may be the result of charge exchange equilibrium state and the plasma rotation by the potential, might be affected by the density profile of the edge plasma. Thus, the study on pellet plasma interaction is one of the most interesting issues to be investigated as the fundamental plasma science [2,3].

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. The ICP discharge is realized at a low pressure (a few mTorr) and a radio frequency (RF: 13.56MHz) power using an external hybrid antennas consisting from helical and spiral antennas. On the other hand, for producing ECR plasma, a microwave (2.45GHz) power of 200W is supplied to the vacuum chamber through a window of fused silica with a divergent magnetic field configuration. 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, an ICP with plasma densities of $n_e = 10^{9}$-$10^{12}cm^{-3}$ and electron temperature of Te=0.2-10eV was investigated as a target plasma in Saga University.
The physics and technical issues have been investigated as to the configuration and pellet injector in the cases of parallel and perpendicular injection with respect to B-field direction in the ECR plasma with $n_e=10^{12}cm^{-3}$, Te=0.2-10eV and B=0.875-1kG. In 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. Plasma parameters will be measured by means of a directional analyzer with high angular resolution (1deg) [4], by spectroscopy and emissive probes [5] and so on. 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

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