§13. Basic Process of Solid Hydrogen Ablation by Means of Pellet Injection Apparatus with Changeable Size

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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. 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, have 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.

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 inductively coupled plasma (ICP). ICP is possible to get high-density of 10^{12}cm^{-3} and uniform density profile at low pressure of a few mTorr. This plasma is considered to be utilized as target plasmas to simulate edge plasmas. In this report, we present spatial distributions of plasma parameters in ICP.

The cylindrical vacuum chamber, made of stainless steel, has a diameter of 500 mm and a length of 1000 mm, in which one-turn helical antenna with a diameter of 200 mm is vertically set in the center of the chamber, having the same symmetry axis as the chamber. Pure argon is introduced into the vacuum chamber at a fixed pressure of 5 mTorr to examine the fundamental plasma characteristics. The helical antenna is connected to RF (13.56 MHz) power source through a matching box. The power is ranged from 50 to 500 W to generate ICP plasma. A tungsten cylindrical probe with 0.1 mm diameter and 2 mm length was used for measuring plasma parameters such as density and temperature of electrons. In order to reduce the effect of plasma potential oscillation to the probe measurement, self-compensated LC filter was added. The center in the RF antenna is defined as r=0cm and z=0cm.

Figures 1(a) and (b) show two dimensional structures of density and temperature of electrons, respectively. Here, circle at r =10 cm in Fig.1 denotes the position of the loop antenna. These measurements were done at ranges of 0 < r < 20 cm and 0 < z < 20 cm. The electron density is about 4 x 10^{10} cm^{-3} at r=0 cm and z=0 cm and decreases gradually with increasing a distance to radial direction. It is about 3×10^{10}cm^{-3} at r=20cm and z=0cm. There is a depression of density at r=12cm and z=0cm. This is ascribed by the presence of RF sheath near the loop antenna. It is found that the density over 10^{10}cm^{-3} is performed at wide ranges of 0<r<20cm and 0<z<20cm.

On the other hand, the electron temperature is about 3 eV and its profile is almost uniform spacially at wide region of 0<r<20cm and 0<z<20cm. The temperature at r=7.5cm is about 4 eV. This is caused by the contribution of high energy electrons accelerated by the sheath near the antenna. As the results, it is revealed that inductively coupled plasma is effectively useful for the target plasma.

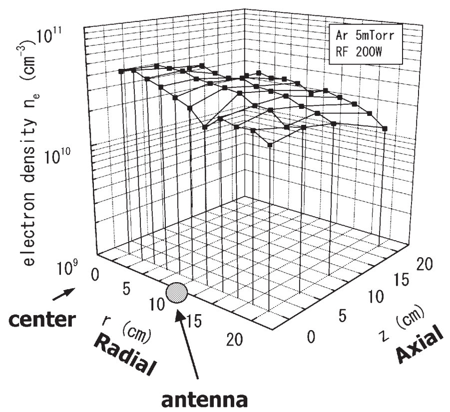

Fig.1 (a) Two dimension structure of electron density

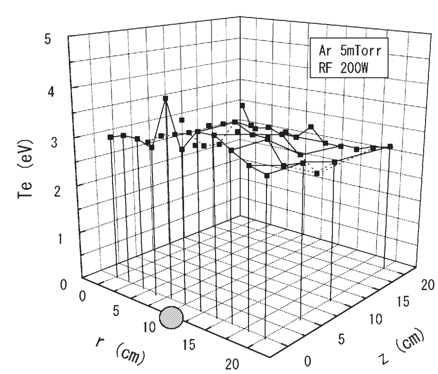

Fig.1 (b) Two dimension structure of electron temperature