§ 38. Characterization of the LHD Divertor Plasma by Ion Sensitive Probe Measurement (III)

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An ion temperature measurement using an Ion Sensitive Probe (ISP) in the divertor leg in LHD has been done during 4th, 5th and 6th experimental cycles. The aim of the measurements is to investigate the ion's behavior in the LHD divertor since it is important to reveal the property of edge and divertor plasma for improving the LHD plasma performance. A lot of studies have been made on electron temperature (T_e) and electron density (n_e) measurements for the divertor region of the LHD. However, an ion temperature (T_i) profile in this region is unknown. Conventional optical methods for measuring the T_i have some difficulty for obtaining the spatial profile of T_i. In particularly, there are many restrictions for the arrangement of optical devices, because the vacuum chamber of the LHD has the complicated geometric structure. An ISP is electrical probes used for measuring the spatial profile of T_i in the magnetized plasmas and has high spatial resolution. Moreover, T_e and plasma space potential (V_s) can be measured, simultaneously.

In 4th experimental cycle, we had designed an ISP for the fast scanning probe system located in the LHD divertor region. The ISP consists of two electrodes that an ion collector (P) and an electron guard electrode (G). The distance between the top surface of the ion collector and the upper end of G electrode is defined as h. The value of h for the experimental conditions of the LHD divertor plasma was estimated to be 0.5 ~ 1 mm according to a numerical simulation and Katsumata theory [1], where n_e, T_e and the magnetic field (B) were assumed to be 5 x 10^{18} m^{-3}, 20 eV and 1 T, respectively. The material of the outside tube was chosen to be BN for withstanding a high heat load from the divertor plasma.

In the 5th experimental cycle, we installed the ISP head constructed during the 4th cycle experiment to the fast scanning probe system and the measurement system was established as shown in Fig. 1. During the cycle, several measurements of plasma parameters in the divertor leg using the probe were performed in hydrogen plasma in the operational configuration with the magnetic axis position of 3.60 m, a toroidal magnetic field strength of -2.887 T (the field direction was reversed from the standard direction). We obtained current-voltage (I-V) characteristics of the inner (Ion Collector; P) and the outer (electron guard; G) electrodes of the ISP inserted in the divertor plasma in LHD obtained during the several discharge shots. In #31256, typical ISP's I-V characteristics were obtained from both electrodes [2]. The I-V curve of outer electrode showed the same characteristic as a conventional single Langmuir probe. On the other hand, the I-V characteristic of the inner electrode shows no negative current at even positive probe voltage. It is reasonable to suppose that electrons are prevented from coming into the inner electrode. T_i is evaluated by the exponential fitting. In this shot, the estimated T_i and T_e were about 20-35 eV. and 5-15 eV at the outside region of the divertor leg, respectively. The spatial distribution of the evaluated T_i is qualitatively consistent with the results of calculations of particle's orbits around the edge and divertor region in LHD.

During 6th experimental campaign, in spite of a new ISP head was installed, most obtained data didn't show reliable T_i because of strong electrical noise. We had tried to check the probe head, but we didn't do that since there were some troubles with the gate value for the fast scanning probe system. In order to improve the S/N ratio and to obtain the full profile of T_i in the divertor plasma, we are preparing an improved ISP head and measurement system for next experimental cycle.

References

1) Katsumata, I., Contrib. Plasma Phys. **36**, (1996) S, 73.
2) Ezumi. N. et al., J. Nucl. Mater. **313-316**, (2003) 696.

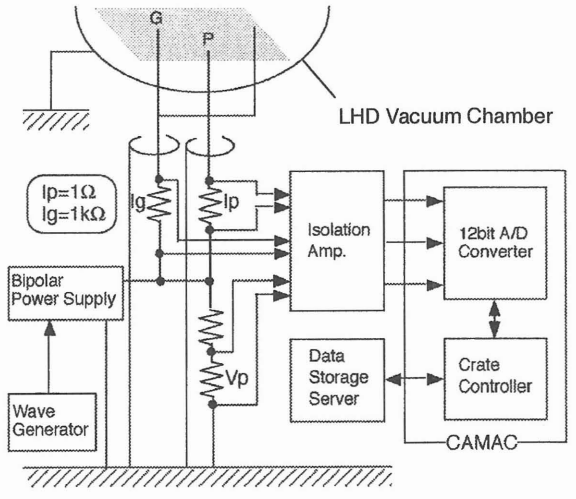

Fig. 1. The electric circuit and the data acquisition system for the ISP measurement during 5th and 6th LHD experimental cycles.