§12. Electrode Biasing Experiments in LHD

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An electrode biasing experiment is one of the active control methods of radial electric field for torus devices. The electrode biasing experiment has the advantage of ability to control radial electric field externally by controlling the electrode voltage and/or the electrode current and to estimate the driving force from the electrode current. In the collaborative research this year, we designed a new electrode and carried out electrode biasing experiments in LHD using the electrode.

Figure 1 shows the configuration of the electrode. We selected carbon as the electrode material due to the high melting point and the low mass density. The electrode head has cylindrical shape with the diameter of 120 mm, the length of 40 mm and the surface area of ~250 cm^2. The electrode was set on the driving apparatus at 4.5L port and was electrically-insulated from the driving apparatus using highly-pure Al_2O_3 pipe.

Figure 2 shows the positional relation between the electrode and the magnetic surface. We tried to bias the electrode positively against the vacuum vessel of LHD and to drive positive radial current by electron collection using a power supply with the capability of 150 V/ 70 A. We must apply biasing voltage over plasma floating potential to realize controllable electrode current. Thus, first of all we investigated the floating potential of the target plasma. Figure 3 shows the radial profile of the floating potential V_f. The target plasma was produced and sustained by ECH (100 kW) under the magnetic configuration of R_{ax} = 3.6 m, B_t = 2.75 T and the typical plasma parameters are T_{e0} < 1 keV, n_e ~ 1.5 x 10^{18} m^{-3}. The floating potential was measured as we set the power supply to 0 A output under constant current mode and monitored the bias voltage. We obtained the radial profile inserting the electrode vertically to the plasma shot by shot. As can be seen from figure 3, it is confirmed that V_f was more than +150 V inside the LCFS.

Figure 4 shows the typical time evolution of the electrode voltage V_E and the electrode current I_E. The electrode was set at Z = -0.85 m (ρ ~ 1.1) and was biased up to +100 V during t = 4-6 s. It was observed that the electrode current of ~2 A was driven in the biasing phase and we confirmed that the safety of electrode biasing experiment for the LHD plasmas produced by 84 GHz ECH under the high magnetic field.

In future work, we are planning to improve the capability of the power supply to drive larger electrode current and downsize the electrode to reduce the perturbation to plasma.

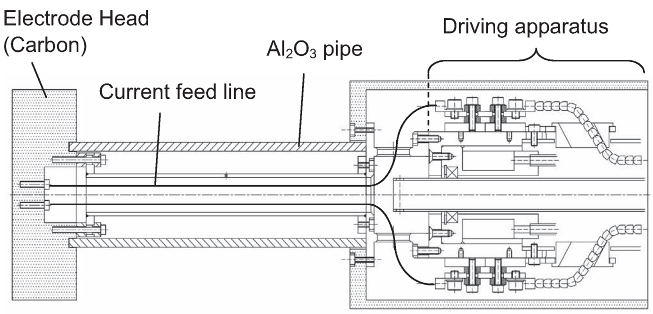

Fig. 1. The configuration of the electrode. The electrode head was made of carbon.

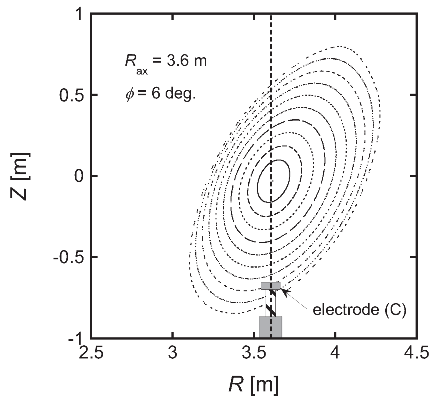

Fig. 2. The positional relation between the electrode and the magnetic surface. The electrode was inserted from 4.5 L port.

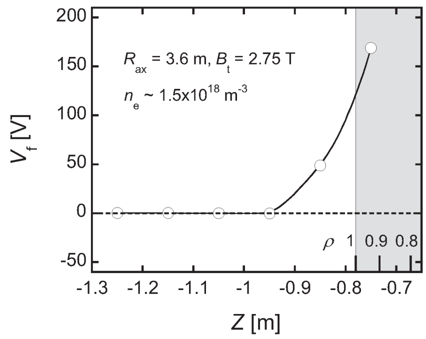

Fig. 3. The radial profile of V_f. The floating potential was more than +150 V inside the LCFS.

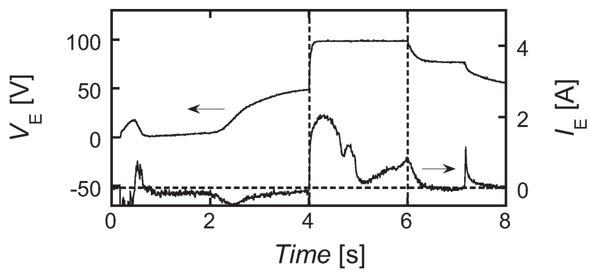

Fig. 4. The typical time evolution of V_E and I_E. The electrode current of ~2 A was driven at t = 4.3 s.