§21. Radial Electric Field Control by Electrode Biasing in Heliotron J

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The radial electric field control experiments were carried out by an electrode biasing in Heliotron J. In L–H transition theories, the local maximum in ion viscosity versus poloidal Mach number M_p around $-M_p \sim 1$–3 is considered to play a key role[1]. This maximum is considered to be related to the toroidicity. In stellarators each machine has its own Fourier components of the magnetic field configuration, causing complexity in radial particle fluxes and in the ion viscous force. In the Tohoku University Heliac (TU-Heliac), the effects of the viscosity maxima on the L-H transition have been experimentally investigated. The poloidal viscosity was estimated from the $\boldsymbol{J} \times \boldsymbol{B}$ driving force for a plasma poloidal rotation, where $\boldsymbol{J}$ was a radial current controlled externally by the LaB_6 hot cathode biasing. It was experimentally confirmed that the local maxima in the viscosity play the important role in the L-H transition[2-6]. However, in the operation condition on TU-Heliac the collisionality is comparatively high (plateau regime) and the friction of neutral particles affects the poloidal damping force. Therefore it is important to perform this biasing experiments mentioned above in the confinement system that has sophisticated diagnostic systems, abilities to produce low collisional plasmas and changeability of the Fourier components of the magnetic configurations. The purposes of our electrode biasing experiments in Heliotron J were, (1) to estimate the ion viscous damping force from the driving force for the poloidal rotation, and (2) to study the dependence of the ion viscosity on helical ripples and bumpiness.

In the biasing experiments in Heliotron J, the H_2 target plasma was produced by the ECH of 2.45 GHz ($P_{max} \sim$ 4kW). We used the hot cathode made of LaB_6 to bias the target plasmas. The experimental set-up for the biasing experiment was shown in Fig. 1. The hot cathode was inserted from the low field side and can be scanned horizontally. We measured the electron density and temperature and the plasma potential by a triple probe. Figure 2 shows the floating potential profiles measured by the triple probe. The electrode position R_E was R_E=130cm ($\rho_E \sim 0.7$) and the bias voltage V_E was 350 V. The floating potential profiles have the deep dip around $0.7 < \rho < 1$ after the biasing. And Figure 2(b) shows the standard deviation of the floating potential which corresponds to the fluctuation level in the floating potential. The radial profiles of the floating potential fluctuation level have also the peaking around $0.7 < \rho < 1$ after the biasing.

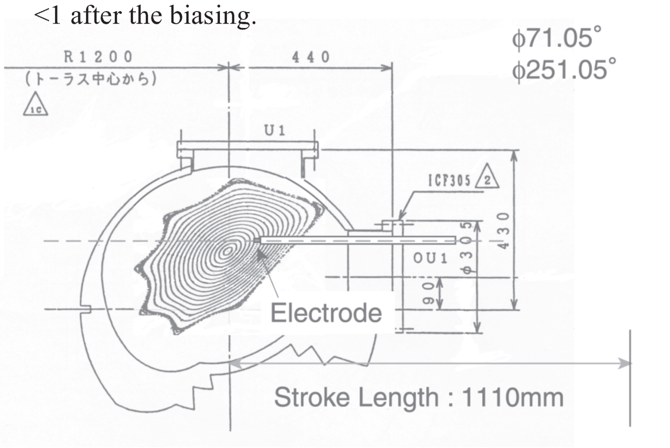

Fig. 1. The experimental set-up for the biasing experiment in Heliotron J. The hot cathode was inserted from the low field side and can be scanned horizontally.

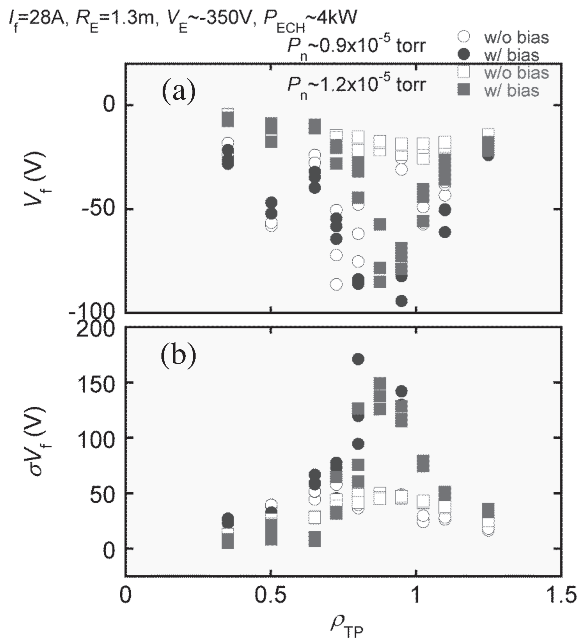

Fig. 2. The radial profiles of (a) the floating potentials and (b) fluctuation levels in the floating potential measured by a triple probe.

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