§42. Transition of Poloidal Viscosity by Electrode Biasing in Heliotron J

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In the Tohoku University Heliac (TU-Heliac), we observed the bifurcation of a radial electric field by a LaB_6 hot cathode biasing [1]. An electrode inserted in plasma generates radial current $\boldsymbol{J}$ and drives $\boldsymbol{J} \times \boldsymbol{B}$ poloidal flows, where $\boldsymbol{B}$ is a confinement magnetic field. Therefore, the electrode biasing experiment is one of useful tools to inject an external torque into confined plasma and control the bifurcation of a radial electric field E_r. In the Tohoku University Heliac, CHS, and LHD, the effect of viscosity maxima on the L–H transition has been experimentally investigated by the electrode biasing [2, 3]. It is important to perform biasing experiments in a confinement system with configuration variability of magnetic Fourier components, e.g., magnetic configuration in helical systems [4]. Therefore, we have been continuing electrode biasing experiments in Heliotron J to study the dependence of ion viscosity on helical ripples and bumpiness.

In this campaign in order to solve the restriction on flexibility in magnetic configurations selected for the biasing experiments in a *low magnetic field* and to perform direct measurements of an ion temperature and a flow velocity, we have adopted the flexibility in the magnetic configuration in a *high magnetic field* in Heliotron J and tried direct measurements of an ion temperature and a flow velocity by CXRS. Using the experiences obtained in the biasing experiment in LHD we manufactured a new type electrode made of carbon (25 mm in diameter and 17 mm in length) for the high magnetic field and improved an electrode driving system. In this campaign we used the power supply for electrode, which consists of MOSFET switches and serves a rectangle waveform output. We produced following results.

1) Using the new type electrode made of carbon we showed the electrical and mechanical robustness of the biasing system in the high magnetic field.

2) We obtained the electrode current characteristics for positive/negative electrode voltage. When the plasma space potential had negative value, the power supply was forced to operate in the second quadrant in the output modes of the power supply.

3) To ECH target plasma in the standard configuration, we successfully performed the electrode biasing and obtained experimental results which showed the increase in an electron density and a stored energy. Figure 1 shows the increase (decrease) in the electron density (red closed circles) after biasing for positive/negative setting voltage. In the negative biasing cases the increases in density (3 ~ 7%) are clearly shown and the decreases in the positive biasing cases. This is supported by the experimental results with Thomson scattering system (Fig. 2).

4) To ECH + NBI target plasma in the standard configuration, we also successfully performed the electrode biasing safely. In this case we can observed the increase in an electron density against both negative and positive biasing (diamond symbols in Fig. 1).

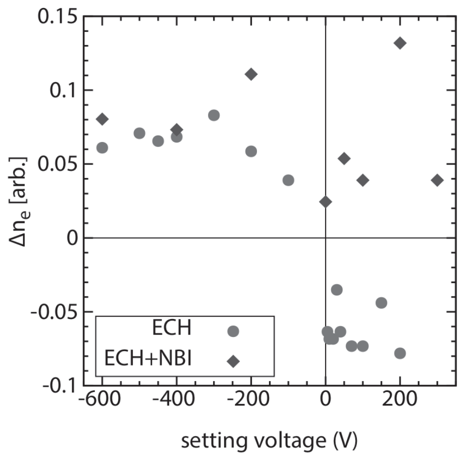

Fig. 1. Dependence of the electron density on the polarity of electrode voltage

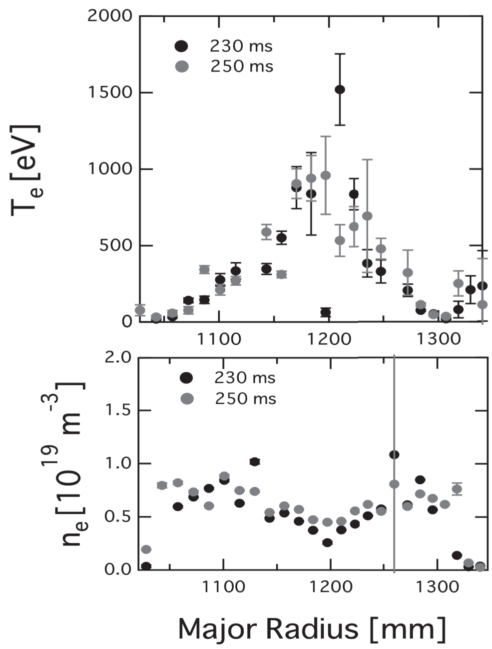

Fig. 2. Experimental results of Thomson scattering system. Black closed circles (before biasing) and red closed circles (after biasing).

1) Kitajima, S., *et al.*: Nucl. Fusion, 46, (2006) 200.
2) Kitajima, S., Takahashi, H. *et al.*: Nucl. Fusion, 48 (2008) 035002.
3) Kitajima, S., *et al.* Nucl. Fusion 53 (2013) 073014.
4) Shaing K. C.: Phys Rev. Lett. 76, (1996) 4364.