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

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In the Tohoku University Heliac (TU-Heliac), we successfully 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 the confinement magnetic field. Therefore, electrode biasing experiment is one of useful tools to inject an external torque into confined plasma and control bifurcation of the 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 electrode biasing [2, 3]. It is important to perform biasing experiments in a confinement system with configuration variability of the magnetic Fourier components, e.g., magnetic configuration in helical systems [4]. Therefore, we have been continuing the electrode biasing experiments in Heliotron J to study the dependence of ion viscosity on helical ripples and bumpiness.

In the biasing experiments in Heliotron J using the hot cathode electrode, the waveform for the bias voltage in the electrode current can be selected. The ramp-up and triangle waveforms were used in the biasing and we observed intermittent increases in the electrode current in the voltage ramp-up stage and ramp-down stage. Then, to precisely observe the intermittent transition, we cautiously chose the operation conditions and successfully observed the same periodic features in the fixed voltage biasing ($V_E \sim -100$ V). The electrode current, electron density, and floating potential also show periodicity in fixed voltage biasing. The period is about 80 ms, and the rise and fall times are about 10 ms each. The pulsating behavior is slower than the pulsation observed in CHS [5]. The radial profiles of the averaged density and floating potential in two states before and after transition are close to the profiles in L-mode and improved confinement mode, respectively. The periodic features are the intermittent transition between two distinctive states.

Figure 1 shows the dependence of the power spectrum density of the fluctuation ($5 < f < 15$ kHz) on the electron density difference between two radial positions Δn_e at $r = 0.5$ and $r = 0.6$. In Fig. 1, we plotted the power spectrum densities evaluated from five intermittent transitions in one discharge. The power spectrum density increased after the increase in Δn_e, which corresponds to the electron density gradient. Lissajous-type dependence can be observed between the power spectrum density and electron density gradient [6].

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 continued to discuss the flexibility in the magnetic configuration in a high magnetic field (standard operation in Heliotron J) and direct measurements of an ion temperature and a flow velocity. Using the experiences obtained in the biasing experiment in LHD we manufactured a new type electrode made of carbon for the biasing experiment in the high magnetic field (25 mm in diameter and 17 mm in length shown in Fig, 2) and improved an electrode driving system. We also tried preliminary biasing experiments in the high magnetic field operation and inspected the robustness of the biasing system.

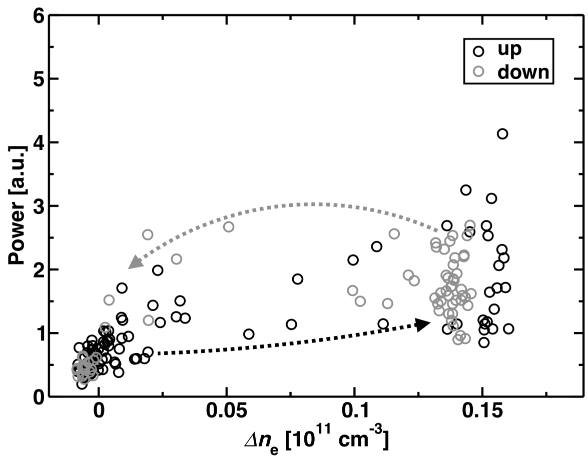

Fig. 1. Dependence of the power spectrum density of the fluctuation in ion saturation current on the electron density difference between two radial positions

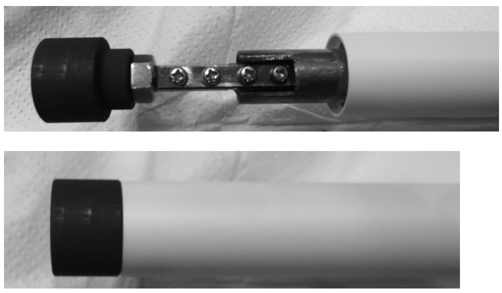

Fig. 2. New type electrode made of carbon for the biasing experiment in the high magnetic field

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