Recent Experimental Results in Tohoku University Heliac (TU-Heliac)

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Tohoku University Heliac (TU-Heliac) has a non-planar magnetic axis, which is a small heliac device (major radius R = 0.48 m, average plasma radius a = 0.06 m and toroidal magnetic period n = 4). In our experiments on the TU-Heliac, the role of the radial electric field on the transition to improved confinement modes has been investigated by electrode-biasing experiments. By negative biasing with a hot cathode electrode, the radial electric fields can be actively controlled by changing the electrode current. The poloidal viscosity was successfully estimated from the $\boldsymbol{J} \times \boldsymbol{B}$ external driving force. It was experimentally confirmed that the local maxima in the viscosity play the key role in the L-H transition [1]. The density collapse was also observed in the improved confinement mode sustained by the hot cathode biasing. The density profiles showed the steep gradient around the core plasma region before the collapse. The steep density profile collapsed accompanied with the bursting high frequency fluctuation ($100 < f < 400$ kHz), which had m = 2 poloidal mode number and the frequency agreed well with the $\boldsymbol{E} \times \boldsymbol{B}$ plasma rotating frequency. After the collapse the steep gradient in the density profile disappeared and the density outside the core region increased in the level consistent with the decrease of the core region [2].

For the development of a new field in biasing experiments, we have fabricated the new type electrode made of hydrogen storage metal for the particle injection (electron, ion and neutral particle). Using the electrode made of titanium (Ti) or vanadium (V) or gold (Au)-coated palladium (Pd-Au), the high-density plasma ($>10^{19}\mathrm{m}^{-3}$) was produced in the negative electrode biasing. Under the low magnetic field (~ 0.08T) in the standard operation, the beta value increased up to about 0.5 %, allowing the realization of a new field of high-beta experiments in small-sized devices [3].

New method of rotating the magnetic islands by the external perturbation fields was also proposed in TU-Heliac. The perturbation fields were produced by 4 pairs of cusp field coil, in which the alternating currents flowed and the currents had the $\pi/2$ phase shift. The phase difference in the floating potential signals measured by the two Langmuir probes confirmed that the magnetic islands rotated in the ion diamagnetic direction. The rotation in the electron diamagnetic direction was also observed in the plasma biased by the hot cathode electrode. These experimental results suggest the ability of the producing plasma poloidal rotation driven by rotating islands [4].

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[2] Y. Tanaka *et al.*, Plasma Fusion Res. **3** (2008) S1055.
[3] H. Utoh *et al.,* Fusion Sci. Tech. **50** (2006) 434.
[4] S. Kitajima *et al.*, Plasma Fusion Res. **3** (2008) S1027.