§63. Study of Temporal Response of Electron Supply from Plasmas to Fast Electron Collection I: Initial Experiment

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Research on confinement and circulation of plasma particles in confined plasmas is one of the most important studies in fusion community. In the QUEST steady state spherical tokamak in RIAM, Kyushu University, mechanism of particle circulation has been investigated. Particle transport by turbulence fluctuation in the plasma edge may play an important role in the mechanism. To diagnose and electrically perturb the edge plasmas of the steady state spherical tokamak, development of an electrode which withstands high heat flux from the steady state plasma has progressed. In this study, initial measurements of current-voltage (I-V) characteristics using a water-cooled movable limiter (ML) were performed to investigate quantity of electric current and fluctuation spectra in the scrape-off layer (SOL) plasma. The information is necessary to evaluate dynamic range of power supply in further study of edge turbulence.

The ML is electrically isolated from the vacuum vessel (VV). To measure the current-voltage characteristic, a number of resistors (10M, 1M, 100k, 10k, 1k, 100, and 10 Ω) are used. Each resistor is connected between the ML and VV in each discharge, and resistance voltage drops are measured during a number of reproducible discharges. Figure 1 shows time evolutions of the voltage drop in reproducible 10 s discharge and I-V characteristic curve. The time evolutions with high resistors of 10M and 1M Ω in figs. (a, b) approximately correspond to the measured floating potential. The ML is located at the far SOL region, 20 mm inside the radial location of the fixed limiters. In figs. 1(a, b), negatively large averaged potential of about 2 kV are observed, suggesting that high energy electrons can access the far SOL plasma. The measured floating potentials have the fluctuation with the amplitude of more than 1 kV and frequency of about 1 kHz (broadband spectra). As the resistance becomes low, the averaged voltage drop also becomes low. When the resistance is low enough that the ML can be estimated to be connected to the VV, the electrical current more than 0.1 A are detected.

Figures 1(h, i) show I-V characteristics averaged over 4-6 s when the abrupt jumps are not observed. We found a linear relationship between the current and voltage in the range of – 2 and – 0.5 kV. On the other hand, a sign of exponential form in the I-V characteristic was observed in the range higher than – 200 V. From the I-V curve, two important findings are suggested. One is that the high energy electron with the energy of keV order can access the far SOL region. The other is that the possibility of bulk electron collection is shown by choosing the voltage range higher than 0 V relative to the VV ground. The collection of the bulk electron is required to observe the bulk electron temperature and to add electric perturbation in the edge/SOL plasmas. The initial experiments succeeded in providing information of operation regimes for investigating edge particle transport in QUEST.

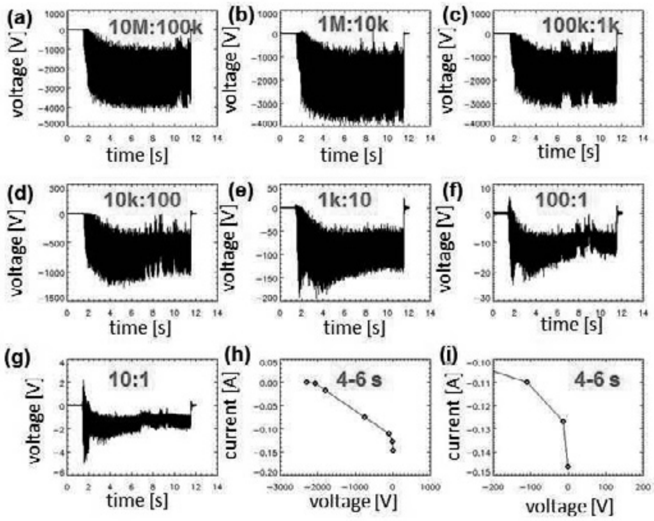

Fig. 1 Dependence of voltage drop on resistance value between the movable limiter and the vacuum vessel in 10 s discharges. (a-g) Time evolutions of voltage drop with the resistance of (a) 10 M, (b) 1 M, (c) 100 k, (d) 10 k, (e) 1 k, (f) 100, and (g) 10 Ω. Figs. (a-b) approximately corresponds to the floating potential. (h) I-V characteristic averaged over 4-6 s. (i) Enlarged view of (h) in the vicinity of V ~ 0 V.