# §12. Study on Spatio-Temporal Structure of Bistable Density Transition

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In the future nuclear fusion studies, understandings of transport barrier and its formation mechanism, which have been actively investigated in NIFS, are crucial. Plasma rotation driven by so-called $\boldsymbol{E}\times\boldsymbol{B}$ drift has been also studied in relation to improvement of the magnetic confinement. Therefore, investigations of the dynamic process of the electric field and its effect on transition phenomena are very important.

We have been trying to control the density transition phenomena along with plasma rotation and density profile modification, using ten concentric circular rings as biased electrodes [1-3]. Here, dynamic changes of plasma performance including the electrode region were studied by applying the steady or pulsed bias voltages. Argon plasma at a pressure $P$ of 0.1 - 10 mTorr in the cylindrical chamber, 45 cm in diameter and 170 cm in axial length, was produced by a RF wave of 7 MHz. Plasma parameters were measured by a developed 24 ch. Langmuir probe and a 3D scanning probe [3]. Data were stored with a data logger. Using this system, detailed spatio-temporal behavior was investigated. Typical plasma density $n_e$ and electron temperature were $4\times10^9$ - $4\times10^{10}$ cm$^{-3}$, 3 - 6 eV, respectively.

Comparing the two states, i.e., state I (high density) and state II (low density), as shown in Fig. 1, floating potential $V_f$ in state II was higher than that in state I, which shows the easier trapping of electrons in state I. On the other hand, ion saturation current $I_{is}$ was smaller in state I than that state II, which is the opposite character in the main plasma region. Applying a pulsed bias voltage from the low to the high voltages to satisfy the transition from state I to state II, fast change of bias current, as shown in Fig. 2, was found. Although the chang of bias current $I_b$ (bias voltage) was less than a few μs (μs), $I_{is}$ in the bulk plasma region changed slowly with less than ms. Here, $V_f$ in the bulk region changed much slower on the order of ms. Note that, near the electrode region, $I_{is}$ and $V_f$ changed fast with less than a few tens of μs [4,5].

In conclusion, we have investigated the detailed spatio-temporal characteristics of density transitions by voltage biasing. Obtained results suggest that the plasma parameters near the electrode play an important role causing the transition, which may be interpreted from the particle behaviors. These understandings will be expected to contribute to the plasma confinement and stability control.

References

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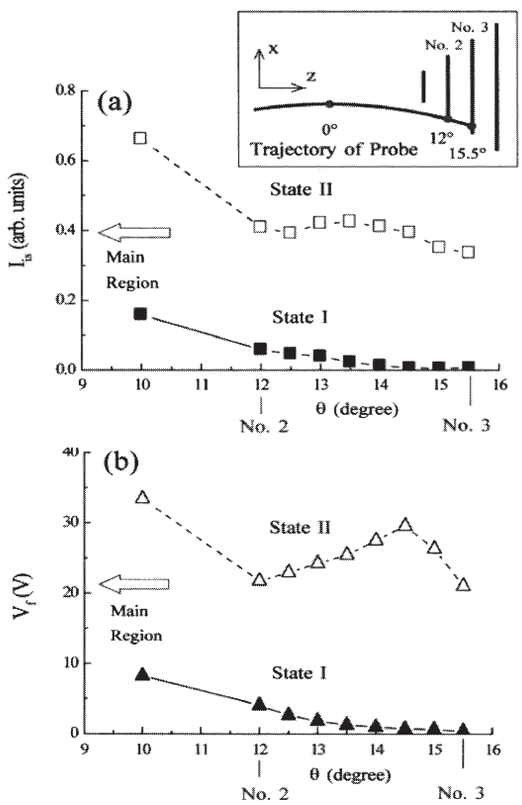


Fig. 1. Spatio-temporal behaviors of (a) $I_{is}$ and (b) $V_f$

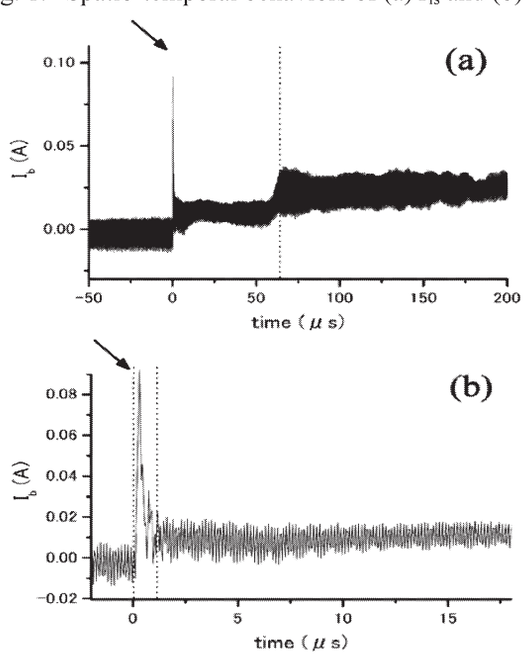


Fig. 2. Time evolution of of $I_b$ [(a) and (b) show different shots].