§10. Generation of Detached Plasmas by using Simple Closed Divertor Module

Ohno, N., Tomiyama, T., Kajita, S., Takagi, M. (Nagoya Univ.), Nakashima, Y., Sakamoto, M., Takeda, H., Hosoi, K., Ichimura, K., Kigure, S. (Tsukuba Univ.), Masuzaki, S., Tanaka, H.

Plasma detachment is thought to be one of the most effective methods to reduce particle and heat loads onto divertor plates in magnetically confined fusion devices. Detached plasma has been mainly investigated in terms of atomic and molecular processes in linear diverter plasma simulators (LDPS). In the conventional LPDS (not like Gamma 10), detached plasmas are generated by feeding sufficient secondary gas to control neutral pressure. On the other hand, in the fusion devices like tokamaks and helical devices, enhancement of neutral recycling near the divertor plates due to plasma density ramp up leads to an increment of neutral pressure in the diverter region to produce detached plasmas (high recycling regime). In order to investigate a fundamental physics of the plasma detachment in the plasma conditions relevant to diverter region in fusion devices by using LPDS, we should establish experimental method to generate detached plasmas in the high recycling regime in LPDS[1]. In this study, we tried to make detached plasma in the high recycling regime in the LPDS by installing a closed diverter module to enhance neutral recycling.

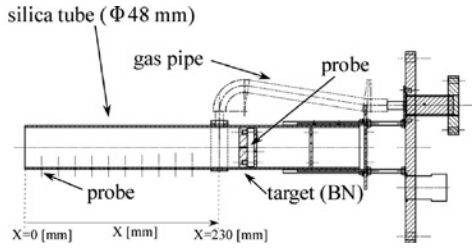

Fig. 1: Schematic of the closed divertor module.

Figure 1 shows the schematic of the diverter module installed in the NAGDIS-II LPDS. Axial profile of ion saturation currents I_{is} was measured with Langmuir probes located inside the module along the magnetic field. Neutral pressure inside the module was detected with a Baratron vacuum gauge. Figure 2 shows the dependence of the neutral gas pressure inside the module on the electron density n_{e0} in front of the module. As the electron density n_{e0} is increasing by varying the dc discharge power, the neutral gas pressure is getting larger to reach about 14 mtorr at $n_{e0} = 1.5 \times 10^{19}\mathrm{m}^{-3}$.

Figure 3 shows the axial profiles of I_{is} as a parameter of the electron density n_{e0}. At a low electron density $n_{e0} = 2.3 \times 10^{18}\mathrm{m}^{-3}$ corresponding to 6.5 mtorr in Fig. 2, the I_{is} gradually decreases toward the target plate. On the other hand, at a higher plasma density $n_{e0} = 1.5 \times 10^{19}\mathrm{m}^{-3}$ with neutral pressure of 14 mtorr, I_{is} at $X = 180$ mm near the target plate becomes less than the one forth of I_{is} at $X = 20$ mm. It means that so-called degree of detachment (DoD) is getting larger at higher plasma density with high neutral recycling.

Spectra of visible light emission were also detected near the target plate with a spectrometer. Usually, in the detached plasmas observed in the LPDS, a series of line emissions from highly excited levels associated with three-body volume recombination was observed. However, we could not observe the series of line emissions from highly excited levels due to three-body volume recombination even at $n_{e0} = 1.5 \times 10^{19}\mathrm{m}^{-3}$. It indicates that the drop of I_{is} in this experiment is not due to volume recombination process.

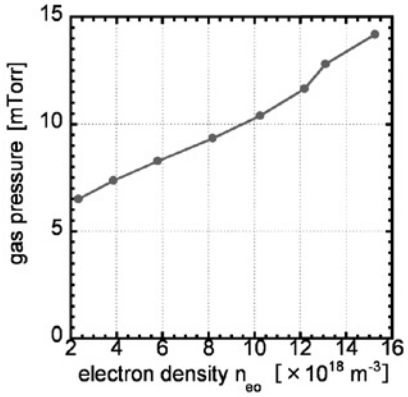

Fig. 2: Dependence of gas pressure inside the module on the electron density n_{e0}.

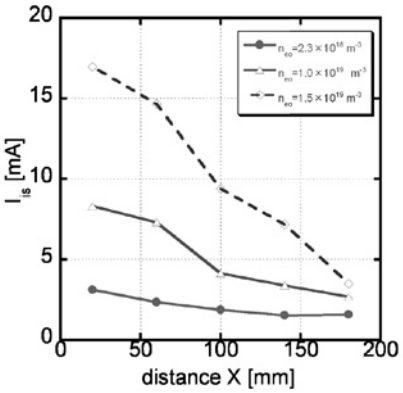

Fig. 3: Axial profiles of ion saturation currents I_{is} as a parameter of electron density n_{e0}.

1) T. Tomiyama, N. Ohno, S. Kajita, M. Takagi, M. Sakamoto, Y. Nakashima, Joint Conf. of the Int. Conf. on OS2012 and PMIF2012, Tsukuba, Japan, P/PMIF-4.