§16. Generation of Detached Plasmas by Using Simple Closed Divertor Module

Ohno, N., Tomiyama, T., Kajita, S., Takagi, M. (Nagoya Univ.), Sakamoto, M., Nakashima, Y. (Tsukuba Univ.), Masuzaki, S.

Plasma detachment by plasma-gas interaction is thought to be an effective method to reduce particle and heat loads on divertor plates in magnetically confined fusion reactors. Mechanism of generation of plasma detachment has been investigated in terms of atomic molecule processes by using the linear divertor plasma simulators. However, to establish plasma detachment to reduce particle and heat loads onto the diverter plate, it is necessary to clarify the influence of plasma detachment on core plasma confinement properties and stability of the plasma detachment.

A closed divertor module is planed to be installed in the tandem mirror GAMMA10 to promote systematical research of plasma detachment. In the mirror end of the GAMMA10, a cryogenic pump is equipped in large volume area. Therefore, even if the large amount of gas is introduced into the end mirror region, neutral particles are easily pumped out. To increase the neutral pressure to produce plasma detachment, a closed divertor module is essential. In this study, we have developed the simple closed divertor module as a prototype[1]. We have investigated its performance in the linear divertor plasma simulator NAGDIS-II.

Figure 1 shows the design of the closed divertor module. The module consists of silica tube and target plate which is made of the boron nitride(BN) and the gas pipe. The inner diameter and length of the silica tube are 48 mm and 400 mm, respectively. The diameter of the plasma is 20 mm. In the silica tube, ten electrostatic probes are mounted. At the BN target, seven electrostatic probes are mounted. The gas pipe is equipped to measure neutrality gas pressure in the silica tube. The enhancement of recycling process increases neutral pressure in the tube. The increase in the neutral pressure may contribute to enhance the recombination process, which is essential for a detached plasma.

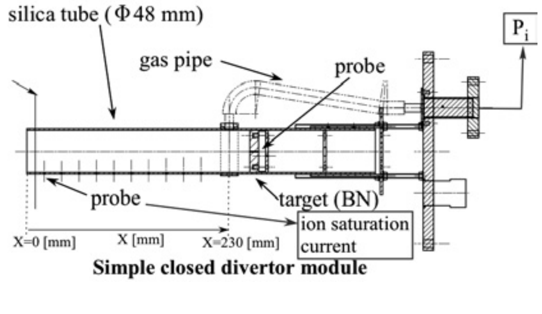

Fig. 1: Schematics of a closed divertor module.

Figure 2 shows dependence of neutral gas pressure inside and outside of the tube on the electron density outside of the tube, n_{eo}. The gas pressure inside of the tube increases with n_{eo} because of the enhancement of the recycling process. On the other hand, at higher n_{eo}, plasma pumping effect leads to reduction of the gas pressure outside of the tube. Figure 3 shows the reduction rate of the ion saturation currents measured with Langmuir probes located near the edge of the tube, I_o and in front of the target plate, I_e. It is found that the reduction rate slightly increases with n_{eo}, however, detached plasmas was not formed in this experiment. To generate detached plasmas, higher gas pressure inside of the tube is necessary. We will improve the module to increase the neutral pressure more efficiently.

1) T. Tomiyama, N. Ohno, S. Kajita, M. Takagi, M. Takagi, M. Sakamoto, Y. Nakashima, Plasma Conference 2011 24P053-P (2011).

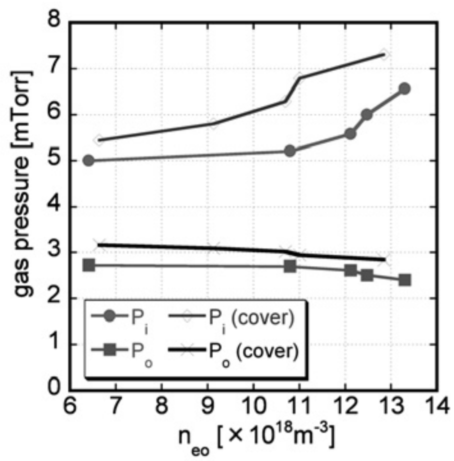

Fig. 2: Dependence of neutral pressures inside and outside of the diverter module on electron density n_{e0}.

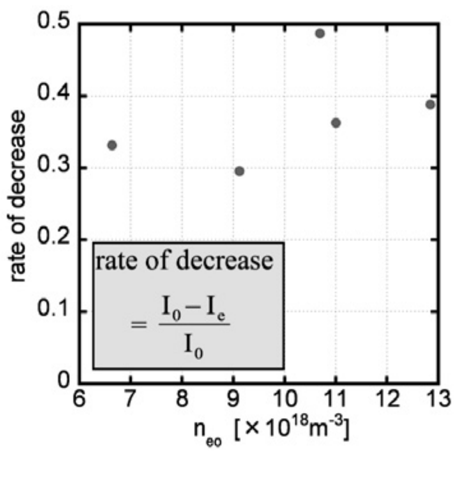

Fig. 3: Reduction rate of the ion saturation currents.