Recent research progress on plasma detachment in divertor simulation experiment in GAMMA 10/PDX: Role of molecular processes and target configuration

N. Ezumi1, T. Sugiyama1, H. Gamo1, K. Nojiri1, A. Kondo1, M. Hirata1, J. Kohagura1, M. Yoshikawa1, Y. Nakashima1, M. Sakamoto1, R. Perillo2, H.Y. Guo3, T. Kuwabara4, H. Tanaka5, N. Ohno6, K. Sawada7, S. Kado7, A. Tonegawa7, S. Masuzaki8

1 Plasma Research Center, University of Tsukuba, 2 University of California San Diego, 3 General Atomics, 4 Graduate School of Engineering, Nagoya University, 5 Faculty of Engineering, Shinshu University, 6 Institute of Advanced Energy, Kyoto University, 7 Graduate School of Science, Tokai University, 8 National Institute for Fusion Science, e-mail (speaker): ezumi@prc.tsukuba.ac.jp

Control of spatial profile and degree of detached plasma is one of the key issues for handling heat and particle load to the plasma facing components and managing high-performance core and edge-divertor plasmas in magnetic fusion devices, such as ITER and subsequently demo reactors. In Plasma Research Center, University of Tsukuba, divertor simulation experiments have been conducted at the end region of the tandem mirror device GAMMA 10/PDX shown in Fig.1 (a). The high temperature end loss plasmas provide an effective tool for simulating edge and divertor plasmas. So far, we have performed characterization of plasma detachment in the divertor simulation experimental module (D-module, see Fig.1 (b)) located at end-loss region of the tandem mirror plasma device for various seeding gases [1,2].

Recently, significant progress has been made on the understanding the synergistic effect of N2 and H2 puffing on plasma detachment in the D-module. We have observed that a combination of N2 and H2 puffing led to a clear decrease of ion flux to the divertor target [3]. The observed spectrum emissions and the detailed analysis of the plasma chemical processes indicate that Nitrogen Molecular Assisted/Activated Recombination (N-MAR) is predominantly enhanced by NHx and NHx+ [4]. The spatial distribution of these emissions and their time evolution have shown that such a molecular process contributes to the plasma detachment process. In addition, the impact of the angle of V-shaped target plate on the detachment is also presented. The target angle is expected to affect plasma detachment by enhancing momentum and energy dissipation of recycling neutrals through local neutral pressure build-up in front of the target. This has been investigated for different target angles using the variable angle V-shaped target system. Images shown in Fig.2 were obtained for the different target inclination angles during the hydrogen discharge in the D-module using a high-speed camera with a bandpass filter of Hα and Hβ. We found that the intensity of Hα and Hβ emissions decreases near the corner of the V shaped target plate as the angle is reduced. This indicates increased degree of detachment at the corner of the V-shaped target and moving of detachment front toward upstream for the reduced angle. Such systematic experiments and the detail analysis may have significant implications for the development of divertor configurations in existing devices and a future Demo.

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Fig. 2: High-speed camera observation of the spatial profile of Hα, Hβ emissions in the D-module for different opening angles of target plate.

References