4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

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

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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 N_2 and H_2 puffing on plasma detachment in the D-module. We have observed that a combination of N_2 and H_2 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 NH_x and NH_x^+ [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 H_α and H_β. We found that the intensity of H_α and H_β 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.

This work is partly supported by JSPS KAKENHI Grant Number 19K03790, and NIFS Collaboration Research program (NIFS19KUGM137, NIFS19KUGM146 and NIFS20KUGM148).

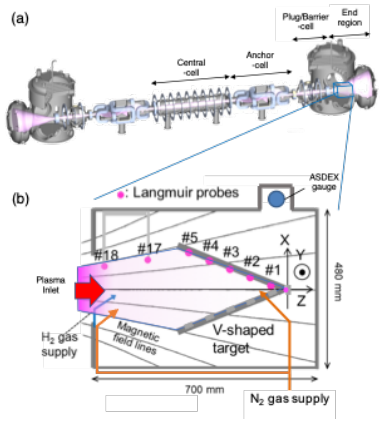

Fig.1: (a) The tandem mirror device GAMMA10/PDX, (b) Divertor simulation experimental module (D-module).

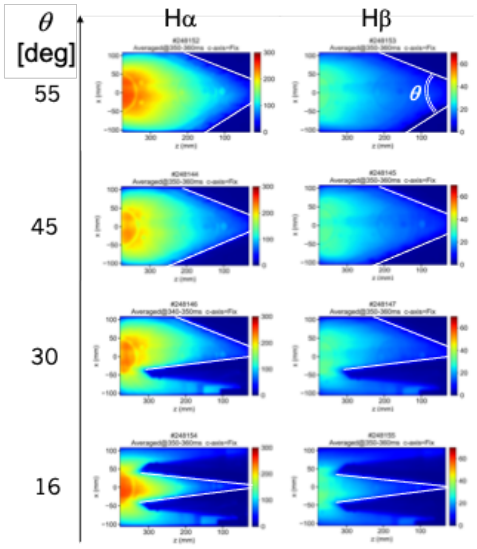

Fig. 2: High-speed camera observation of the spatial profile of H_α, H_β emissions in the D-module for different opening angles of target plate.

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