Recent Results from Divertor Simulation Experiments in GAMMA 10/PDX

N. Ezumi*, T. Okamoto, S. Takahashi, S. Togo, M. Hirata, J. Kohagura, M. Yoshikawa and M. Sakamoto

Plasma Research Center, University of Tsukuba

Plasma-gas interaction is crucial for managing heat and particle flux in magnetic fusion devices, as well as for maintaining plasma control and stability. We studied plasma behavior during detached operations using the divertor simulation experimental module (D-module) with a variable-angle V-shaped target plate in the tandem mirror plasma GAMMA 10/PDX [1]. The plasma in the end regions reaches ion temperatures of several hundred eV and electron temperatures of tens of eV. This high-temperature end-loss plasma is valuable for simulating scrape-off layer and divertor plasmas, facilitating important studies of edge and divertor dynamics.

The importance of molecular hydrogen in the vibrationally excited state in the recombination reaction between hydrogen plasma and molecular hydrogen (H-MAR) is pointed out, and the ratio of Balmer α and β is shown to be one of the effective indicators [2]. Recently, we observed that a further increase in H_2 gas pressure led to a transition from H-MAR to three-body and radiative electro-ion recombination (EIR). A detailed analysis of the transition shows that not only the EIR but also the mutual neutralization between H_2^+ and H^- is significant for the emission from highly excited levels [3]. In combination with hydrogen plasma and N_2 gas, strong particle flux reduction effects are experimentally demonstrated, and NH_x molecules and ions play an important role in the recombination process (N-MAR) [4]. The spatiotemporal behavior of these molecular reaction processes is observed simultaneously using a high-speed camera with a 4-branch optical system. The transition from H-MAR-dominated phase to N-MAR-dominated phase, as well as the coexistence of both MARs, is also observed. This phenomenon relates to the formation of NH_x at the target plate surface, highlighting the importance of the molecular state released from the wall surface [5].

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*Corresponding author: tel.:+81-29-853-6228, e-mail: ezumi@prc.tsukuba.ac.jp (N. Ezumi)