Influence of recombination front region on plasma detachment in a linear divertor plasma simulator

N. Ohno, Y. Hayashi, S. Kajita[a], H. Tanaka, H. Ohshima, M. Seki,
K. Sawada[b], M. Aramaki[c], M. Yoshikawa[d], H. J. van der Meiden[e]

Graduate School of Engineering, Nagoya University, Furo-cho, Nagoya 464-8603, Japan
[a]Institute of Materials and Systems for Sustainability, Nagoya University, Furo-cho, Nagoya 464-8603, Japan
[b]Faculty of Engineering, Shinshu University, 4-17-1, Wakasato, Nagano 380-8553, Japan
[c]College of Industrial Technology, Nihon University, 1-2-1 Izumi-cho, Narashino, 275-8575, Japan
[d]Plasma Research Center, University of Tsukuba, 1-1-1 Tennodai, Tsukuba 305-8577 Japan
[e]FOM Institute DIFFER, Dutch Institute for Fundamental Energy Research, 5612 AJ Eindhoven, Netherlands

ohno@nuee.nagoya-u.ac.jp

Various researches on plasma detachment are currently underway through complementary studies with magnetically confined fusion devices, linear diverter plasma simulators[1], and numerical simulations in order to control heat and particle loads on plasma-facing components. It has been investigated in the linear divertor plasma simulator NAGDIS-II that recombination front (RF) region, in which volume recombination strongly occurs in a detached plasma, has strong influence on the characteristics of plasma detachment. Detailed observation of plasma profiles and dynamical behaviors around the RF was conducted using newly developed two-dimensional driving Langmuir probe (2-D LP) as well as a laser Thomson scattering (LTS) diagnostics[2]. The LTS system, developed with international collaboration of DIFFER, is enable to measure electron temperature (T_e) less than 0.5 eV. LTS data can be utilized to calibrate 2-D LP data. Plasma fluctuations near RF were measured with a microwave interferometer (MI).

In a detached plasma, axial and radial profiles obtained with the 2-D LP show monotonically decreasing electron density (n_e) and T_e along the magnetic field line at the central region of plasma column. On the other hand, in the peripheral region of the plasma column, n_e peaks near the RF, which means a strong local cross-field transport from the central to peripheral region exists near the RF. Plasma instability accompanied with strong n_e fluctuation was observed by MI near RF[3]. The instability leads to the enhancement of the cross-field plasma transport near RF in a detached plasma. The local enhancement of the cross-field plasma transport also changes the plasma flow pattern, showing that inverse plasma flow along the magnetic field at the peripheral region of plasma column appeared[4].

We have also investigated the effects of magnetic field structure on RF by simulating magnetically expanding and contracting plasmas[5]. The total ion particle flux measured with a large-diameter target plate dramatically changed under the detached plasma condition compared to that in attached plasma. Under the detached plasma condition, the magnetically expanding plasma clearly exhibited a significant degradation of detached plasma formation.

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