Characteristics of recombination plasma in divergent magnetic field on the linear divertor simulator TPD-Sheet IV

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The relationship between recombination plasma and divergent magnetic field has been investigated on the linear divertor simulator TPD-Sheet IV. The divergent magnetic field was performed by individually controlling some stationary magnetic coils current and a magnet core. The neutral pressure in upstream and downstream (near the target) of the plasma (P_{up} and P_{down}) was measured by Baratron vacuum gauges. The peak value of the neutral pressure difference ($P_{down} - P_{up}$) depends on the magnetic field strength ratio (R_B) between the upstream and downstream. This peak characteristic was similarly confirmed even if the discharge current was different. It is suggested that the degree of magnetic field divergence has the optimal value to promote recombination.

1. Introduction

The divertor design for stable recombination plasma formation should be optimized to handle high heat and particle fluxes. Recently, a Super X divertor (SXD) is planned to accomplish an active neutral particles control to improve plasma confinement in the high-performance plasma for high power and a long pulse operation [1]. Both the divertor target geometry and the magnetic field design to be compatible with the high-performance plasma is one of key significant issues on stable recombination plasma.

Although there are a number of papers on the numerical simulation of the SXD configuration [2], very little is known about the experimental simulation of the SXD-shaped target on recombination plasma formation. Design studies about SXD-shaped target in the divertor plasma are not easily understood because three-dimensional geometry of the target in divertor plasma of tokamaks is complex. Therefore, in order to verify more accurate validity, it is necessary to investigate by basic experiments how divergent magnetic field exerts changes on the plasma. To be more specific, it is important to clarify the relationship between recombination plasma and divergent magnetic field.

We carried out the experiments for that on the linear divertor simulator TPD-Sheet IV [3]. The divergent magnetic field was performed by individually controlling some stationary magnetic coils current and a magnet core. It was measured the electron temperature and density of the plasma near the target by a Langmuir probe. The neutral pressure in upstream and downstream (near the target) of the plasma (P_{up} and P_{down}) was measured by Baratron vacuum gauges.

2. Results

In the experiment, the recombination plasma was generated by changing the gas flow rate. In the condition of the gas flow rate where the recombination plasma exists, a peak of the neutral pressure difference $\Delta P = P_{down} - P_{up}$ was observed. The peak is considered to indicate the degree of neutralization by recombination. Each peak showed different values depending on the magnetic field strength ratio between the upstream and downstream (R_B). Figure 1 shows the relationship between the pressure difference peak and R_B when the discharge current was 70 A and 40 A. Both discharge currents showed the characteristic that the pressure difference peaks became the maximum in a certain R_B. It was suggested that R_B (the degree of magnetic field divergence) has the optimal value to promote recombination.

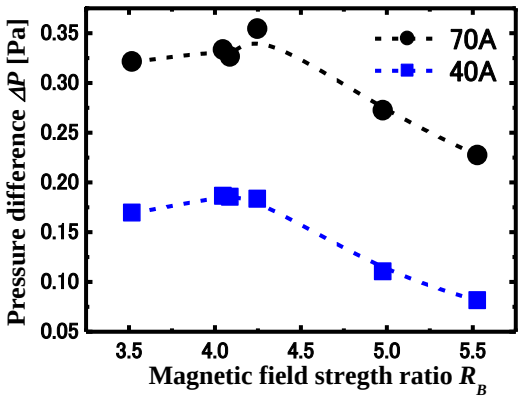

Fig. 1. The relationship between the pressure difference peaks and the magnetic field strength ratio when the discharge current is 70 A and 40 A.

3. References

[1] P. M. Valanju *et al.*: Fusion Engineering and Design 85 (2010) 46–52.
[2] E. Havlíčková *et al.*: Plasma Phys. Control. Fusion 57 (2015) 115001 (13pp).
[3] S. Tanaka *et al.*: Fusion Science and Technology, 63 (2013) 420-422.