8P27

LHDヘリウムプラズマへのボロン粉末投下の効果
Impact of boron powder dropping on helium plasma in LHD

増崎　貴[1), 2)]、ネスポリ　フェデリコ[3)]、ランスフォード　ロバート[3)]、ギルソン　エリック[3)]、庄司　主[1), 2)]、大石鉄太郎[1), 2)]、田中謙治[1)]、居田克巳[1), 2)]、吉沼幹朗[1)]、本島　厳[1), 2]

MASUZAKI Suguru[1), 2)], NESPOLI Federico[3)], LUNSFORD Robert[3)], GILSON Erik[3)] et al

[1)]核融合研、[2)]総研大、[3)]プリンストンプラズマ物理研究所

[1)]NIFS, [2)]SOKENDAI, [3)]PPPL

Boron (B) powder dropping has been conducted in the Large Helical Device (LHD) to investigate the effects of the real-time wall conditioning on plasma and plasma-wall interactions. In hydrogen (H) and deuterium (D) discharges, reductions of intrinsic low-Z impurities such as carbon and oxygen and enhanced wall pumping for fueled particles have been observed [1, 2]. Furthermore, it has been observed during helium (He) discharges that B powder dropping also enhances wall pumping for He. Because B is not reactive with He, the enhanced pumping can be attributed to co-deposition.

The impurity powder dropper developed by PPPL was installed in LHD at a top port. B powder is dropped from the top port to high temperature plasmas with a central electron temperature of a few keV with a typical dropping rate of several tens of mg/s. In both H and D discharges, reductions in fuel recycling and intrinsic low-Z impurities such as carbon and oxygen in plasma have been observed. B powder dropping also affects plasma confinement via modification of turbulence in the core plasma [3].

This study investigated the effects of the B powder dropping on He plasma. He plasmas heated and sustained by ECH or NBI were analyzed. Figure 1 shows time-evolutions of plasma parameters in NBI discharges (P_{heat}~6MW) with and without the B dropping. The line averaged density ($n_{e,bar}$) was kept to be ~ 4×10^{19} /m^3 by the feedback-controlled gas puffing. The emission intensities of B II and B V start to increase from 4 s indicating the dropped powder reached to plasma. The dropping rate was kept constant during the discharge. It is clearly seen that neutral pressure and He I line intensity decrease with the B dropping. On the other hand, the control voltage of the piezo valve for the gas puffing in the discharges is almost the same though electrons were supplied by B particles, too. These suggest that He recycling was reduced with the B powder dropping.

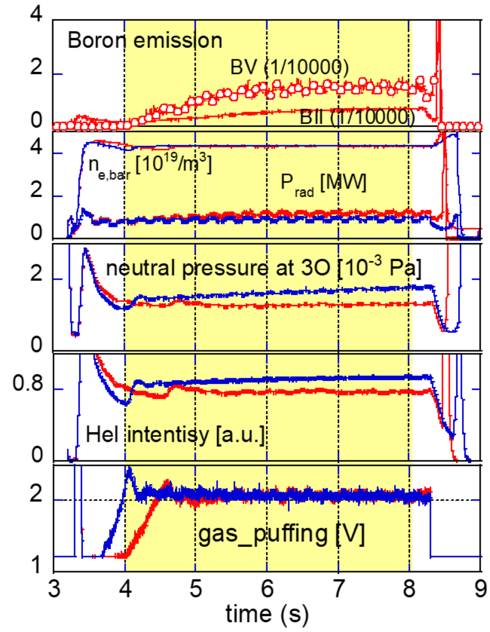

Fig. 1. Time-evolutions of plasma parameters in NBI discharges (P_{heat}~6MW) with (#178587, red) and without (#178585, blue) the B dropping. From time=4s, the powder attached to the plasma. In these discharges, the density ratio of He /(He+H+D) was larger than 0.7.

Because B is not reactive with He, the reduced He recycling can be attributed to co-deposition. A numerical simulation using EMC3-Eirene code, DUSTT code, and ERO2.0 code showed that dropped B particles deposit on divertor tiles along the divertor traces at which large He recycling occurs [4]. That can make the co-deposition to be efficient.

[1] F. Nespoli et al, Nucl. Mater. Energy 25 (2020) 100842.
[2] R. Lunsford et al, Nucl. Fusion 62 (2022) 086021.
[3] F. Nespoli et al, Nat. Phys. 18 (2022) 350–6.
[4] M. Shoji et al, Nucl. Mater. Energy 25 (2020) 100853.