§58. Boronization in LHD

Nishimura, K., Sagara, A., Noda, N., Komori, A.

In Large Helical Device (LHD), boronization (boron coating) using diborane gas was carried out as a part of wall conditionings during 5th campaign of experiments. Diborane gas was supplied in helium glow discharge plasma. As diborane gas supplied in glow discharge plasma was decomposed into boron and hydrogen easily, hydrogen was exhausted and boron was coated on a vacuum chamber wall. As a result, suppression of impurity release from a wall was expected. Figure 1 shows a schematic figure of the Boronization system. High-pressure supplying lines of diborane gas consist of co-axial tubes for safety, and exhaust gas is led to the diborane filter unit where residual diborane gas changes to the nonpoisonous oxidized gas by catalysis. Quantity of supplying diborane gas is controlled by a mass flow controller (MFS). For safety, 6 diborane detectors are installed around and in this system.

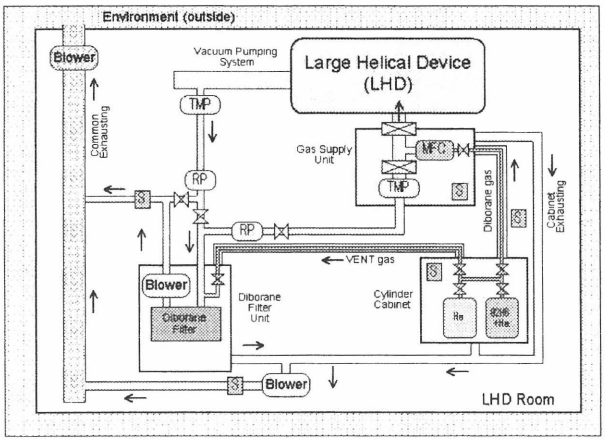

Fig. 1. Schematic figure of the Boronization system.

During 5th experiment campaign, boronization was carried out two times, January 12 and January 28. Diborane gas was supplied at 1.5L port which was apart 180 ° from vacuum pumping system. Duration of boronization was 6 hours and 7 hours, respectively, and supplied volumes of diborane were 7.2 NL and 14.4 NL, respectively. Thickness of the boron film estimated from supplied boron volume was 20nm and 40nm, respectively. It was estimated that about 3 sector (around 30% of LHD chamber wall) was done coating in a toroidal direction.

Figure 2 shows comparison of emission lines of Oxygen (OV) between before and after boronization. These shots had similar density and temperature. It seems that the oxygen impurities reduces in around 20-30% by boronization. Metal impurities and total radiation power were reduced slightly (20-30% reduction).

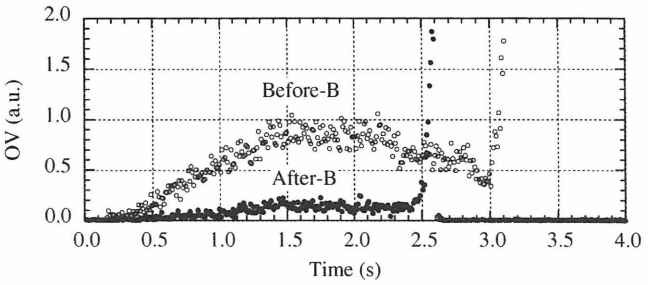

Fig. 2. Comparison of emission lines of Oxygen (OV) between before and after Boronization.

Figure 3 shows comparison of an operational density regime before and after boronization. The symbols except ∇, Δ show the data at stored energy maximum. Symbol ∇ shows the data at the maximum density before collapse and the symbol Δ shows the data at recovered maximum stored energy. Gas was supplied by gas puff except pellet data. The electron density reaches at higher region after boronization only by gas puff. It may be caused by the suppression of a radiation power by impurities.

Although the confinement time decreases a little, it is possible to get high nuclear fusion triple product ($n\tau_E T$) by increase of gas more or utilize a re-heat phenomenon. However it needs more detail operation and analysis to confirm such condition.

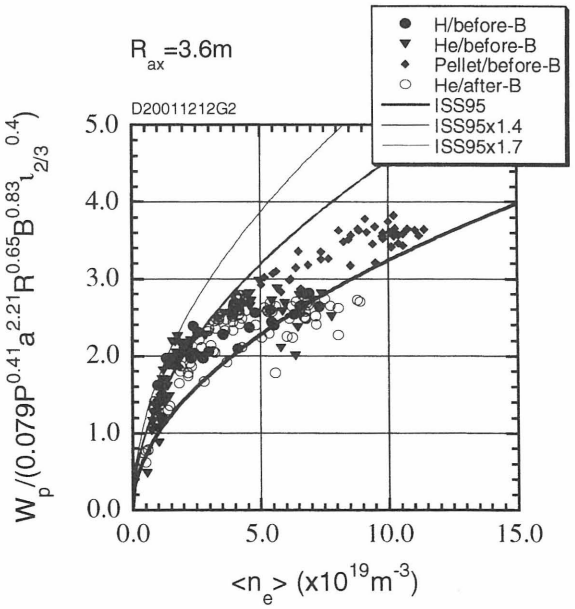

Fig. 3. Comparison of operational density region between before and after Boronization.