§4. Boronization and High Density Plasmas

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Good wall conditioning and impurity-control are important to get high plasma performance. To reduce impurity release from the chamber wall, boronization using diborane (10 % B_2H_6 in helium) was started from FY2001 (5th experimental campaign) without wall baking.1) Diborane was introduced into a He-GD plasma without wall baking. The introduced diborane was easily decomposed into boron and hydrogen by a GD plasma, and most of the hydrogen was exhausted and boron was coated on the vacuum chamber wall with residual hydrogen. After boronization, He-GDC was continued for about three hours to reduce decomposed hydrogen in the boron film. By this coating, oxygen was trapped into the boron film and kept in the form of boron oxide. Other contaminations on the vacuum vessel were covered with the boron film and their releases from the wall were suppressed. Operational density regime was enlarged.2)

During the 7th experimental campaign, boronizations were carried out three times for 7 hours each. The averaged thickness of 40 – 50 nm and the coated area of 60 % of the vacuum vessel were estimated from the material probe analysis.

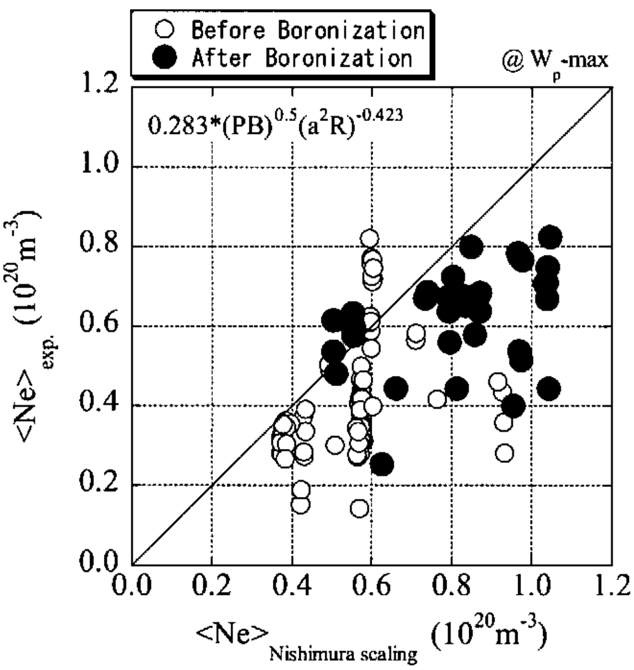

Fig. 1 Comparison of the density in low field between before and after boronization.

Figure 1 shows the comparison of the attained line-averaged density with gas-puff between before and after boronization at the timing of the stored energy maximum in low field (~ 1.5 T). Open circles are the data before boronization and solid circles after boronization under the various experimental conditions: R_{ax} = 3.6, 3.75, 3.9 m, B_T ~ 1.5 T, P_{NBI} = 1.6 – 10.0 MW. Abscissa is the density derived from the density limit scaling.3) After boronization, the density is increased easily without radiation collapse. Figure 2 shows the attained line-averaged density at the timing of the stored energy maximum under the various experimental conditions: R_{ax} = 3.6, 3.75, 3.9 m, B_T ~ 1.5, 2.75 T, P_{NBI} = 1.6 – 12.7 MW, gas-puff and pellet injection. Open squares are the data in low field with gas-puff, open circles in high field with gas-puff, and solid diamonds in high field with pellet injection.

Together with the progress of the heating power and the wall conditioning by boronization, we could obtain the averaged electron density of 1.6×10^{20} m^{-3} by gas-puff (at the stored energy maximum) and 2.4×10^{20} m^{-3} by pellet injection (at the density maximum).

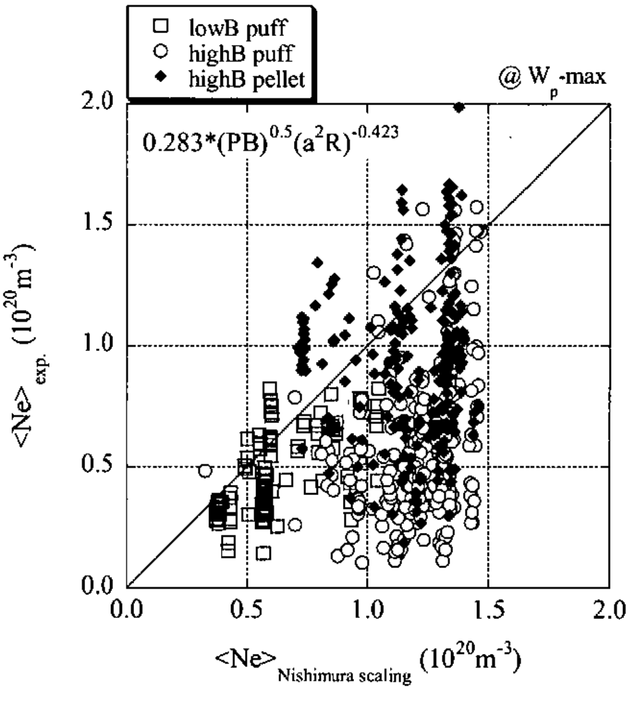

Fig. 2 Attained density under the various experimental conditions.

References

1) Nishimura, K.: Ann. Rep. NIFS (2001-2002) 62.
2) Nishimura, K. et al.: J. Plasma Fus. Res. 79 (2003) 1216.
3) Nishimura, K.: Ann. Rep. NIFS (2000-2001) 14.