§62. Toroidal Uniformity of Boronized Wall During 8th Experimental Campaign

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Boronization experiments were conducted from the 5th experimental campaign. The oxygen impurity level in the LHD plasma was several orders of magnitude reduced after the boronization. In order to understand the reduction of oxygen impurity level, the boronized wall surface was analyzed using a material probe technique. Material probes were installed at 10 positions along the toroidal direction from the 6th experimental campaign, and the toroidal uniformity of the boron deposition was investigated. The boronization during the 8th experimental campaign was three times conducted using glow discharge. Two anodes between toroidal sectors 1 and 10 and between toroidal sectors 4 and 5 were employed for the glow discharge. The diborane plus helium gas was driven from three gas inlets between toroidal sectors 1 and 2, between toroidal sectors 3 and 4 and between toroidal sectors 7 and 8. After the campaign, the material probes were extracted and the depth profile of atomic composition was examined using Auger electron spectroscopy.

The thickness of boron film largely depended on the toroidal position. Figures 1 (a), (b) and (c) show the depth profiles of atomic composition in the probes placed at the toroidal sectors 1, 9 and 10. In the positions close to the anodes and gas inlets, the boron deposition was clearly observed. In opposition, the boron deposition was very small in the positions far from the anode. Thickness of the boron film was as high as approximately 500 nm. In the positions with a thick boron film, the discharge history is observed. After each boronization, the carbon deposition due to main and glow discharges in Figs. 1 (b) and (c).

Figure 2 shows a plot of thickness of boron film against toroidal sector number. The ratio of the boronized wall to the entire wall was approximately 30 % and 40 % in the 6th and 7th experimental campaigns. The ratio in the 8th experimental campaign significantly increased (approximately 70 %). This increase is due to that the gas flow rate at every gas inlet was taken roughly the same. The amount of oxygen retained in the boron film was measured based upon the depth profile of atomic composition. The amount of retained oxygen was roughly proportional to the thickness of boron film. Thus, the oxygen impurity concentration might have been further reduced by the improvement of toroidal uniformity of boron film.

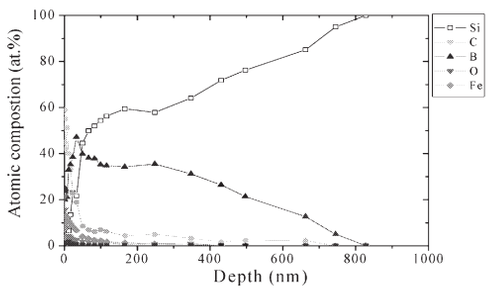
In summary, the boronization was very successfully conducted in the 8th experimental campaign, and the toroidal uniformity of the boron film was significantly improved. This result contributes to further increase of plasma stored energy in LHD.

References

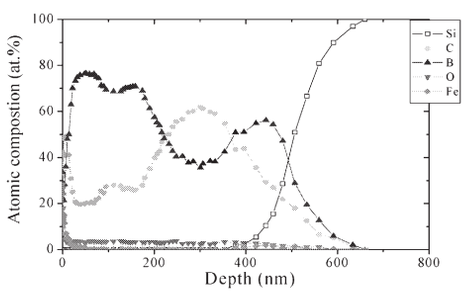
(1) Nobuta, Y., Ashikawa, N., Hino, T., et al, Fusion Eng. and Design, 81(2006)187-192

(2) Hino, T., Nobuta, Y., Ashikawa, N., "New Development in Nuclear Fusion Research", NOVA Scientific Publishers Inc., NY, (2006)

(a) Toroidal sector, 1



(b) Toroidal sector, 9



(c) Toroidal sector, 10

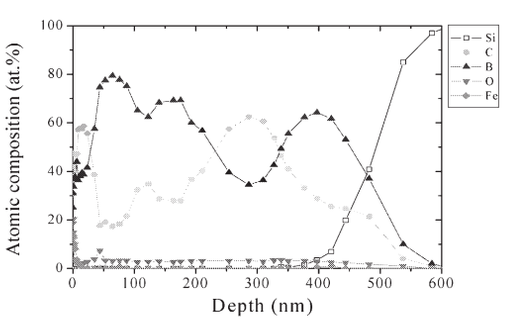


Fig. 1 Depth profiles of atomic composition at probes placed at toroidal sectors 1 **(a)**, 2 **(b)** and 3 **(c)**.

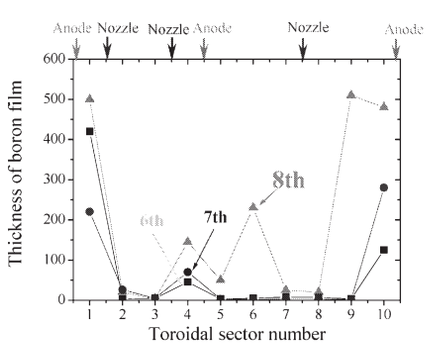


Fig.2 Boron thickness and amount of oxygen retained versus toroidal sector number.