§11. Reduction of Impurity Contamination of ICRF Plasmas after Boronization

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ICRF heating and plasma sustainment were carried out with titanium gettering. The progress, however, was usually limited by increasing impurities. It was very clear that the impurity sources were the ICRF antennas. The most important thing is to reduce radiation losses from oxygen, which radiates strongly in the edge region only.

Boronization was carried out twice using decaborane, and a total of 10g of decaborane was introduced into CHS; 5g of boronization makes a boronized surface with an average thickness of 800Å in each case. The boronization was very effective for our ICRF experiment, whereas it has not shown a clear advantage for NBI heating with Ti gettering except for a small increase in the plasma stored energy (W_p) in a high-density region [1]. After boronization, the metal impurity (titanium) completely disappeared, and oxygen radiation was largely reduced as shown in Figs.1 and 2. The reason originates in the difference in accessibility for ICRF antennas between the Ti-gettering and the boronization. The flashing area of the Ti-gettering in CHS covers 70% of the total vacuum surface. This covering, however, is largely reduced for the ICRF antennas because of their complex geometrical features. In contrast to this, the boronization was very effective for covering the anttennas including the behind area, since it is carried out using He-glow discharge.

The impurity concentration was estimated for the typical results of the Ti-gettering and boronization cases:

Ti-gettering: P_{rf}=300kW, n_e=1.8x10^{13}cm^{-3}, T_e=240eV, P_{rad}=150kW, Z_{eff}=3

Boronization: P_{rf}=300kW, n_e=3.2x10^{13}cm^{-3}, T_e=240eV, P_{rad}=120kW, Z_{eff}=3.

The total radiation consists of 80kW oxygen, 40kW titanium, and 30kW others (hydrogen, carbon, nitrogen) for the Ti-gettering case. For the boronization case, it consists of 25kW oxygen and others. The main part of the remaining radiation in the boronization case is estimated to be from the boron itself. The impurity concentration can be estimated from these results with the observation of the Z_{eff}. For the Ti-gettering shot the impurity concentration was 1% for carbon, 1.5% for oxygen, 0.5% for titanium; and for the boronization shot it was 5% for boron, 1% for carbon, 0.5% for oxygen, and 0% for titanium.

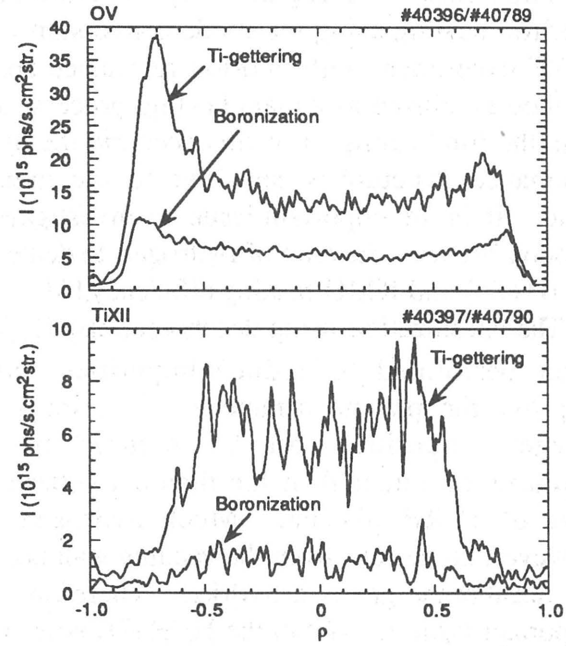

Fig.1 Radial profiles of OV and TiXII in both cases of Ti-gettering and boronization.

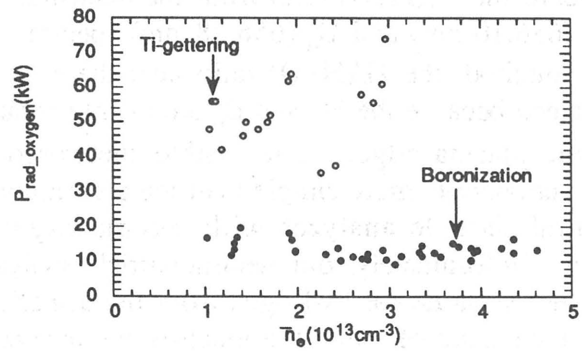

Fig.2 P_{rad} from oxygen as a function of n_e.

Reference
1) Yamada,H., Morita,S. *et al.*, Jpn.J.Appl.Phys. 33 (1994) L1638.