§20. Deuterium Retention and Desorption Behavior of Boron-titanium after Deuterium and Helium Ion Irradiations

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Titanium flash and boronization have been often employed for controls of fuel hydrogen recycling and oxygen impurity level in fusion devices. The hydrogen retention behavior may be changed when titanium is mixed into boron, i.e. boron-titanium (B-Ti) is produced on the wall. The fuel hydrogen behavior for B-Ti little investigated so far. In this study, deuterium ion irradiation experiments were conducted for B-Ti prepared, and then the deuterium retention and desorption behavior was examined. This result was compared with B, Ti and crystallized TiB_2.

B-Ti film was prepared by electron beam evaporations of titanium followed by boron. B-Ti was irradiated by 1.7keV deuterium ions and an amount of retained deuterium and desorption temperatures were measured. For comparison, similar experiments were conducted for boron (B) and titanium (Ti) films similarly prepared and hot pressed TiB_2. The amount of retained deuterium in B-Ti was approximately 1/3 or 1/2 of that in Ti or B, respectively. Desorption peaks of deuterium in B-Ti were 470 and 620K, corresponding to desorption observed in B in the low temperature regime and desorption in Ti, respectively. An average desorption peak in B-Ti was 590K, which is lower than that in B (660K) and in Ti (650K).

The amount of retained deuterium in B-Ti was compared with that in TiB_2 . As shown in Fig. 1, the amount of retained deuterium in B-Ti was comparable with that in TiB_2. However, the desorption temperature in TiB_2 was 730K, higher than that in B-Ti

This difference was discussed based upon chemical binding and crystal structures of B-Ti. As shown in Fig. 2, the binding state of B in TiB2 is of TiB2, but the binding states of B in Ti-B were partly TiB2 and B-B. This result suggests that the boron in B-Ti is amorphous, so that B-D-B bond is easily produced. The deuterium desorption temperature from B-D-B bond is 470K. This is the reason why the deuterium in B-Ti desorbs at low temperature regime.

Helium ion irradiation was conducted for B-Ti after the deuterium ion irradiation. The amount of retained deuterium decreased and the average desorptin peak shifted to a lower temperature regime, as increase of helium ion fluence. The shift to the low temperature regime is due to enhancement of amorphous structure in B-Ti.

The present results show that use of amorphous B-Ti can reduces fuel hydrogen retention in first walls and improves fuel hydrogen recycling.

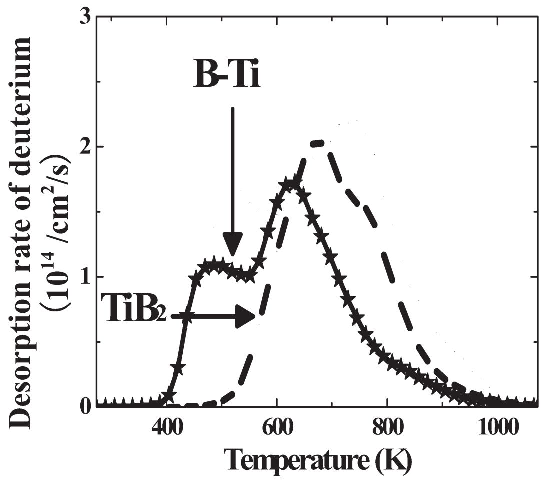

Fig. 1 Deuterium desorption spectra of TiB2 and B-Ti.

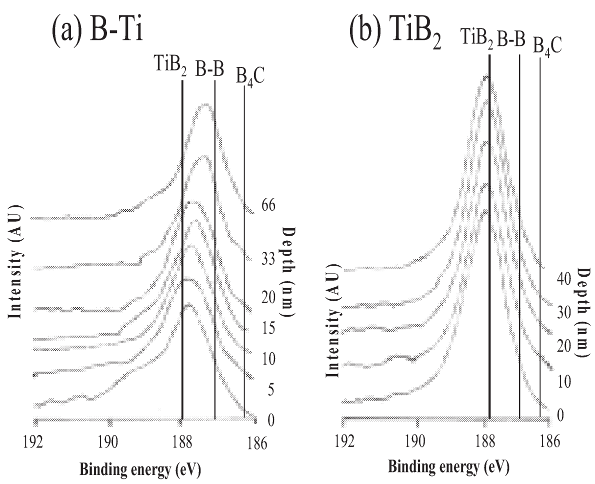

Fig.2 XPS spectra of B in TiB2 and B-Ti.

Reference

1) T. Hino et al. Submitted to Nuclear Fusion, (2007)