§61. Behavior of Hydrogen Atoms in Boron Films

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Hydrogen behavior in boron films has been investigated using SUT(SUrface modification Test-stand) for the study of H recycling control.

The experimental procedure consists of three stages. (I) Boron film of 200 nm thick is deposited on a stainless steel liner of 400 mmϕ and 400mm high by 5% B_2H_6 + He DC glow discharge. The film is once heated up to 500°C to evacuate the H atoms retained in the film during the deposition. (II) A series of H_2 and/or He discharges is carried out with measuring H_2 pressure to investigate H absorption and desorption behavior. (III) The retained H are desorbed by heating up to 500°C to measure retained number and to reset the boron film into the beginning of the stage (II). The stage (II) and (III) were repeated alternately with various schemes of the discharge procedure in the stage (II) but same procedure in the stage (III).

Fig. 1 shows typical time evolution of the total pressure during H_2 discharges (series (1)) with and without boron film on the liner. When the discharge was ignited, the H_2 pressure was decreased due to hydrogen absorption to the wall. Similar to the case of B films on graphite liner reported previously, the continuous absorption of H atoms into the boron film was observed, namely the pressure in the later half of discharge was lower than those without discharge.

The hydrogen discharge was continued up to 3 hours in another series (2) in the stage (II). The results showed that hydrogen atoms were continuously absorbed up to 3 hours.

In contrast, the continuous absorption was not remarkable in the case of SS liner without coating. The hydrogen absorption capacity was 5 times higher with the boron film than without one. Thus we can conclude that the hydrogen atoms are accumulated in the boron films but not in the liner.

The alternate H_2 and He discharges are carried out (3, 4) to investigate the effect of He ion bombardment. The hydrogen accumulation was also shown.

To investigate these effects more quantitatively, the retained number of H in each series is plotted in Fig.3. In one hour discharge (1), hydrogen atoms of 11.0×10^{16} atoms/cm^2 were absorbed. The number increased to 14.5×10^{16} atoms/cm^2 in 3 hours discharge (2). In the series (3); alternate H_2, He and H_2 discharges; each discharge was continued 1 hour. The total discharge time was 3 hours which was same as the series (2). The retained number in the series (3) was, however, smaller than that in the series (2). It means that hydrogen ion impact has grater effect to accumulate H atoms into film than He ion impact. In the series (4), total time of H_2 discharge was 3 hours, which was same as the series (2). However, the retained number was clearly larger than the series (2), which means that He discharges have some effect for H accumulation.

The mechanism of this slow absorption is understood as follows. When the energetic ions (He^+ or H_2^+) are injected to the boron film, in which hydrogen is almost saturated, hydrogen atoms trapped in the film are detrapped by the ion impact. Some of the detrapped atoms migrate or are implanted deeper into the film and the surface trap site is evacuated to catch implanted H atoms.

The effects of detrapping and migration were shown from the depth profile measurements by ERD method.

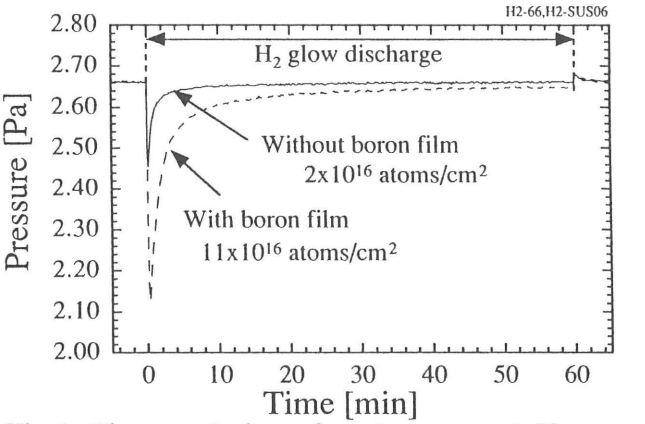

Fig.1. Time evolution of total pressure (=H_2 pressure) during H_2 discharge with and without B films.

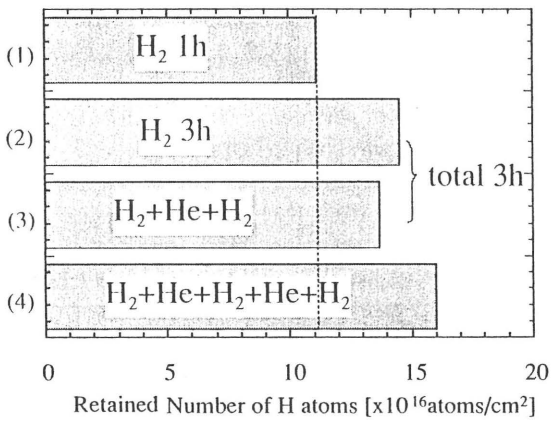

Fig.2. Comparison of H retention in various series of discharge experiments.