§52. 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.

Boron films of 200nm thick are deposited on the graphite liner (IG-430U) of 400mmϕ and 400mm high by B_2H_6 (5% in He) DC glow discharges (0.2A, 400V, 72min). The films are once heated up to 500°C to evacuate the H atoms retained in the films during deposition.

H atoms are absorbed in the film by H_2 glow discharge. Fig. 1 shows typical time evolution of the total pressure during the discharge (0.02Torr, 0.2A, 500V). No significant increase of any impurities is observed by QMA analysis. Then the pressure is considered as H_2 partial pressure. The pressure is almost constant until the discharge is ignited. Hydrogen is not absorbed in boron films by H_2 injection without plasma(Actually absorption is not zero but less than 1% of that by glow discharge). The pressure abruptly decreases when the discharge is ignited because of hydrogen absorption in the wall. H absorption is almost saturated within 20min. However, the pressure is still 1×10^{-4}Torr lower than the initial value. It is presumed that H atoms are slowly absorbed after the saturation of near surface region. The surface density of retained H atoms after the discharge of 1 hour is estimated to be 1.8×10^{17} atoms/cm^2. The longer discharge results in larger retention. This slow absorption may be caused by the diffusion, but the diffusion flux is much larger than is expected. The mechanism of such a large diffusion is not clear yet.

H atoms of 0.3×10^{17}atoms/cm^2 are desorbed by He glow discharge of 1 hour (0.2A, 300V). This value is smaller than that from graphite liner by factor 2.

H absorption is recovered by the He glow discharge. The abrupt decrease of the pressure as in Fig.1 is observed during the second H_2 discharge after the He discharge. H atoms of surface density of 0.4×10^{17}atoms/cm^2 are absorbed, which is lager than desorbed one. Repetition of H_2 and He discharges sequence, therefore, results in gradual accumulation of H atoms as shown in Fig. 2, where vertical axis indicates retained H atoms in the film. The H retention increases with almost same rate as in the long time H_2 discharge. This gradual accumulation might be originated from same mechanism as slow absorption during long time H_2 discharge. In addition, recoil implantation of H atoms into the films by He bombardment might have some effect.

The liner is heated up to 500°C by the ramp rate of 10°C/min, after the H absorption and desorption by the H_2 and He discharges . H pressure reaches peak value around 400°C. Even when the H atoms are accumulated by the several repetitions of H_2 and He discharges or long time discharge, all H atoms are released by the thermal desorption.

Mechanisms of the H implantation and re-emission behavior will be discussed by considering the effect of diffusion, ion induced desorption, recoil implantation, and recombination of H atoms.

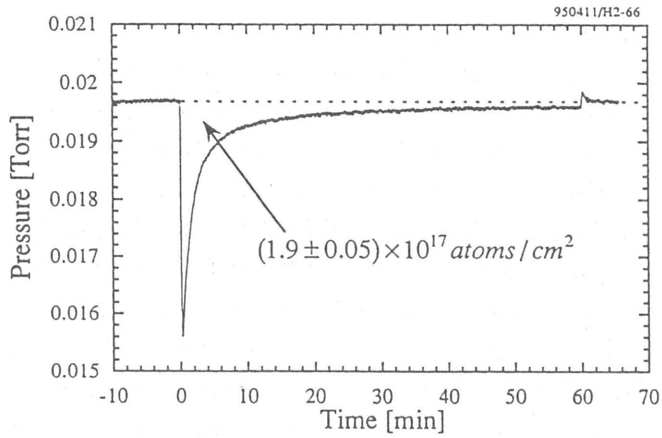

Fig.1. Time evolution of total pressure (=H_2pressure) during H_2 discharge(0.02 Torr, 0.2A, 500V)

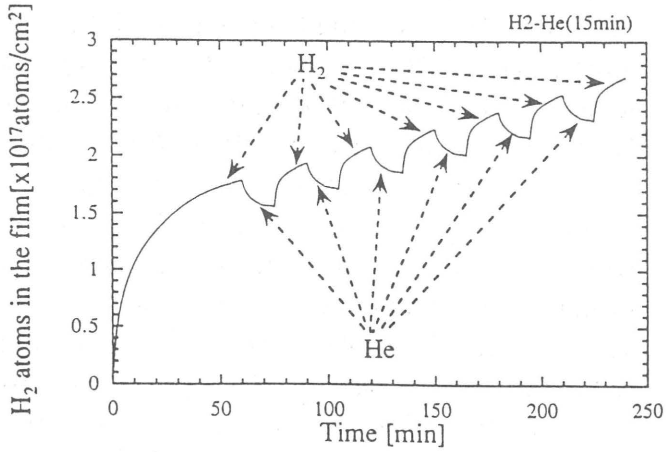

Fig.2. H retention in the films when the H_2 /He discharges are alternated.