§72. Retention and Desorption of Hydrogen and Helium in Stainless Steel Wall

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In LHD, helium and hydrogen gases have been employed in both the main plasma discharge and glow discharge. During the hydrogen or helium main discharge, hydrogen or helium emits into the main plasma. Then, the dilution of discharge gas of main plasma takes place. The confinement characteristics and ICRH heating condition becomes different compared with the case of pure gas discharge. In LHD, the first wall has been made by SS 316L. In order to control such the gas emission into the plasma, retention and desorption of helium and hydrogen have to be clarified.

In the present experiment, a glow plasma apparatus with SS 316L liner was fabricated, and the retained and desorbed amounts of helium and hydrogen were measured based upon a residual gas analysis.

We repeated helium discharge followed by hydrogen discharge, and then obtained the retained and desorbed amounts of helium and hydrogen. The retained amounts of helium and hydrogen for a case of liner temperature of RT are shown in Fig. 1. The retained amount of helium was large, approximately half of the retained amount of hydrogen. The helium implanted in the first helium discharge little desorbed by the second hydrogen discharge. The hydrogen implanted in the second hydrogen discharge significantly desorbed by the third helium discharge. Namely, the desorption amount of helium ion impact for hydrogen was large although the desorption amount of hydrogen impact for helium was very small.

The retained amounts of helium and hydrogen were measured for the case of elevated temperature, as shown in Fig. 2. The temperature range was from RT to 200°C. The retained amount of helium roughly remained the same but the retained amount of hydrogen decreased with increase of temperature. This difference takes place that the peak desorption temperatures are 250°C and 300°C for H and He, respectively. If the wall temperature is taken higher than the present value in LHD, the fuel hydrogen recycling is further suppressed.

The desorption amounts of helium and hydrogen ion impact for hydrogen and helium were measured for the case of elevated temperature. Figure 3 shows the fractions of desorbed hydrogen by helium ions and desorbed helium by hydrogen ions. The desorption amount of hydrogen by helium ions increased up to approximately half of retained amount of hydrogen. This result shows that the hydrogen retention can be reduced by helium ion impact although the helium retention is not reduced by hydrogen ions.

In the recent experiment in LHD, argon glow discharge has been conducted and low density operation with high ion temperature was successfully carried out. Since both the hydrogen and helium may be desorbed by argon ions and the wall surface is also sputtered, the retained amounts of helium and hydrogen may be reduced. This is a reason for the low density operation with a high temperature.

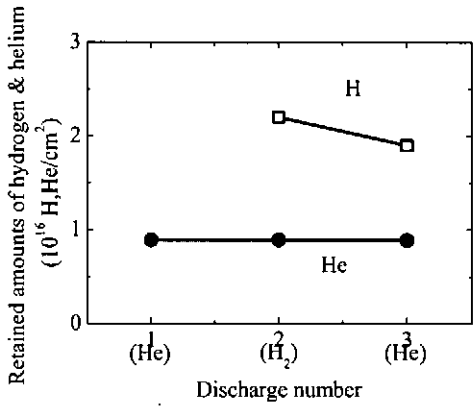

Fig. 1 Retained amounts of helium and hydrogen versus discharge number.

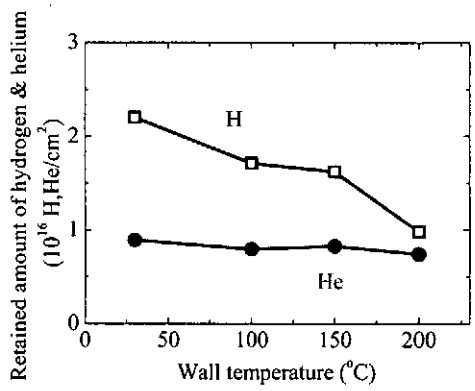

Fig. 2 Retained amounts of helium and hydrogen versus wall temperature.

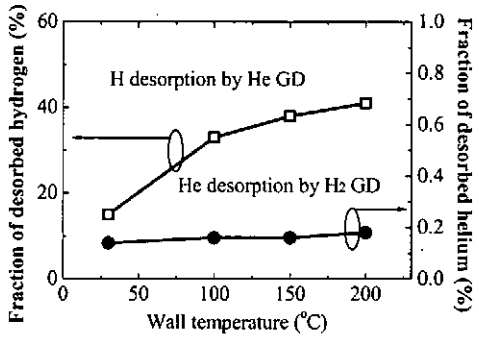

Fig. 3 Fractions of desorbed hydrogen and helium versus wall temperature.

References

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2) Satoh, S. et al, J. Vac. Soc. Jpn. **46**, (2003)795