§23. Fuel Hydrogen Retention of Plasma Facing Material and Its Removal by Inert Gas Glow Discharges

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Tritium is produced by DD fusion reactions in the next stage of LHD experiment. Thus, the tritium retention in plasma facing materials has to be evaluated and reduced by using wall conditionings. The present plasma facing materials in LHD are SS and graphite. In the future experiment, tungsten may be employed. The baking temperature is limited low temperature, so that the glow discharge may has to be applied as the wall conditioning.

In our previous study, the hydrogen and deuterium retention for SS wall has been investigated by using H_2 and D_2 glow discharges. The glow discharges using inert gases, He, Ne and Ar, were applied to reduce the hydrogen and deuterium retention[1)]. It was seen that the deuterium retention was the same as the hydrogen retention, and the He glow discharge significantly reduced the hydrogen and deuterium retention, as high as ~30%.

In the present study, similar experiments were carried out for polycrystalline tungsten wall. Fig. 1 shows the H_2 partial pressure during the H_2 glow discharge. The reduced amount of the partial pressure corresponds to the hydrogen retention. Fig.2 shows the D_2, HD and H_2 partial pressures during the D_2 glow discharge. The implantation of deuterium ion desorbs the hydrogen, and thus HD and H_2 partial pressures increased. The net amount of retained deuterium was the same as the hydrogen retention. This result is the same as the case of SS, but the H or D retention was several times larger than that of SS.

Fig. 3 shows the desorbed amount of (H+D) during the He, Ne and Ar glow discharges. Again He discharge was most effective for reduction of deuterium retention. This result was the same as the case of SS, but the reduced amount was one order of magnitude smaller (only several %) compared with the case of SS.

The surface analysis using SEM and AFM showed that the surface of tungsten was rough owing to the small crystal grains with a size of 100 nm. The bulk density at the grain boundaries is smaller than that of the grain. The fuel hydrogen can penetrate to the deeper depth region through the grain boundaries. Thus, the fuel hydrogen retention becomes large. During the inert gas glow discharge, the inert ion does not reach to such the deeper depth region. The fuel hydrogen implanted at the deeper region is not desorbed. This explanation is the reason that the tungsten has the fuel hydrogen retention higher than that of SS and the inert gas discharge little reduces the fuel hydrogen retention.

The present result is quite important to evaluate the fuel hydrogen retention of tungsten. In order to reduce the fuel hydrogen retention of tungsten, the surface baking may be suitable since the glow discharge is not useful.

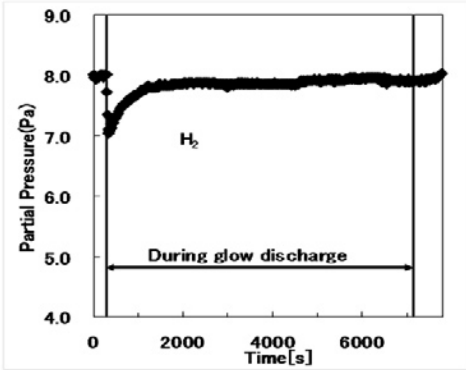

Fig.1 Change of H_2 partial pressure during H_2 glow discharge.

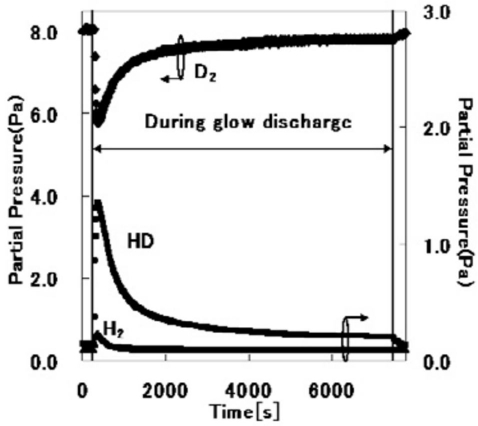

Fig.2 Change of partial pressures during D_2 glow discharge.

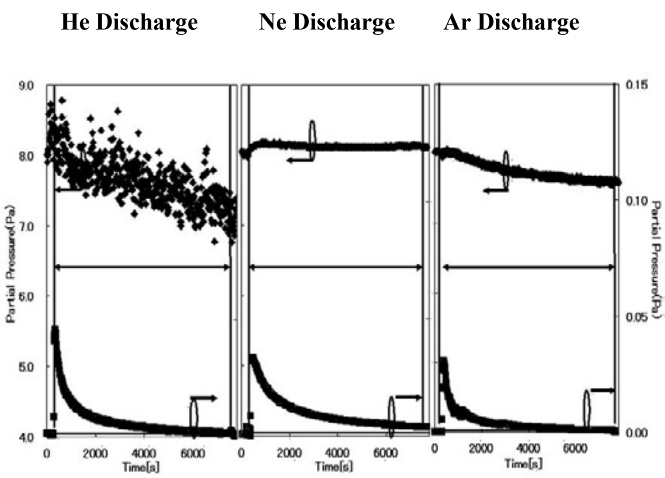

Fig.3 Desorption of (H+D) during inert gas discharges (He, Ne, Ar).

1)T.Hino, K.Nishimura et al, Fusion Eng. and Design, **85**(2010)974-978.