§2. Studies of Tritium Behavior in LHD Cooling Pipe

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i) Introduction

In DT fusion reactors, tritium will be used as fuel and a part of tritium will be retained on/in the cooling pipe, especially stainless steel, through adsorption or isotope exchange reaction. The behaviors of adsorption and desorption of tritiated water have been studied [1,2] and the understanding of the interaction between hydrogen isotopes and stainless steel is one of the most important issues for the assessment of tritium release to the environment and tritium inventory by the adsorption. It is important to elucidate the chemical behavior of stainless steal for the decontamination and the evaluation of tritium permeation. In this study, the interaction between hydrogen isotopes and stainless steel by various adsorption/absorption processes were studied by XPS and TDS techniques.

ii) Experimental

A typical material for cooling pipe, SS-304, was used as a specimen and hydrogen isotopes, hydrogen and deuterium, were charged on/in the specimen by various adsorption/absorption processes, such as supersonic adsorption, electrolysis and ion irradiation. The chemical states of iron, chromium, nickel and oxygen on the SS-304 specimen were evaluated by X-ray photoelectron spectroscopy (XPS). The thermal desorption spectroscopy (TDS) was also applied to the evaluation of the desorption behavior of hydrogen isotopes from the stainless steel. The heating rate was set to 30 K/min from room temperature to 1273K.

iii) Results and discussion

Figure 1 shows the photoelectron spectra of O-1s of SS-304 specimen with various implantation methods by XPS. It was found that iron oxide, chromium oxide and oxyhydroxide, FeOOD or CrOOD, had been formed on the surface of the SS-304 specimen. The oxyhydroxide was removed by D_2^+ ion irradiation. However, the hydroxide existed on the surface of SS-304 after D_2O absorption. Figure 2 shows the TDS spectra from the as-received sample with various adsorption/absorption methods. The peak at around 700 K was observed for all the samples. However, the other two peaks at around 400 K and 900 K were observed only by the sample pretreated with electrolysis.

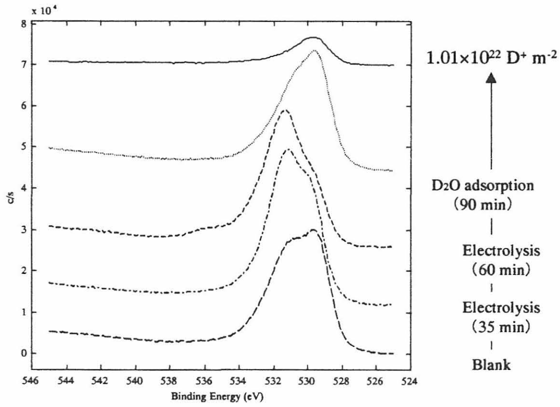

Fig.1 Photoelectron spectra of O-1s with various adsorption/absorption methods

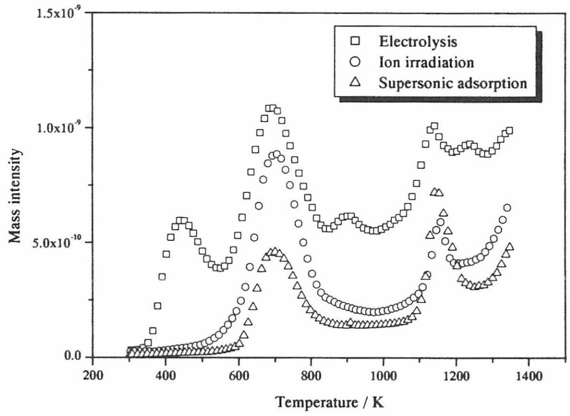

Fig.2 TDS spectra of deuterium from SUS304 with vairous adsorption/absorption methods

Comparing with the experimental results, these two peaks would be ascribed to the release from oxyhydroxide.

iv) Conclusion

The chemical behaviors of SS-304 with hydrogen isotopes were studied by means of XPS and TDS techniques. It was found that iron oxide and oxyhydroxide had been formed on the surface of as-received SS-304 from O-1s, Fe-2p and Cr-2p photoelectron spectra. The ratio of iron oxide and oxyhydroxide was changed by the implantation methods. In the TDS experiment, three peaks were confirmed in the SS-304 pretreated with electrolysis.

References

[1] Ohmori, R. et al., J. Nucl. Mater., 258-263 (1998) 474.
[2] Shiraishi, T. et al., J. Nucl. Sci. & Tech., 34 (1997) 687.