§1. Studies of Tritium Trapping States and its Desorption Behavior from Cooling Pipe Materials

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i) Introduction

Stainless Steel (SS-304, 316 etc) is expected to be used in fusion reactors as various component materials like cooling pipe because of its good mechanical properties and corrosion resistance. The elucidation of tritium behavior in SS and its interaction, especially, the tritium trapping and desorption behaviors in SS bulk are important issues for the safety evaluation of DD discharge experiment in LHD. However, the chemical behaviors of hydrogen isotopes in SS bulk have not been well studied. In the present study, the typical material for components, SS-316, was chosen as a specimen and tritium trapping behavior in SS was evaluated by Thermal Desorption Spectroscopy (TDS).

ii) Experimental

The SS-316 sample with size of $10\times10\times1mm^3$ was used. The sample was heated at 1273 K in vacuum for 10 minutes to remove surface oxide layers. 4 keV deuterium ion (D_2^+) was implanted into the sample with the ion flux of 5.0×10^{18} D^+ m^{-2} s^{-1} at room temperature. The fluence was changed from 1.0×10^{21} D^+ m^{-2} up to 2.0×10^{22} D^+ m^{-2}. After D_2^+ implantation, thermal desorption spectroscopy (TDS) was applied to the evaluation of the desorption behavior of hydrogen isotopes for the sample. The heating rate was set to 30 K min^{-1} from room temperature to 1273 K.

iii) Results and discussion

It was found that deuterium (m/e=4) and heavy water (m/e=20) were released from the D_2^+ implanted sample according to the TDS results. Figure 1 show D_2 TDS spectra for SS-316 sample as a function of D_2^+ fluence. It was found that the D_2 TDS spectra have consisted of at least three peaks [1] and D_2 retention increased largely above the fluence of 1.0×10^{22} D^+ m^{-2} as shown in Fig. 1. It was found from the peak analyses using Gaussian distribution function that three release peaks of deuterium were located about 350, 410 and 950 K as shown in Fig. 2. In addition, the release behavior of heavy water was similar to that of deuterium. From these results, it was suggested that the release peaks of 350, 410 and 950 K were attributed to, respectively, the deorption of absorbed deuterium on the surface, trapped deuterium in the sample and trapped

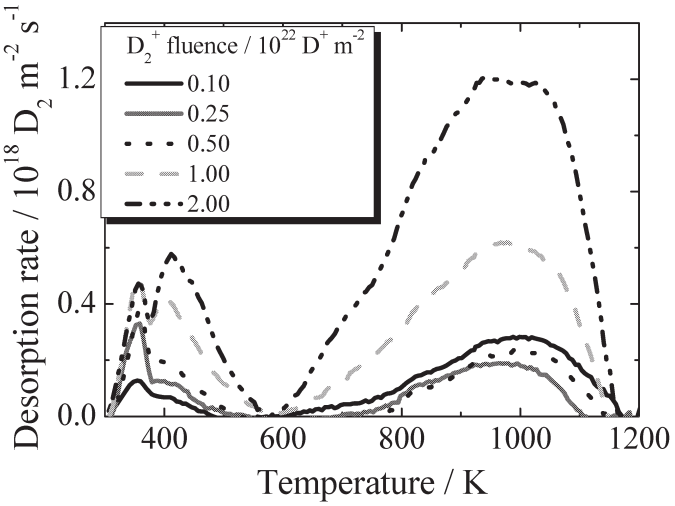

Fig.1 D_2 TDS spectra for SS-316 sample as a function of D_2^+ fluence

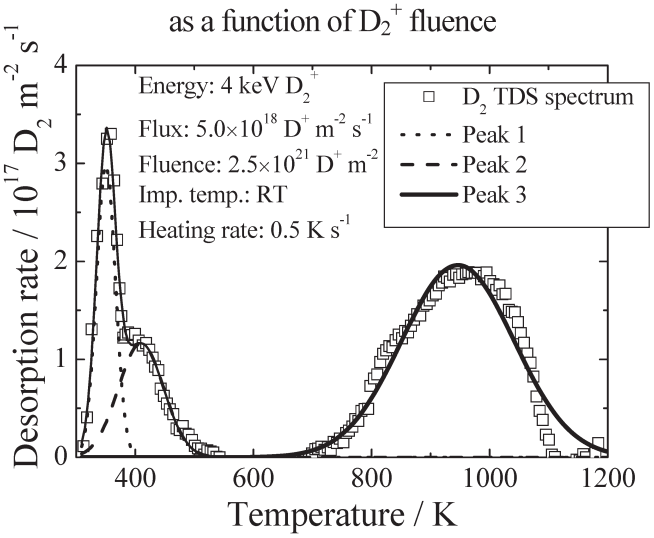

Fig.2 Peak analysis of D_2 TDS spectra using Gaussian distribution function in fluence of 2.5×10^{21} D^+ m^{-2}

deuterium as O-D bond in the bulk of the sample by thermal decomposition, which is major trapping state of deuterium in the sample. On the other hand, it was found that D_2 retention was about 10% in the fluence of 2.0×10^{22} D^+ m^{-2}. These facts indicated deuterium trapped in SS-316 removed oxide layer [2]. In addition, the major trapping state of deuterium in SS-316 would be deuterium bound to oxygen as forming O-D bond. From these results, it was concluded that the tritium retention will be accumulated by interaction between SS and hydrogen isotopes, indicating the desorption of O-T bonds will be important for the tritium decontamination under the long term operation by DD discharge.

In the future study, more detained chemical state of O-D bond and its desorption behavior will be elucidated.

[1] Y. Oya et al., *Fus. Sci. Tec.*, 44 (2003) 359-363.
[2] Y. Oya et al., *Fus. Sci. Tec.*, 48 (2005) 597-600