Helium and hydrogen isotope retention behavior in simultaneous implanted tungsten

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Tungsten is the candidate for plasma facing materials (PFMs) in the fusion reactor. It will be simultaneously irradiated by hydrogen isotopes and helium (He) produced by D-T fusion reaction. In this study, simultaneous He-H implantation was performed and the retention behavior was evaluated by high temperature thermal desorption spectroscopy (HT-TDS). Experimental results showed that He retention behavior was affected by the incident hydrogen to a large extent.

Keyword : Tungsten; Helium; Simultaneous implantation; Bubbles; TDS

1. Introduction

In the fusion reactor, PFMs will be exposed to the heavy bombardment of helium generated by the D-T fusion reaction. Serious damage can be introduced such as He bubbles and dense dislocation loops. The formation of these damages will be further complicated by the incident hydrogen isotopes. Thus, it is important to understand the He behavior in W under simultaneous implantation of He and hydrogen isotope. In this study, simultaneous He^+-H_2^+ implantation with different hydrogen ion energy and flux ratio was performed. Helium and hydrogen isotope retention behavior are elucidated using the HT-TDS.

2. Experiment

Polycrystalline W (10 mm$^{\phi}$, 0.5mm^{t}, A.L.M.T. Corp. Ltd), was preheated at 1173 K for 30 min under ultrahigh vacuum (< 10^{-6} Pa). Thereafter, only He^+ and simultaneous He^+- (H_2^+) implantation were performed using 3.0 keV He^+ with the fluence of 1.0×10^{21} and 1.0×10^{22} He^+ m^{-2} and 1.0~3.0 keV H_2^+ with the fluence of 1.0×10^{22} H^+ m^{-2}. Then, TDS measurements were carried out at the temperature from 300 K to 1700 K.

3. Results and discussion

Figure shows the He desorption spectra for the irradiated W at two He fluence. He desorption spectra can be roughly divided into three stages: 300-600 K (Small vacancy helium), 600-1000 K (He trapped by dislocation loops), and above 1000 K (He bubbles) [1]. At the lower He fluence of 1.0×10^{21} He^+ m^{-2} (Fig. (a)), a significant desorption peak was observed at 1650 K in the case of only He implantation, indicating that most incident He was trapped by He bubbles. Simultaneous He^+-H_2^+ implantation reduced He trapping at He bubbles. At the higher He fluence of 1.0×10^{22} He^+m^{-2} (Fig. (b)), simultaneous implantation enhanced the He retention when H_2^+ energy is 3.0 keV, but depressed the bubble formation when 1.0 keV H_2^+ was implanted. Thus, the He retention behavior is obviously affected by the simultaneous implanted hydrogen, especially depending on the incident hydrogen energy.

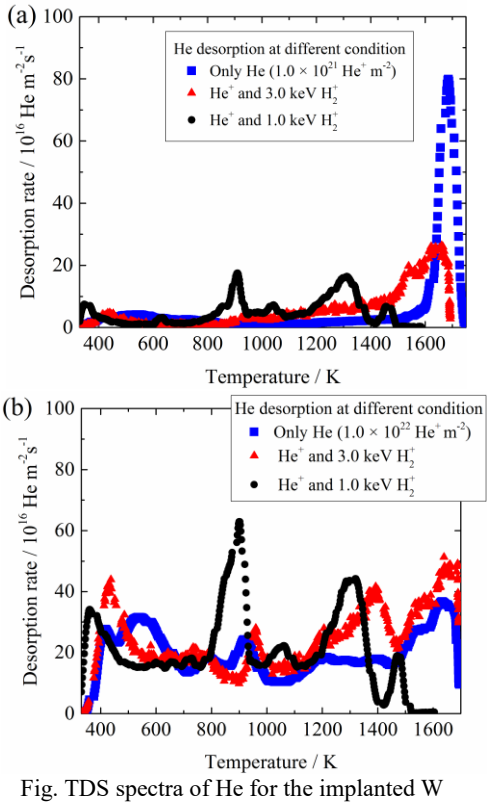

Fig. TDS spectra of He for the implanted W

Reference

[1] M. Tokitani, et al., J. Nucl. Mater., 463 (2015) 91.