§100. Correlation between Annihilation of Irradiation Defects and Tritium Retention for Neutron Irradiated W

Oya, Y., Sato, M., Yuyama, K., Miyazawa, T. (Shizuoka Univ.), Toyama, T. (Tohoku Univ.), Hatano, Y. (Univ. Toyama), Otsuka, T. (Kyushu Univ.), Nobuta, Y., Yamauchi, Y. (Hokkaido Univ.), Sagara, A.

1. Introduction

Tungsten (W) as a plasma facing material in fusion reactor will be irradiated with 14 MeV neutron produced by D-T fusion reactions. Irradiation defects, which act as trapping sites of hydrogen isotopes, are introduced in W by neutron (n) irradiation. Hydrogen isotopes retention in W will be enhanced by introduction of defects, so that it is important to evaluate the hydrogen retention behavior in n-irradiated W. In previous study, hydrogen retention behavior in damaged W by heavy ion irradiation to simulate n-irradiation was evaluated. But, the defects produced by heavy ion irradiation are distributed near surface region. On the other hand, those produced by neutron irradiation are evenly distributed in the bulk[1]. It is expected that hydrogen retention behavior in neutron irradiated W is different form heavy ion irradiated W.

In this study, W samples were irradiated with 6 MeV Fe^{2+}, fission neutron or fusion neutron and then were performed deuterium (D) implantation and Thermal Desorption Spectroscopy (TDS) measurement. From those results, the relation of hydrogen retention behavior and defects induced processes by different damage source was considered.

2. Experimental

Disk-type polycrystalline W samples (6 mm$^{\varphi}$×0.5 mm^{t}, A.L.M.T. Corp. Ltd) were heat-treated at 1173 K for 30 minutes under ultrahigh vacuum (<10^{-6} Pa) to remove the impurities and damages introduced during the mechanical polishing processes. The Fe^{2+} irradiation were performed at room temperature with the damage concentration of 0.01 and 0.1 displacement per atom (dpa) by Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) at Japan Atomic Energy Agency (JAEA). The fission neutron irradiation was performed at Kyoto University Research Reactor Institute (KUR) with the damage concentration up to 4.3×10^{-4} dpa. For 14 MeV neutron irradiation (fusion neutron irradiation), Fusion Neutronics Source (FNS) at JAEA was used with the damage concentration up to 1.0×10^{-6} dpa. Thereafter, these samples were transferred to Shizuoka University and 1.0 keV D_2^+ implantation was performed with the ion flux of 8.75×10^{17} D^+ m^{-2} s^{-1} up to the ion fluence of 1.0×10^{22} D^+ m^{-2}. The D desorption behavior was evaluated by TDS at the temperature up to 1173 K for Fe^{2+} irradiated samples and 1273 K for n-irradiated samples, respectively, with the heating rate of 0.5 K / s.

3. Results and Discussion

Fig.1 shows the D_2 TDS spectra for various damaged W samples. The TDS spectra were consisted of 4 desorption stages, attributing as follows.. The Peak 1 at 400 K, Peak 2 at 550 K, Peak 3 at 650 K and Peak 4 at 850 K corresponded to the desorption of D adsorbed on the sample surface or trapped by dislocation loops, trapped by vacancies, vacancy clusters and voids, respectively[2-4].

Fig.2 shows D retention at each Peak. No large difference for Peak 1 was found among 0.01 and 0.1 dpa Fe^{2+}-irradiated samples, indicating that the retention of D adsorbed on the sample surface or trapped by dislocation loops would be almost saturated. However, for 0.1 dpa sample, major D desorption stage was shifted toward higher temperature side at 850 K, showing that voids would be more stable D trapping sites. Even in these lower damage concentrations by both n-irradiated samples, it was clear that the D retention was increased, compared to that for un-damaged sample. The D_2 TDS spectra for fusion neutron irradiated tungsten were extend to both of Peak 2 and Peak 3, indicating the mono vacancies and vacancy clusters would be D trapping sites. However, no voids were formed due to its lower damage concentration. For fission neutron irradiated tungsten, on the other hand, the retention as Peak 1 was only increased, compared to un-damaged sample, indicating that the dislocation loops would act as major trapping sites.

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2) Eleveld H, *et al.* 1992 *J. Nucl. Mater.* **191** 433-38.
3) H. Iwakiri, *et al.* 2002 *J. Nucl Mater.* **307-311** 135-38.
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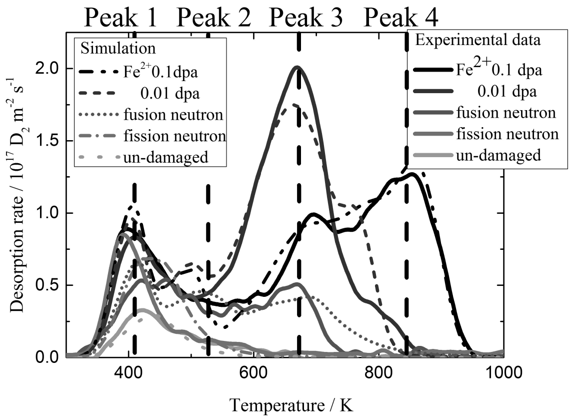

Fig.1 D_2 TDS spectra for various damaged tungsten

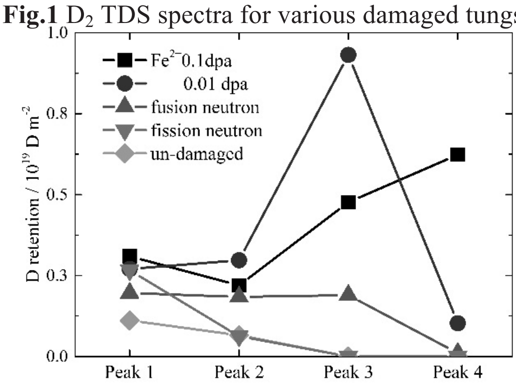

Fig.2 Summary of D retention for each peak