## §87. Tritium Retention Behavior in Neutron Irradiated W at Higher Temperature

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**1) Introduction**

Tungsten (W) having the characteristic of lower hydrogen isotope retention is considered using for Plasma-facing wall in fusion reactor. It is expected that hydrogen isotope was trapped by the irradiation defects introduced by energetic particles including the neutron produced by D-T nuclear fusion reaction. In previous experiment, deuterium (D) retention behavior for $Fe^{2+}$ irradiated W with various damage concentrations has been estimated. It was found that the addition w D trapping site was formed with increasing damage concentration. However, irradiation defect was stabilized or recovered at higher temperature. Therefore, the evaluation of hydrogen isotope retention with considering heating effect is necessary to understand hydrogen isotope dynamics. In this study, $D_2^+$ irradiation and thermal desorption spectroscopy (TDS) for neutron or heavy ion irradiated W were performed. In addition, D permeation experiment was performed in these samples to understand effect of stability of vacancy or void and recovery behavior at high temperature.

**2) Experimental**

Polycrystalline W disk samples (6 mm$^{\varphi}$×0.5 mm$^{t}$) and rolled W foils (10 mm$^{\varphi}$×0.035 mm$^{t}$) purchased from A.L.M.T. Corp. Ltd and Nilaco Co. Ltd respectively were used as a sample. For the pretreatment, the samples were heated at 1173 K for 30 minutes under ultrahigh vacuum (<$10^{-6}$ Pa). Thereafter, 6 MeV $Fe^{2+}$ was irradiated with the damage concentration of 0.1 and 1.0 dpa (displacement per atom) by 3MV tandem accelerator in Japan Atomic Energy Agency (JAEA). 14 MeV neutron irradiation for W disk samples was performed with the damage concentration of $1\times10^{-6}$ dpa at Fusion Neutronics Source facility (FNS) in JAEA. Then, 1.0 keV $D_2^+$ implantation for these irradiated samples and un-irradiated W and TDS measurements were performed. In addition, D permeation experiment for $Fe^{2+}$ irradiated W foils and neutron irradiated W disk samples was performed with the D pressure of 80.0 kPa and the temperature between 973 and 1173 K.

**3) Results and discussion**

Fig. 1 shows $D_2$ TDS spectra for W with various damage concentration. TDS spectra were consisted of four desorption peaks located at 400, 550, 650, and.850 K. It is known that Peak 1 is desorption of D adsorbed on the surface and/or trapped by dislocation loops[1-2]. Peak 2, 3, and 4 are considered to be derived from desorption of D trapped by vacancies, vacancy cluster, and voids, respectively[2-3]. The results indicated that voids were increased as damage concentration was increased and became stable D trapping site in $Fe^{2+}$ irradiated W. For Peak 2, D desorption rate in neutron irradiated W is the same as that in $Fe^{2+}$ irradiated W with the damage concentration of 0.1 dpa, indicating that defect such as vacancies and vacancy cluster started to be introduced by displacement from the low damage concentration.

Fig 2 shows the D permeability for each sample, as compared with Zakharov's data[4]. The D permeability for neutron irradiated W was decreased in comparison to that for un-irradiated W. However, the D permeability for neutron irradiated W was the same as that for un-irradiated W at more than 1123 K. In addition, the D permeability for neutron irradiated W after annealing at 1173 K was the same as that for un-irradiated W at 973 K. These result indicated that the defect introduced by neutron irradiation was recovered by heating at 1173 K. The D permeability for $Fe^{2+}$ irradiated W with the damage concentration of 0.1 and 1.0 dpa was almost all of the same as each other and the lower value than that for neutron irradiated W. However, the D permeability for $Fe^{2+}$ irradiated W was also the same as that for un-irradiated W at more than 1123 K and D permeability for $Fe^{2+}$ irradiated W after annealing at 1173 K was reduced. It can be said that irradiation defect make an influence on D permeation at temperature less than 1073 K.

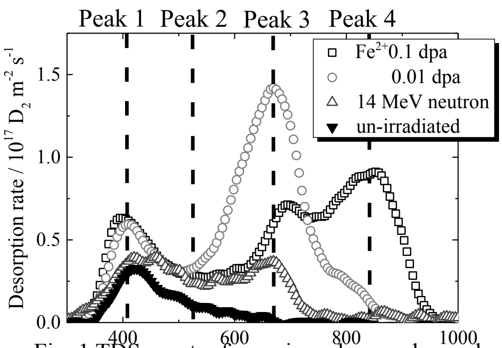


Fig. 1 TDS spectra for various damaged samples

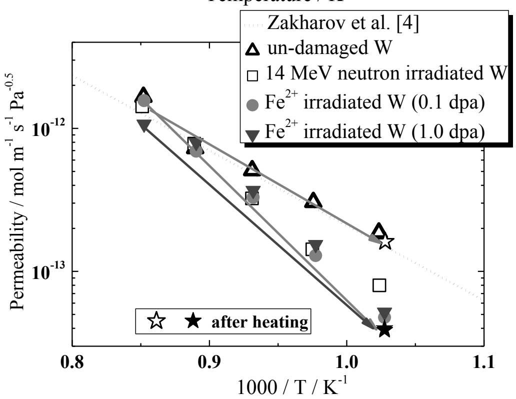


Fig. 2 D permeabilities for $Fe^{2+}$ irradiated W and neutron irradiated W, as compared with un-irradiated W and other experimental result.

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3) G.N. Luo *et al.*, Fusion Eng. Des. **81** (2006) 957.
4) A.P.Zakharov *et al.,* Fiz.-Khim.Mekh. Mater. 9(2) (1973) 29.