§88. Retention in Tungsten under High Particle Loading Conditions

Ueda, Y., Uehata, K., Yamane, T., Oya, M., Lee, H.T. (Osaka Univ.),
Torikai, Y., Taguchi, A., Hatano, Y. (Univ. Toyama)

Recent experimental works suggest that high flux and/or high fluence hydrogen irradiation would make additional trapping sites through over-saturation states of D. Although the mechanism to form these sites is under intensive investigation, it could be due to precipitation of hydrogen isotopes and D bubble formation. But detailed investigation on ion driven trapping site production without recoil and its interaction with premade damage. In this work we made damage by high energy ion implantation (6.4 MeV Fe) then 1keV D implantation to the damaged samples. Tritium distribution in the samples were measured by combination of chemical etching and IP methods, which gave 3D tritium distribution images in tungsten. This method is very powerful to study tritium behavior in any materials.

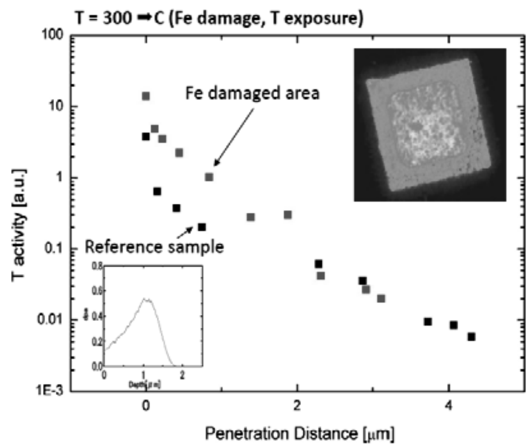

Fig. 1 Depth profile of T loaded by gas exposure at 573 K to Fe damaged and undamaged sample.

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In this study, W samples used are conventional powder metallurgy, hot rolled ones with the purity of 4N. Annealing was made at 2273 K for recrystallization to reduce intrinsic damage to an insignificant level. T exposure with D/T mixed gas (7.2% T) was done at 573 K for an hour to 5 hours at the pressure of 1.2 kPa. After exposure to D/T mixed gas, samples were left in vacuum until their temperature became RT.

Figure 1 shows depth profiles of T exposed Fe damaged samples. Depth distribution for damaged area and reference area (without Fe damage) is shown. For damaged area up to about 2 μm, T density is higher, indicating T is trapped at trapping sites made by Fe irradiation. Decaying T depth profile for both damaged and undamaged area may indicate that T diffusion into the bulk was not explained by the so-called bathtub model. There could be diffusion channels beside trapping sites, which determine main T diffusion and some of diffusing T was trapped by either damaged sites or

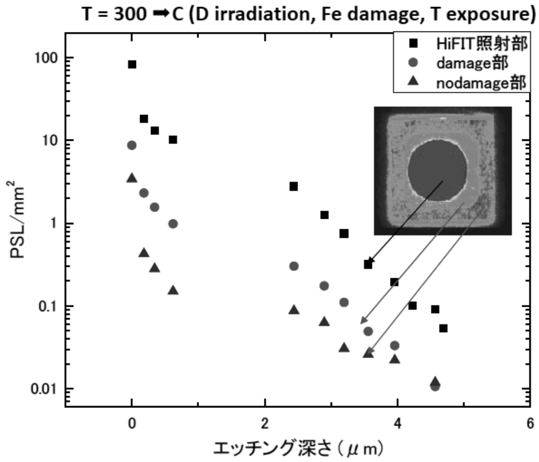

Fig. 2 T depth profiles for Fe damaged and D implanted W at 573 K.

intrinsic sites. More detailed works are in progress.

Figure 2 shows depth distribution of D implanted W with premade Fe damage. It is clearly shown that in D implantation area T concentration is higher than that of only damaged area by about an order of magnitude. In addition, over damaged depth (more than 2 μm in depth) T concentration is also higher for D implanted area. This could be due to surface modification of D implantation which made T solubility increased during T gas exposure.

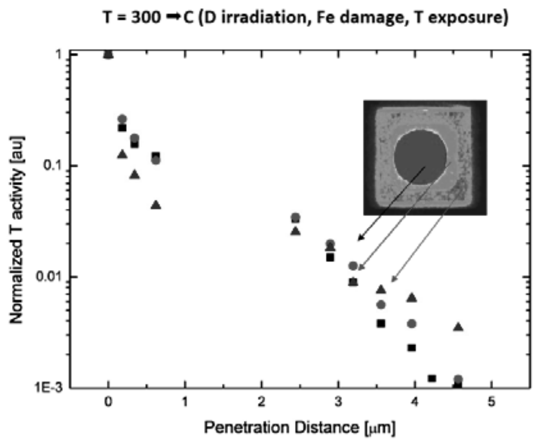

Fig. 3 Normalized depth distribution in the W sample to the T concentration beneath the top surface.

This theory is supported by the data shown in Fig. 3, where normalized T depth profiles are plotted against surface T concentration. Especially depth area over 2 μm normalized T concentration is similar for all areas, indicating that diffusivity for the three areas is almost the same with only difference of solute T concentration beneath the top surface. T diffusion channels for these cases is not clear but it could be grain boundaries which exist similarly for all areas. Additional studies are in progress.