§97. Study of Hydrogen Depth Distribution in Tungsten Exposed to D Plasma

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Estimation of tritium inventory of Fusion reactor is a key issue of safety. Especially, a vacuum vessel, which has large tritium inventory, is an important object for estimation. Tungsten is going to be used as a material for the plasma facing components of ITER. Therefore, a lot of investigation has been carried out to evaluate tritium inventory in tungsten. Hydrogen isotopes inventory in tungsten was found to widely change by the manufacturing method and the plasma exposure condition. To reveal the reason of the change, tritium distribution on the surface after D plasma and then tritium gas exposure was already carried out[1]. Tritium was found to be concentrated on the grain boundaries and blisters by the measurement with tritium autoradiography (TARG). On the other hand, tritium contributed to TRAG measurement could not be distinguished whether tritium move easily during measurement. In addition, the provided information of tritium distribution was limited to that on surface. In this study, the change of tritium concentration on surface at time was investigated by using the imaging plate (IP) and depth distribution of tritium was measured with the etching method.

The W specimen exposed to plasma was the recrystallized W (A.L.M.T. Corp., Japan) with 99.99 wt% purity. D plasma exposure with low energy (38 eV), high flux (10^{22} $D^+/m^2/s$) was carried out to W at 550 K of specimen to the fluence of 10^{26} D/m^2. Tritium was introduced into the specimen thermally by exposure to hydrogen gas containing tritium. The exposure of tritium gas, in which the pressure of gas was 1 kPa, was carried out at 473 K in 5 hours. This gas exposure was carried out in 2009 and specimen was kept at room temperature. Tritium concentration on the surface of specimen was continuously measured by IP. After the IP measurement in 3 year later, the specimen was dipped into the etching solution in one minute. Dipping time and weight loss after etching was measured. After that, tritium concentration of the solution was measured by liquid scintillation counter to evaluate the amount of tritium removed by the etching.

Fig. 1 shows the luminescence intensity of surface in each year and after etching by measurement with IP method. The luminescence intensity in Fig. 1 was the value that normalized the luminescence intensity of the 1.1 μCi/g standard specimen for 100 and the value that average intensity of exposed area. Tritium concentration of the surface decreased until it passed for 2 years, however, there was no obviously change after 2 years. This result shows that there was tritium trapped strongly in tungsten surface after 2 years. And it was indicated that the tritium distribution on the surface reported in Ref.1 was formed of tritium strongly trapped. Fig. 1 also shows the intensity decreased after the etching treatment. From the measurement of weight loss after the etching, the region of 0.5μm depth from the surface was removed from the specimen. Therefore, many amount of tritium was found to exist near surface in the region of 0.5 μm depth of specimen. These results and discussions indicated that there were two kinds of site in tungsten exposed to D plasma. One site could trap tritium strongly and the other could trap tritium only weakly. Therefore tritium trapped weakly could be removed easily at room temperature. To identify both trapped site, Thermal Desorption Spectroscopy (TDS) system, which can use tritium, was prepared in Hydrogen Isotope Research Center, University of Toyama. Fig. 2 shows the schematic diagram of TDS system. The cooperation with JAEA and the university are going to be continued to clarify two kinds of hydrogen trap site in tungsten exposed to D plasma.

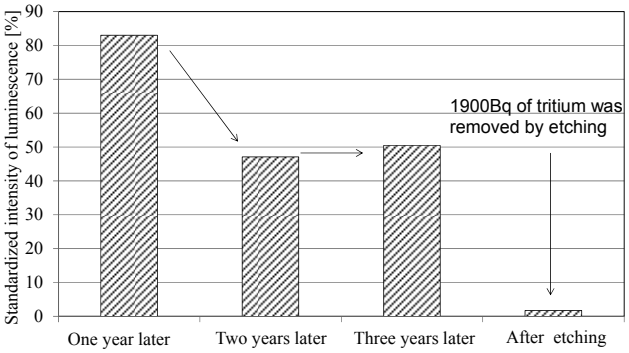

Fig. 1. The luminescence intensity of surface in each year and after etching by measurement with IP method

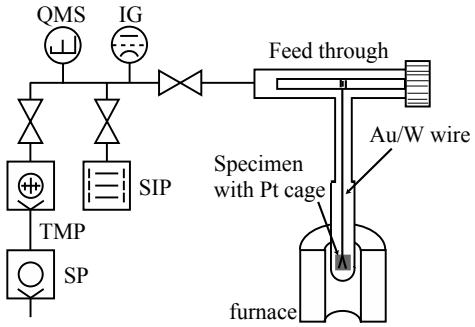

Fig. 2. The schematic diagram of TDS system installed in Hydrogen Isotope Research Center, University of Toyama.

1) Isobe, K., et al.: J. Plasma. Fusion Res. SERIES, **10**(2013)81.