§96. Tritium Adsorption Properties on Helium Irradiated Tungsten

Yajima, M., Masuzaki, S., Tokitani, M., Kajita, S., Ohno, N. (Nagoya Univ.), Hatano, Y. (Toyama Univ.), Torikai, Y. (Ibaraki Univ.)

Tungsten (W) is one of the most important candidates as a plasma-facing material for the International Thermonuclear Experimental Reactor (ITER) because of its excellent material properties such as high melting point, high threshold energy for physical sputtering, and low retention of hydrogen isotopes. However, it is known that helium (He) holes/bubbles and fiberform nanostructure are formed on W surfaces by the exposure to He plasma even when the incident ion energy is less than the threshold energy of sputtering. It is important to clarify the effects of He on hydrogen isotope retention and surface damage in W from the viewpoint of hydrogen isotope retention and safety control of nuclear fusion reactor. Recently, it has been reported that tritium (T) retention of the nanostructured W (Nano W) surface was investigated by an imaging plate (IP) and β-ray induced X-ray spectrometry (BIXS) technique.[1] However, the full T retention in Nano W has not been clarified. In this study, the retention of T in Nano W was examined by the thermal desorption spectroscopy (TDS).

W samples were powder metallurgy W sheets (Nilaco. Co.) of 15×8×0.2 mm^3. W sample was exposed to He plasma in the NAGDIS-II to various He ion fluence. The irradiation temperature and the incident ion energy were 1550 K and 55 eV, respectively. The helium ion fluences was 5.0×10^{25} m^{-2}. As reference, W sample with smooth surface (Polished-W) was also prepared by polishing W sheets with abrasive paper and alumina particulate suspension. After heating in vacuum at 600 °C for 1 h 30 min, W samples of Nano W and Polished W were exposed to a D–T mixture gas (5 at.% T) at 300 °C and 1.2 kPa for 5 h. The T release rate from samples was determined with a flow system operated at argon (Ar) stream (100 ccm) comprising a quartz tube maintained at constant temperature (25 °C) and a sequence water bubbler placed downstream.[2] Aliquots from the bubblers were taken from time to time and analyzed for T by liquid scintillation counting. After the end of T release from samples at 25 °C, T desorption behavior was investigated with TDS analysis. In the TDS analysis, samples were heated from room temperature to 800 °C with a ramp rate of 0.5 $°Cs^{-1}$. In this analysis, those samples were heated in Ar stream and T desorption was measured using a proportional counter located downstream of the sample.

Fig. 1 shows the T release rate into Ar stream at 25 °C from Nano W and Polished W. The first plot obtained over a period adding up to almost 20 min showed that T is initially liberated rather rapidly at rates of nearly 3×10^5 Bqh^{-1}. This rate drops to less than 4×10^4 Bqh^{-1} after about 1 h 20 min and continues to decrease further to even lower values after about 17 h 20 min. Those results shows that TDS result described below shows the release of T from stable trapping site into sample.

Fig.2 shows TDS spectra of T in Nano W. T retained in Nano W started to desorb at around 100 °C and the major peak was seen at around 430 °C. On the other hand, the major peak of T retained in Polished W was seen at around 500 °C. The total amount of retained T in Nano W were was about 6 times of it in Polished W. For future works, the behavior of hydrogen isotope into the bulk and fiberform nanostructure area will be investigate.

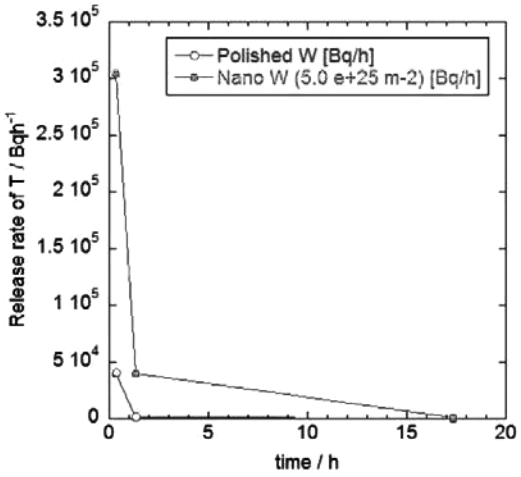

Fig. 1. The plot of the T release rate into an Ar stream at 25 °C from Nano W and Polished W.

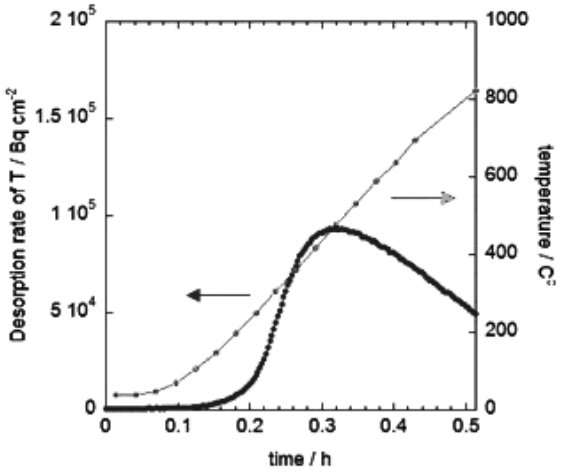

Fig. 2. Thermal desorption spectra of T for Nano W.

1) Yajima, M. et al. : 438 (2013) S1142-S1145.
2) Torikai, Y. et al., : 48 (2005) 177-181.