

## §72. Tritium Adsorption Properties on Helium Irradiated Tungsten

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Tungsten (W) has a high melting point, low neutron activation cross-sections and low tritium (T) solubility, so that it is a candidate of plasma-facing materials. In spite of these advantages, it is known that He bubbles and fiber-form nanostructure<sup>1)</sup> are formed on tungsten surface by exposing to He plasma. To clarify the effects of He on hydrogen isotope retention and surface damage in W, sequential irradiations/exposures of He and D (or H) plasmas have been performed<sup>2)</sup>. It has been revealed that the D retention is suppressed by the He irradiation. However, the effect of the nanostructure development on the retention property has not been investigated. In this study, T and D retentions in the nanostructured W were measured with an imaging plate (IP) technique and thermal desorption spectroscopy (TDS), respectively. Moreover, the effective surface area was measured by BET method, and the correlation between the surface area and T/D retention is discussed.

Tungsten specimens with nanostructure (nano-W) were prepared by exposing pure tungsten sheets to He plasma in the linear divertor plasma simulator (NAGDIS-II). Two types of specimens, #1 and #2, were prepared by exposure to He plasma at 1200 K, 60eV with the helium fluences of  $2.0\text{--}2.4 \times 10^{25} \text{ m}^{-2}$  and  $4.2 \times 10^{25} \text{ m}^{-2}$ , respectively. In Fig. 1, BET plot of the nanostructured tungsten is shown. From the slope and the y-intercept, we can obtain the surface area. The surface area measurement showed that the effective surface areas of #1 and #2 were increased by 6 and 12 times, respectively, due to nanostructure development. It is shown that the fiberform nanostructure increase the surface area significantly.

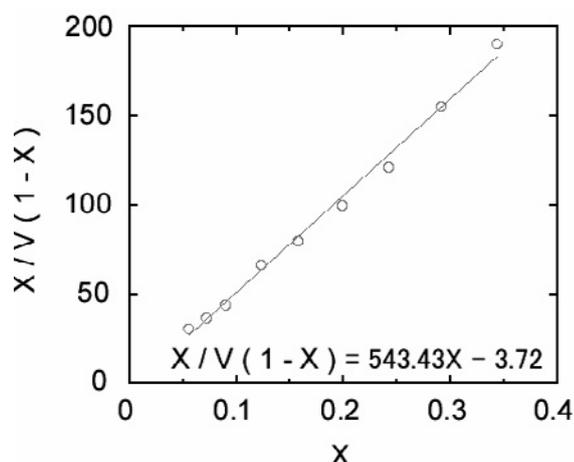


Figure 1 BET plot for the surface area measurement.

The #1 nano-W was exposed to DT gas, and #1 and #2 nano-W were exposed to D<sub>2</sub> gas at 573 K and 1.2 kPa for 5 hours, together with reference W specimens with polished surfaces (polished-W). The amounts of T and D retained by polished/nano-W were then measured by IP and TDS, respectively.

Figure 2 shows the intensity of IP signal for different samples. The intensity of IP signal obtained for #1 nano-W was higher than that for polished-W by factor of 4. The TDS measurements showed that D retentions on #1 and #2 nano-W were larger than that on polished-W by factors of 12 and 23, respectively. These observations clearly indicate that the hydrogen isotope retention was increased by the development of nanostructure. The difference in IP signal intensity between #1 nano-W and polished-W was smaller than those in the effective surface area and D retention probably due to the small escape depth of  $\beta$ -rays from tritium in comparison with the thickness of nanostructures. Another possibility is that it takes much longer time to saturate the tritium retention by the exposure to the gas. Further investigation is required to make it clear the mechanism to cause the phenomena. Linear correlation was observed between the effective surface area and D retention. Nevertheless, the extent of increase in D retention was larger than that in the effective surface area. It appears that D was retained in W lattice and/or He bubbles in the nano-fibers in addition to the fiber surfaces.

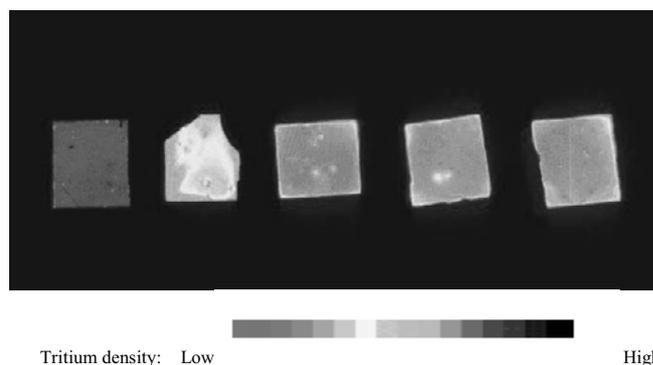


Figure 2: IP images of the samples exposed to tritium gas at 573 K.

- 1) S. Kajita, et al., Nucl. Fusion **49** (2009) 095005.
- 2) D. Nishijima, et al., Nucl. Fusion **45** (2005) 669. ; M. Miyamoto, et al., Nucl. Fusion **49** (2009) 065035.