

§88. Hydrogen Elements 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 nanostructures are formed on tungsten surface by exposing to He plasma¹⁾. Until now, the surface area of W specimens exposed to helium plasmas was measured with B.E.T. method. In addition, tritium (T) in the nanostructured W was measured with an imaging plate (IP) and β -ray-induced X-ray spectrometry (BIXS) technique. It was found that the surface area and the tritium adsorption were increased by the formation of nanostructures²⁾. In this study, the exposure time dependences of the amount of deuterium retained on the nanostructured W was investigated.

Two different W plates were used for the specimen; (1) nanostructured tungsten formed specimen, which was fabricated in the divertor simulator NAGDIS-II at the surface temperature of 1500 K, the incident ion energy of 60 eV, and the He fluence of $2.0 \times 10^{26} \text{ m}^{-2}$, and (2) non-irradiated specimen. These specimens were heated in vacuum at 753 K for 1.5 h to remove the impurity on the surface. Then, the specimens were exposed to the deuterium gas at the pressure of 1.2 kPa for 5, 20, and 40 hours. After the exposure, the specimens were analyzed by thermal desorption spectroscopy (TDS). The specimens were heated to 875 at the heating rate of 0.5 K/s, and sustained at 873 K for 30 min.

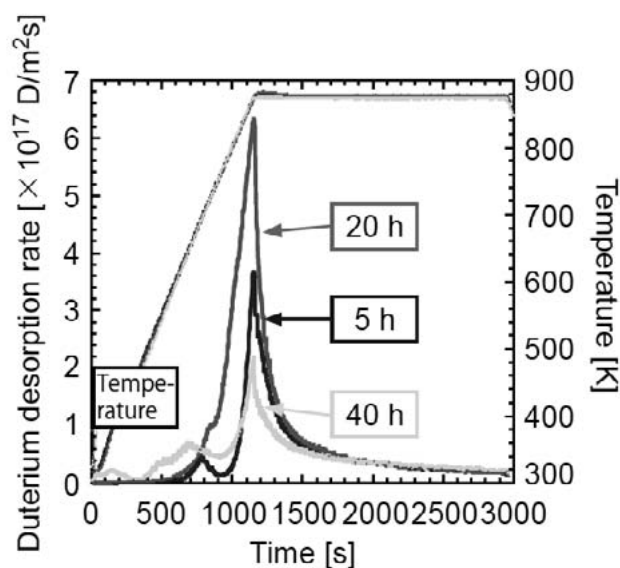


Figure 1: Deuterium desorption from nanostructured W.

Figure 1 shows the deuterium desorption from the nanostructured specimens. For all the specimens, the desorption peak was observed at 600-700 K. Furthermore, desorption decreased gradually when sustaining the temperature at 873 K.

Figure 2 shows the total desorption of deuterium from polished and nanostructured W specimens. For 5 hour exposure, the total desorption of deuterium was $1.3 \times 10^{20} \text{ m}^{-2}$ for irradiated specimen and $5.1 \times 10^{18} \text{ m}^{-2}$ for non-irradiated specimen. The results indicated that the nanostructure formation increased the adsorption amount of deuterium on the surface. However, the total desorption did not increase with the exposure time, although that for the non-irradiated specimen increased. It was suggested that the diffusion of deuterium in the nanostructures can be slower than that in the bulk material.

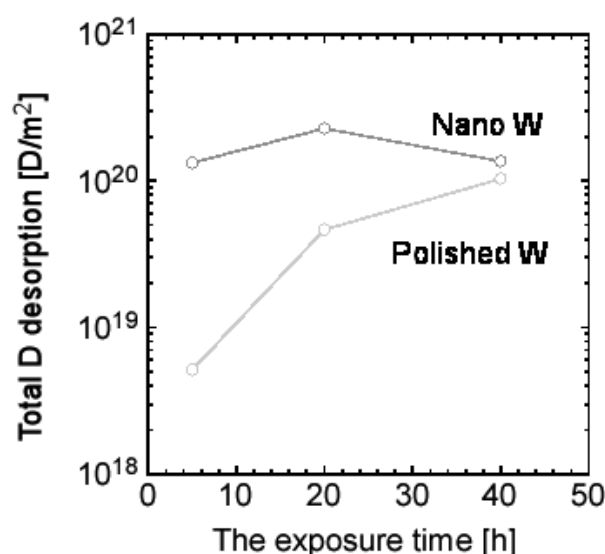


Figure 2 : Total desorption of deuterium from polished and nanostructured W specimens.

1) S. Takamura, N. Ohno, D. Nishijima, *et al.*, Plasma Fusion Res. **1** (2006) 051.

2) M. Yajima, Y. Hatano, S. Kajita, J. Shi, M. Hara, N. Ohno, J. Nucl. Mater 438 (2013) S1142.