§72. Tritium Retention of Co-deposited Carbon Film and Tungsten

Nobuta, Y., Hino, T., Yamauchi, Y. (Hokkaido Univ.),
Hatano, Y., Akamaru, S., Matsuyama, M., Abe, S. (Univ. Toyama),
Sagara, A.

From the point of view of tritium safety and fuel hydrogen recovery, understanding of hydrogen retention behavior of plasma-facing materials is urgent issue for fusion reactor. Carbon material and tungsten are widely used as a plasma-facing material in present fusion devices and are candidates for plasma-facing material of ITER. Carbon materials are easily eroded by incident hydrogen bombardment and the sputtered carbon atoms are co-deposited with hydrogen isotopes in vacuum vessel.

In the FY of 2011, the authors have investigated tritium (T) absorption for tungsten, graphite and co-deposited carbon film and reported that the amount of absorbed T in co-deposited carbon films were much larger than that for graphite and tungsten[1),2)]. Therefore, co-deposited carbon film is responsible for T absorption. Also, the authors have investigated the T concentration (atomic ratio of T to carbon, T/C) after T absorption in co-deposited carbon film. The value of T/C is essential for estimation of tritium retention in fusion devises.

In the FY of 2012, tungsten, graphite (IG-110) and co-deposited carbon films were irradiated by T ions and the amount of retained T and the change of the amounts of retained T after irradiation were investigated by β-ray-induced X-ray spectrometry (BIXS) and imaging plated (IP) technique. The T ion irradiation experiments were conducted in University of Toyama. The irradiated ion species are D_2^+ and DT^+ and the ratio of T in the irradiated ions is 5 %. The ion energy of DT^+ ion was 1.0 keV and the substrate temperature during the irradiation was a room temperature. The fluence of implanted T was (4.4-4.55) x 10^{15}/cm^2.

Figure 1 shows the amounts of retained T for each material. The amount of retained T in tungsten was several times smaller than the other materials. The amounts of retained tritium of carbon films were smaller than that of graphite. The volume density of the carbon films (1.48-1.77 g/cm^3) was smaller than that of graphite (1.88 g/cm^3). This means that the carbon film has more porus microstructure than that of graphite and that the film would have more pores connecting to the surface. Then, in the case of carbon film, some implanted T would be released from the film through the pore during irradiation. This might be a possible reason for the difference of the T retention between graphite and carbon films. The irradiated samples were stored in a desiccator pumped by a rotary pump and the amount of retained tritium was occasionally investigated by an imaging plate technique. Figure 2 shows the amount of retained tritium normalized against the initial amount as a function of elapsed time after irradiation. In the case of graphite, the amount of retained T was constant 106 days after the irradiation. The retained amount of tritium for carbon film was decreased by 10-15 % 125 days after the irradiation. As mentioned above, a more porus structure of carbon film than that of graphite might be responsible the T release after the irradiation. On the contrary to the graphite and carbon films, a large decrease in T retention was observed in tungsten. In the tungsten case, approximately 60 % of retained T was released after the irradiation. In general, the trapping energy for implanted hydrogen was smaller than that for graphite and the diffusion coefficient of hydrogen isotopes in tungsten was much higher than that of graphite. These would be a responsible for the difference of the decrease in the amount of retained T. This T release behavior of tungsten would be useful for reduction/removal of tritium.

1) Nobuta, Y. et al.: Fus. Eng. Des. **87** (2012) 1070.
2) Nobuta, Y. et al.: Fus. Sci. Tec. **60** (2011) 1535.

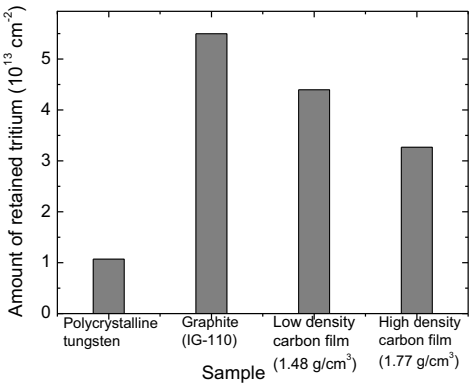

Fig. 1 Retained amounts of T for each sample after tritium ion irradiation.

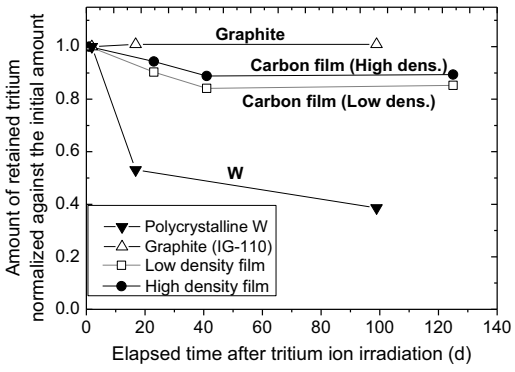

Fig. 2 Amount of retained T for each sample normalized against initial amount as a function of elapsed time after T ion irradiation.