Thermal Growth of Hydrogen Traps in Ion-irradiated W

I. Takagi[a,*], K. Yamamichi[a], R. Imade[a], T. Sasaki[a], H. Tsuchida[a], K. Moritani[a], H. Moriyama[b]

[a]*Graduate School of Engineering, Kyoto University, Yoshida Sakyo-ku, Kyoto 606-8501 Japan*

[b]*Research Reactor Institute, Kyoto University, Kumatori-cho, Osaka590-0494 Japan*

Tungsten and its alloys are candidates for plasma-facing materials in fusion devices. As the plasma facing materials are damaged by fast neutrons and charged with tritium from fusion plasma, tritium retention in these materials is an important issue. In the present work, tungsten samples are damaged by energetic ions and deuterium trapping in the damaged area will be experimentally investigated.

A sample is a tungsten disk with thickness of 1 mm and purity of 99.97% from ALMT corp. It was annealed at 1573 for 3.6 ks in vacuum and then mechanically polished with diamond paste. In the experiment, on side of the sample was irradiated with 0.8 MeV ^{4}He ions to introduce radiation damages. After the irradiation, deuterium depth profiles near the surface were observed by a nuclear reaction analysis (NRA) at several temperatures. During the irradiation and the NRA, the sample was continuously exposed to deuterium plasma so the deuterium-tungsten system would be in the steady-state.

Just after the irradiation at the sample temperature of 398 K, the deuterium concentration was not changed compared to that before the irradiation. The concentration increased with temperature to reach a maximum at 600 K and decreased at higher temperatures. When the temperature was subsequently lowered the concentration monotonically increased. Finally the concentration at 398 K became 4 times larger than before temperature rising. In a sample which was irradiated at 573 K, no increase during temperature rising was observed. In another sample which was irradiated with 0.2 MeV H ions at 450 K, the deuterium concentration increased at 550 K as in the case of the ^{4}He irradiation at 398 K. The traps were not annihilated at 700 K.

These indicated that precursors were produced by radiation damages and became grown up to hydrogen traps around 550 K. The precursors are considered to be point defects such as vacancy and interstitial. It is well known that 550 K corresponds to a recovery stage III in tungsten [1] and the point defects can migrate at that stage. The traps would be clusters of the point defects.

[1] L. K. Keys and J. Moteff, J. Nucl. Mater. 34 (1970) 260.