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Hydrogen isotope exchange in ion-damaged tungsten
イオン照射タングステン中における水素同位体交換

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1. Introduction

Tungsten (W) is one candidate for plasma facing materials (PFM's) in ITER and planned future fusion reactors. PFMs are simultaneously exposed to fuel particles and 14 MeV neutrons generated by DT reactions. The radiation damage produced by neutrons can increase tritium retention in tungsten due to production of additional trap sites. Increased tritium retention will impact the safety and operational limit of ITER and future fusion reactors. Therefore, it is important to assess both the trap characteristics produced in tungsten due to irradiation damage and also develop ways to remove tritium trapped in such sites. In our previous study, we examined isotope-exchange in damaged W, where the damage was created by MeV H ions. However, the damage produced by H ions is not identical to those of neutrons. A closer approximation to the dense collision cascade produced by neutrons can be achieved by using heavier ions for damage (e.g. Fe). Therefore, the purpose of this study was to examine isotope exchange in Fe ion damaged W, and compare the results to our previous study. Such comparison allows one to examine the difference in isotope exchange process as function of different traps.

2. Experiment

Square-shaped tungsten specimens 7×7×1 mm size were mechanically polished to a mirror-finish. These specimens were annealed at 2173 K for 1 h in vacuum after annealing at 1173 K for 1 h in ultra high vacuum prior to irradiation experiments.

As a proxy for neutron damage, tungsten specimens were damaged using a 6.8 MeV Fe^{3+} ions was irradiated to the surface centreover a 5 mm square area of tungsten specimens at 473 K using by the DuET (Dual beam ion accelerator) at the University of Kyoto. After introducing damage, W specimens were irradiated at 473 K using a low energy(~1 keV) deuterium ion beam at Osaka University up to a fluence of 1.5×10^{24} D/m^2. Next, the D implanted specimen was irradiated at 473 K at the same energy using a hydrogen ion beam, while varying the fluence from 5.0×10^{22} to 1.5×10^{24} H/m^2. Following irradiation experiments, the retention and desorption behavior of both deuterium and hydrogen were analyzed by Thermal Desorption Spectroscopy (TDS).

3. Results and Discussion

In this presentation, we present the following thermal desorption spectra with the aim of clearly showing the following points:

i) Difference in desorption rate of deuterium and hydrogen and their dependence on temperature
ii) The change in D retention as function of incident hydrogen fluence, and
iii) Difference in desorption spectra between Fe and H ion damage.