Hydrogen Behavior in Damaged Tungsten by High-Energy Ion Irradiation


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For future fusion devices, such as ITER, the high Z material tungsten has proposed as a plasma facing material (PFM) due to its low sputtering yield, high melting temperature, and low solubility of tritium. At DT fusion phase, the PFM is irradiated by 14 MeV first neutrons as well as ions and charge exchange neutrals. The first neutron impingement to PFM induces radiation damage such as point defects and these clusters in the materials. However, effect of radiation damage on hydrogen behavior in tungsten has not understood yet. In this study, changes of hydrogen behavior in tungsten caused by high energy particle irradiation were examined.

The radiation damage was introduced by high-energy hydrogen negative ion beam irradiation with MeV Test Facility (MTF) at Japan Atomic Energy Agency (JAEA) [1]. The maximum radiation damage introduced into the tungsten samples at ~3.3 µm in depth was ~3.5 dpa by 700 keV hydrogen negative ion beam irradiation. Low-energy hydrogen and carbon mixed ion beam was irradiated to the damaged and not damaged samples using High Flux Ion beam Test device (HiFIT) [2]. Sample temperature during all experiment was controlled not to exceed 473 K in order not to recover the radiation damage. Surface morphology of irradiated tungsten was observed using SEM and FIB.

Effect of radiation damage on hydrogen behavior in tungsten was investigated. The number of blisters with a diameter of 20 µm or less was decreased with an increase in radiation damage. From FIB observation, this is attributed to decrease in retention of postirradiated hydrogen at grain boundaries because of increase in trapping sites caused by high energy ion beam irradiation. Further experiment will be done for tungsten samples with shallower damaged depth to clarify the effect of radiation damage on hydrogen behavior. In order to examine the trapping site of irradiated hydrogen, we also observe hydrogen distribution and retention in the damaged and recovered samples.

References