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ダイバータ運転温度で中性子照射したタングステン中の重水素滞留挙動

Deuterium retention behavior in tungsten irradiated with neutron under divertor operation temperature

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In the fusion reactor, tungsten (W) will be exposed to high heat flux, neutrons, ash and fuel plasma of fusion reaction including tritium. The irradiation defects generated by neutrons will dynamically migrate, which results in the accumulation and annealing of irradiation defects. The irradiation defects in tungsten will act as potential trapping sites for hydrogen isotopes, and increase the hydrogen isotope retention. Therefore, the experiments to investigate the retention of hydrogen isotopes in W irradiated with neutron under high temperature is required. In this study, the neutron irradiation was carried out into W under the nominal temperature above 1000 K to imitate the steady-state high temperature divertor operation. Then the deuterium (D) retention was investigated by the Thermal Desorption Spectroscopy (TDS).

Polycrystalline tungsten samples purchased from Allied Material Corp. Ltd, with the size of 6 mm$^{\varphi}$, 0.5 mm^{t}, were irradiated by neutrons in HFIR (High Flux Isotope Reactor) in ORNL (Oak Ridge National Laboratory) up to 2.1-2.4 $\times 10^{25}$ n m^{-2} (E > 0.1 MeV), which is corresponding to ~0.5 dpa, at nominal temperatures of 1073 and 1373 K (named as AW-51 and AW-53 according to the sample ID in ORNL, respectively). W samples were dark-colored compared to that before irradiation. Then, the samples were exposed to deuterium plasma at 673 K, and deuterium retention was evaluated by TDS conducted in INL (Idaho National Laboratory).

Fig. 1. shows the D-TDS spectra for AW-51 and AW-53. First, the D retentions in these samples were quite higher than that of un-irradiated W[1]. Neutron irradiation produced irradiation defects uniformly through W, resulting in the D retention in the bulk region of W. The D desorption spectrum for AW-51 showed D desorption peak at around 850 K. That of AW-53 was also at the same temperature. This indicates the species of

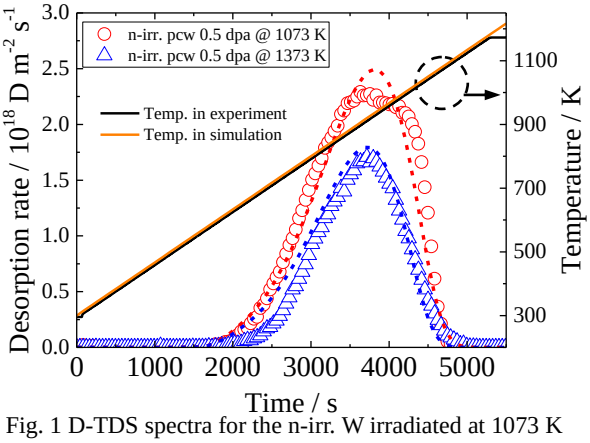

Fig. 1 D-TDS spectra for the n-irr. W irradiated at 1073 K (AW-51) and 1373 K(AW-53). The red and blue dashed lines were simulated D-TDS spectra.

irradiation defects should be the same between these W samples. Besides, D retention in AW-53 was almost 2/3 compared to that of AW-51. It was suggested that the irradiation defects induced in W annealed during neutron irradiation under high temperature. Consequently, D retention was reduced for AW-53 due to the lower concentration of irradiation defects.

The simulation code considering the D diffusion with trapping/detrapping equilibrium in W [2] showed that the D desorption behaviors from neutron damaged W was simulated well with assuming that the vacancies are the dominant D trapping site. The vacancies as the major D trapping site in neutron damaged W would be caused by the high temperature, long irradiation time period and small-scale cascade collisions by neutron irradiation.

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