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FTP/4-1: Hydrogen Isotope Trapping at Defects Created with Neutron- and Ion-Irradiation in Tungsten

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Tritium (T) inventory in tungsten (W) after neutron (n) irradiation is an important safety problem because radiation defects trap hydrogen isotopes. Therefore, deuterium (D) retention in n-irradiated W has been examined in Japan/US joint project TITAN. In this project, small W disks were irradiated in High Flux Isotope Reactor, Oak Ridge National Laboratory at coolant temperature (ca. 50 degree Celsius) to 0.025 dpa and exposed to high flux D plasma at 100 –500 degree Celsius in Idaho National Laboratory. Irradiation of 20 MeV W self-ions at room temperature to 0.5 dpa has also been performed to understand effects of displacement damages without transmutation. The ion-irradiated W specimens were exposed to low energy, low flux D atoms and D_2 gas not to modify the damaged structure near the surface at 130 –600 degree Celsius. Deuterium depth profiles and detrapping energy were examined by nuclear reaction analysis and thermal desorption spectroscopy (TDS), respectively. Both n- and ion-irradiations led to rather high D retention (0.1 –1 atomic percent) even at high temperatures (at/above 500 degree Celsius) due to the presence of strong trapping sites with detrapping energy of ca. 2 eV. Those defects were thermally stable at least up to 700 degree Celsius. These observations suggest that baking in vacuum at moderate temperatures could not be so effective for T removal. Nevertheless, significant D release from the ion-irradiated W was observed even at 200 degree Celsius under the exposure to H atoms.

Country or International Organization of Primary Author

Japan

Primary author: Mr HATANO, Yuji (Japan)

Presenter: Mr HATANO, Yuji (Japan)

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