Deuterium retention in damaged tungsten

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Plasma facing materials are exposed to fuel particles and 14MeV neutrons generated by DT reactions. Tritium retention in tungsten could be increased due to the increase in trap sites produced by neutron irradiation. Therefore, it is important to assess the characteristics of the trap sites by neutron damage. In recent years, several high energy damaging ions such as hydrogen, silicon, and tungsten have been used to simulate neutron damage. For reliable evaluation of neutron effects, it is important to compare results and to make comprehensive understanding of interactions between hydrogen isotopes and irradiation damage.

In this study, hydrogen ions with 300 keV and 700 keV were used to make damage in tungsten. Following damage creation, low energy deuterium ions were irradiated to the samples. Ion energy, flux, and sample temperature were 1 keV (mainly D_3^+), ~1.4×10^{20} D^+/m^2s, and 473K, respectively. Deuterium fluences of 5×10^{23} - 5×10^{24} D^+/m^2 were irradiated. Deuterium depth profiles of irradiated samples were measured with NRA (Nuclear Reaction Analysis). Total deuterium retention was measured by TDS (Thermal Desorption Spectroscopy). Trap site density as a function of dpa (displacement per ion) as well as estimation of trapping energies are presented.

In our case, the maximum energy of PKA (Primary Knock-on Atom) (6.3 keV for 300 keV H) is much lower than that of 14 MeV neutron (294 keV). On the other hand, previous experiments with 5.5 MeV W[1] and 12 MeV Si[2] gave much higher PKA energy conditions (~5.5 MeV for both cases). In this paper, we will make comparison of our data with theirs to comprehensively understand ion damage characteristics and appropriate evaluation for 14 MeV neutron damage. Difference between ion damage and neutron damage is also discussed.

[1] B. Tyburska et al., presented at 12th PFMC (Jülich, May 2009).

[2] W. Wampler and R. Doerner, Nucl. Fusion **49** (2009) 115023.