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ABSTRACT:

Study of Deuterium Location in Irradiated Tungsten

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Due to its advantageous characteristics, tungsten (W) is the leading candidate for the plasma-facing material in future fusion reactors. In a future nuclear environment, the W crystal lattice will be exposed to fuel, in the form of heavy hydrogen isotopes deuterium and tritium (D and T), while simultaneously undergoing significant alternation due to defects caused by 14 MeV neutrons. Information on which traps are responsible for hydrogen isotope trapping is vital for predicting fuel retention and transport in plasma-facing materials. Nuclear reaction analysis (NRA-C) combined with Rutherford backscattering spectrometry (RBS-C), both in the channeling configuration, is one of the few methods that can provide insight into the location of hydrogen trapped around the defects. In order to study the location of deuterium in W, we irradiated W(100) single crystals with 10.8 MeV W ions at two different doses (0.02 and 0.2 dpa) and temperatures (290 and 800 K) and then exposed them to D plasma at 370 K in order to populate the created defects. The aim was to produce samples containing either dominantly single vacancies, small vacancy clusters or large vacancy clusters, as later confirmed by positron annihilation spectroscopy [1]. We employed NRA-C, utilizing the D(3He,p)4He nuclear reaction with a 0.8 MeV 3He probing beam. The maximum NRA signal was detected in <100> axial and in the (110) planar channels [2]. A higher and broader peak was detected in <100> axial channel for samples irradiated at 800 K compared to those irradiated at 290 K. The spectra were interpreted using the RBSADEC code, which was recently upgraded to simulate the NRA-C signal [3]. This involved taking crystal cells containing different defect size filled with D atoms, and the results will be presented.

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