# Trapping and Diffusion Profile of Hydrogen Isotopes for Damaged Tungsten-Tantalum alloy

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Plasma-facing components, such as the divertor and first wall in fusion reactor, will be exposed to high-heat flux and energetic particles, which lead to tritium (T) accumulation and degradation of mechanical properties. These effects raise concerns regarding fuel management and structural reliability during long-term reactor operation. Tungsten alloys, known for their excellent thermal and mechanical properties, are considered as one of the promising materials to endure such extreme environments [1,2,3]. The addition of Ta to tungsten is expected to alter defect characteristics and influence the trapping behavior of hydrogen isotopes under irradiation. In this study, focusing on tungsten-tantalum (W-Ta) alloy, the trapping and diffusion processes of hydrogen isotopes were investigated. The impact of Ta addition on hydrogen isotope retention and migration was explored, aiming to understand how alloying affects hydrogen behavior in plasma-facing materials.

In this experiment, polycrystalline W and W-1,3,5wt%Ta samples were prepared using powder metallurgy and hot rolling, with 6 mm in diameter and 0.5 mm in thickness. These samples were fabricated by A.L.M.T Co, Ltd. Surface damage was introduced by irradiating the samples with $Fe^{2+}$ up to 1 dpa at R.T. at TIARA facility. Positron Annihilation Spectrometry (PAS) was employed to evaluate the size and density of irradiation-induced defects, such as vacancy-type defects. The irradiation-induced defects were also directly observed by Transimisson Electron Microscope (TEM), and the dynamics of dislocations and voids were investigated using in-situ heating to reveal the effects of Ta addition.Deuterium (D) ion implantation and T gas exposure were performed to introduce hydrogen isotopes into the damaged samples. Results from Glow-Discharge Optical Emission Spectrometry following D implantation revealed that the implanted D diffused into the bulk was enhanced by the damage. After D ion implantation, Thermal Desorption Spectroscopy (TDS) was also performed. The TDS results were analyzed using Hydrogen Isotope Diffusion and Trapping (HIDT) simulations to estimate the trapping energies and calculate the trap densities [4]. Furthermore, the dissolution of hydrogen was suppressed when Ta concentration exceeded 3%. Imaging Plat analysis after T gas exposure showed the different T distribution, suggesting that the solute Ta migrated on the surface, leading to variations in Ta concentration, and change in T absorption behavior. The findings from PAS and additional analysis of hydrogen isotopes behavior will be further discussed in the presentation.

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