

INFLUENCE OF TUNGSTEN OXIDE ON T RETENTION IN W MATERIALS

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Plasma-facing materials for next generation fusion devices, like ITER and DEMO, will be submitted to intense fluxes of light elements, notably H isotopes (HI). Several types of interaction occur between those particles and the first wall materials and their consequences need to be evaluated; among them, the evaluation of the hydrogen inventory, and in particular tritium (T), is of primary importance for both tokamak operation and safety management due to its radioactivity. Interaction of the first wall materials with particles escaping the magnetic confinement is particularly significant for the divertor components, and tungsten (W) was chosen for ITER's due to its favourable properties and high melting point. The W surface plays a major role on the HI inventory and retention, being the physical interface between the vacuum vessel and the material. Yet, W plasma-facing components present a native oxide layer at the surface that can survive or possibly evolve during conditioning and operational conditions. It is therefore of major interest to study T inventory in W oxide, whether it acts as a diffusion barrier or an additional trapping site, in order to integrate its impact in the modelling efforts and estimate the long term inventory in W PFM for ITER.

In that frame, we coupled a multi-scale material characterization of W samples with tritium inventory studies led at Saclay Tritium Lab [1]. To compare with references for pure crystalline W and W samples with native oxide, we developed an oxidation protocol to create stable enhanced W oxide layers (200-300 nm thick) and characterized the columnar structures formed by EBDS and FIB-TEM. We also exposed W particles with various oxide content and morphologies, with and without preliminary oxide reduction. The tritium gas-loading process used does not introduce new damage in the material and therefore characterizes the trapping sites originally present. Tritium desorption is measured by Liquid Scintillation counting (LSC) at ambient and high temperatures (800°C), the final step being full material dissolution to reach global T inventory. It appears that T trapping is strongly dependent on surface condition, with a major change in the desorption dynamic at room temperature: only 3 days are needed to desorb 75% of all T trapped in pure W, whereas it extends to 30 days in the enhanced W oxide case. This room temperature desorption indicates original trapping sites with low energy, with an estimation through MHIMS code around 1.13 eV, close to values obtained through our TPD deuterium study, which indicates a contribution to the short term T recycling in tokamaks rather than long term inventory.

[1] A. El-Kharbachi et al, Int. J. Hydrogen Energy 39 (2014) 10525

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