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Deuterium ion driven permeation through palladium coated tungsten

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1. Introduction

Tungsten (W) is the material choice for ITER divertor and DEMO. Therefore, it is important to understand hydrogen interaction with tungsten to estimate recycling, permeation, and in-vessel tritium inventory. We have performed ion driven permeation experiments to study hydrogen diffusion, recombination, and trapping processes in tungsten. However, surface barriers (e.g. thin oxide layer) can greatly affect permeation experiments. Often, their role is unknown or simply ignored. Therefore, we have performed permeation experiments with Palladium (Pd) coated tungsten specimen to quantify surface barrier effects. This presentation compares permeation fluxes between Pd-coated and uncoated tungsten specimens as function of temperature.

2. Experimental

A 75 μm thick tungsten specimen was coated on one side with 250 nm thick layer of Pd. The specimen was irradiated with Deutrium ion beam using HiFIT apparatus at Osaka University.[1] The permeation flux was measured in the apparatus described in Ref. 2. The incident D flux was varied between 10^{19}-10^{20} m^{-2} s^{-1} and ion energy was 1.0 keV. The temperature was 500 K ≤ T ≤ 1000 K.

3. Results and Discussion

The steady state permeation flux as function of temperature is plotted in Figure 1 for Pd-coated and previous data on uncoated W specimen.[3] At T < 800 K, good agreement between the coated and uncoated W was observed. At T > 800 K, large deviation between the two specimens was observed. Evidently, the conditions of permeating surface have a large effect at higher temperatures.

Next, the diffusivity was determined by fitting the transient rise of the permeation spectra and is plotted in Figure 2. A clear break is observed at AT = 740 K which we interpret as trapping effects. We further argue that the activation energy for diffusion at T > 740 K represent volume diffusion. A corresponding trap energy of 0.63 eV can be calculated using diffusivity measured at T < 740 K. We compare our results to the presently widely used hydrogen transport values in the literature and the implication for fusion.

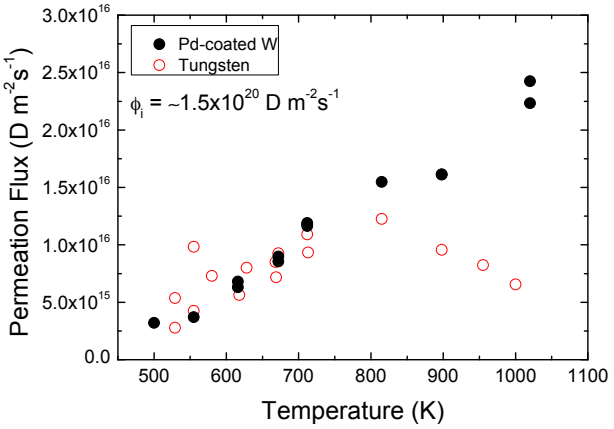

Fig.1. Steady state permeation flux for Pd-coated and uncoated tungsten specimen as function of temperature.

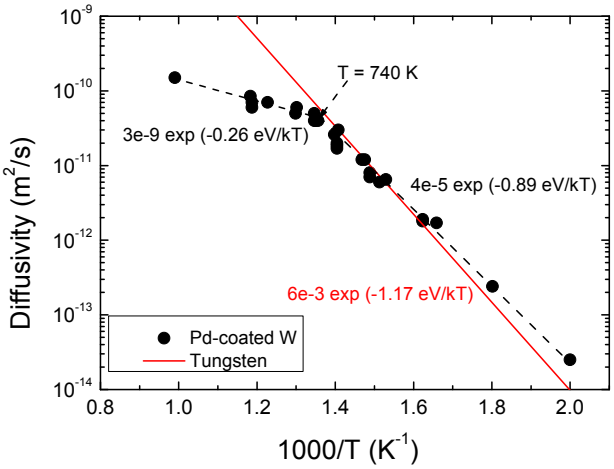

Fig.2. Diffusivity determined by fitting the transient rise to steady state.

References

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