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Hydrogen Isotope Behavior in Tungsten and RAFM Steels

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The transport and retention of hydrogen isotopes is of vital importance for the realization of future commercial fusion reactors, because it is closely related to plasma operation, fuel recycling and radiation safety. However, the hydrogen isotope behavior in fusion reactor materials is not well understood. Reduced activation ferritic-martensitic (RAFM) steel and tungsten (W) are promising candidate structural materials and first wall materials, respectively. In this presentation, we reported the deuterium permeation and retention behaviors of 7 kind of RAFM steels and 2 kind of W. Gas-driven permeation (GDP) method was used to investigate the deuterium permeability, diffusivity, and solubility of the studied materials, with loading pressure up to 1×105 Pa. For RAFM steels, the results indicates that the deuterium permeability has little materials dependence. In contrast, the deuterium diffusivity of 7 studied RAFMs showed significant variation. And W show lower permeability and diffusivity than RAFMs in the working temperature range. The influence of low-energy high-flux plasma irradiation on deuterium permeation in W has also been studied. Besides, thermal desorption spectroscopy (TDS) was performed to assess the retention behaviors of RAFMs and W with a temperature ramping rate of 0.5 K/s following a static thermal gas charging. Dominant desorption peak of ~1000 K was observed for W while ~500 K for RAFMs. And the retention of deuterium in RAFMs is about 1 to 2 order of magnitude higher than W. Finally, microstructural features contributing to the desorption and retention properties was discussed.

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