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Hydrogen permeation through the first wall: isotope effect and material interface effect

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In our recent studies on hydrogen permeation, two progresses have been achieved. (1) To understand the isotope effects on mixed plasma-driven permeation (PDP) through the ITER TBM wall, which is typically made by reduced activation martensitic/ferritic steel (RAFM), mixed D and protium (H) PDP experiments for a Chinese RAFM CLF-1 have been performed. The H/D ratio of the permeation fluxes is found to be stable when changing sample temperature and is insensitive to ion incident energy. In addition, the mixed H can provide more channels for D recombination to reduce the D permeation. (2) Special attention is paid to the W-Cu joining of plasma-facing wall. The retention behavior in W-Cu sample has been investigated by deuterium (D) gas exposure and thermal desorption spectrometry (TDS). D retention in the W-Cu sample is found to be more than twice higher than those in reference samples. HRTEM confirms the formation of oxide structures in the intermediate layer between W and Cu. Dislocations are also found at the interface. In addition, EDS analysis reveals there is a significant oxygen enrichment in the intermediate layer. All these defects may contribute to the significant increase of D retention in the W-Cu samples.

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