Investigation of Deuterium Permeation and Retention in RAFM Steel

H.-S. Zhou[1,2], H.-D. Liu[1,2], Y.-P. Xu[1], G.-N. Lou[1,2]

[1] *Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, China*
[2] *University of Science and Technology of China, Hefei, China*

Reduced activation ferritic/martensitic (RAFM) steel has been selected as the candidate structural material for fusion reactors. Recently, hydrogen isotopes (H) permeation and retention in RAFM steel under plasma exposure conditions have been intensively investigated at the Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP) in laboratory scale facilities as well as in the EAST tokamak.

Deuterium (D) transport parameters like diffusivity, permeability and solubility in a Chinese RAFM material: CLF-1 have been experimentally measured. The surface recombination coefficient for various D ion incident energies has been evaluated and the steady state permeation flux is found to extremely sensitive to the surface condition [1]. Helium (He) effects have been investigated as well. The RAFM steel surface can be strongly modified by the low energy helium plasma exposure [2]. Using an accelerator, high-energy He ion is pre-implanted into RAFM to study its effects on D retention. Deeply injected He has been found to act as a permeation barrier and reduce D bulk retention [3]. Finally, D plasma-driven permeation through a monoblock-type plasma-facing component (PFC) mock-up made by W and RAFM has been tested. The results suggest that W armor with gaps cannot stop hydrogen isotopes permeation through PFC into the coolant effectively. The RAFM material can act as T permeation "short cut", resulting in faster penetration speed and higher permeation flux than expected, which then may raise more complicated T contamination issue to the coolant [4].

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