Deuterium retention and erosion of CLF-1 and CLAM steels exposed to deuterium plasma

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During last one and half year, two parts of work have been performed in Lanzhou institute of chemical physics. First, the measurement method of deuterium and helium depth profile in metal using glow discharge optical emission spectroscopy were established in our laboratory, and the deuterium and helium retention in tungsten and RAFM steel samples exposed to deuterium plasma were measured. Using co-deposited and implanted samples, a deuterium and helium depth profile measurement method was successfully developed, the results show that GDOES can be used to evaluate the deuterium depth profile up to 20 μm in tungsten, and the total retention amount measured by TDS and GDOES shows the same increasing tendency. But in RAFM steel sample, due to the deuterium concentration is lower than the measurement limitation, the total deuterium retention amount measured by GDOES shows large scatter compare the data obtained by TDS.

The fuel retention and erosion of different reduced-activation ferritic/martensitic (RAFM) steels including CLF-1, CLAM, EUROFER and RUSFER exposed to deuterium (D) plasma were investigated. D plasma exposure was performed in a linear experimental plasma system with the incident ion energy between 30 and 180 eV per D, fluence from 10^{23} to 10^{25} D/m^2 and sample temperature between 300 and 900 K. After D plasma exposure, erosion structure development of surface topography was observed, but no significant difference was seen among various RAFM steels within the examined conditions. W-enriched layers are formed at the surface of all investigated RAFM steels determined by RBS. RAFM steels studied exhibited similarities in erosion and dependence on D plasma energy or fluence. The total erosion of CLF-1 and CLAM steel samples exposed at temperature from 400 to 900 K shows no obvious difference. Thermal desorption spectroscopy reveals in all steel samples only one broaden releasing peak from 450 to 800 K and total D inventory of 10^{18} - 10^{20} D/m^2. Similar D retention behavior of five RAFM steels was found that it decreases with increasing incident fluence or ion energy. Moreover, different cutting treatment along rolling direction leads to different erosion structure and D releasing behaviors.

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