Damage induced by irradiation in W and deuterium trapping in vacancy defects probed by slow positrons

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Tungsten has been chosen to cover the divertor and is envisaged for first wall material in fusion power reactors because of its high melting point, good thermal conductivity, low thermal expansion, high strength at high temperatures and high sputtering threshold energy. In such systems, tungsten will be submitted to neutron irradiation, high Helium and Hydrogen (deuterium and tritium: the fuel mixture) fluxes, and high heat fluxes up to 10 $MW \cdot m^{-2}$ in stationary and up to 20 $MW \cdot m^{-2}$ in transient operation and will have to sustain a temperature up to 1780 K. Such severe operating conditions could have a high impact on the macroscopic properties of the material, such as embrittlement and swelling. Furthermore it is of most importance to foresee what will be the quantity of tritium retained in the wall of the tokamak.

In order to study and understand the evolution of the microstructure of tungsten under conditions similar to those expected in future fusion reactors such as ITER and DEMO, well-prepared high purity tungsten samples were irradiated with W ions at 1.2 MeV and 20 MeV for damage doses between 0.01 and 0.4 dpa and for temperature of 773K. Vacancy type damage induced close to the surface (first 700 nm) was probed using Positron annihilation spectroscopy. Both Doppler and lifetime spectrometries were performed using slow positron beams: the CEMHTI-Orleans slow positron beam for Doppler measurements and the PLEPS set-up for Lifetime spectroscopy at the NEPOMUC facility at the MLZ in Garching. The positron results are compared with Transmission Electron Microscopy (TEM) observations for some conditions. In this paper the effect of the damage dose on the distribution of vacancy type defects and the evolution of the positron annihilation characteristics after deuterium exposure will be discussed.

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