Contribution ID: **35** Type: **contributed**

Flux dependence of deuterium retention in recrystallized tungsten exposed to high fluence plasma in Magnum-PSI and STEP

To investigate the effects of particle flux on deuterium (D) retention, a series of D plasma exposures were systematically investigated in recrystallized tungsten (W) at ~500 K using two linear plasma devices STEP and Magnum-PSI. A low flux plasma with the highest fluence of 1.0×10^28 m^-2 was achieved in STEP and a high flux plasma with the highest fluence of 1.0×10^29 m^-2 was achieved in Magnum-PSI. Scanning electron microscope (SEM) observations indicate that some blisters with elliptic and domed shapes was observed in case of low flux plasma exposure and the density of blisters develops with increasing fluences. In case of the high flux plasma exposure, blisters were featured by stepped flat-topped and irregularly-shaped features, and the blister density exhibits a tendency to saturate with fluence. Nuclear reaction analysis (NRA) results show that D concentration distributed with the first 7 μm from the sample surface at low flux is lower than that at high flux under the same fluences. Moreover, a maximum D concentration of up to 0.012 at.fr., distributed within the first 4 μm from the sample surface, was detected at high flux. D retention, measured by NRA and thermal desorption spectroscopy (TDS), are both proportional to the square root of the plasma fluence at low flux, but tend to saturate at high flux. Based on the rate theory code TMAP, simulation of D2 thermal desorption spectroscopy were conducted to infer the de-trapping energies and concentration depth profiles of defects. It is found that the maximum D distribution depth at the low flux increases gradually with fluence but exhibit little variation at the high flux, and the former is much deeper that of the latter at the same fluence. Additionally, the simulation results indicates that the maximum D distribution depth does not follow a proportional relationship with the square root of exposure time, this can be attributed to the growing number of plasma-induced defects and the reducing injection coefficient with increasing fluences. The discrepancy between the retention results using STEP and Magnum-PSI indicates a flux dependence of the defect-production efficiency and impact depth, potentially due to the difference in the D concentration gradient in W near surface using the two devices. As a full W plasma-facing material design is considered in ITER, this investigation would provide valuable references to evaluate and model hydrogen isotope retention and defect production due to plasma exposure in W.

Primary authors: SUN, Yiwen (Beihang University); CHENG, Long (Beihang University); Prof. ZHOU, Haishan (Institute of Plasma Physics, Chinese Academy of Sciences); Prof. YUAN, Yue (Beihang University); Dr MORGAN, Thomas W. (Dutch Institute for Fundamental Energy Research); Prof. LU, Guang-Hong (Beihang University)

Presenter: CHENG, Long (Beihang University)

Session Classification: PSI and PMI experiments