Microscopic damage creation in irradiated materials raises concerns about the evolution of physical properties of wall materials in fusion nuclear devices. Intensive helium (He) irradiation of tungsten (W) may lead to change of surface roughness and accumulation of He in form of bubbles in the bulk. Since W will compose ITER divertor, it is important to understand the process of damage creation due to the He irradiation of W under ITER-relevant irradiation conditions as well as the surface and He bubbles creation and morphology evolution at high temperatures.

In this contribution we focus on surface and He bubbles morphology evolution under annealing cycling. Two polycrystalline W samples have been exposed to a 75 eV He plasma in the linear plasma device PSI-2 in Jülich (Germany). The fluxes were $2.3 \times 10^{22}$ and $2.9 \times 10^{20}$ He m$^{-2}$s$^{-1}$. The fluence of $3 \times 10^{23}$ He m$^{-2}$ and exposure temperature (~1063K) were the same for both samples. Then, samples were introduced into the UHV setup CAMITER in Marseille (France) for low fluence deuterium (D) implantation and annealing experiments. Cycles of room temperature in-situ D$^+$ 500 eV $4.5 \times 10^{19}$ D m$^{-2}$ ion implantations followed by annealing up to 1250-1350 K were performed 5 times. The surfaces of the samples were analysed by Scanning Electron Microscopy. Thin laminae were cut on both samples using the Focused Ion Beam technique. Transmission Electron Microscopy (TEM) allowed cross-sectional observations of the He bubbles formed in the near-surface region after He exposure and their evolution due to annealing cycles.

He pre-irradiation in PSI-2 causes appearance of nanometer-scale holes on W surfaces. Furthermore, round-shaped He bubbles of different sizes are observed by TEM up to 40 nm below the surface of both W samples. The majority of He bubbles in both samples have sizes up to 5 nm. There are nearly 2 times more bubbles with size around 10 nm in the high flux case than in the low flux case. After 5 annealing cycles up to 1250-1350 K, surfaces appear smooth. Additionally, all He bubbles in the near-surface region of both samples are shaped with flat faces (facets) and, thus, the TEM observation of He bubbles shape is dependent on crystallographic orientation. Bubbles of all sizes appear for the most part in the hexagon shape in the <111> direction, in rectangles or squares shapes in the <100> direction and in irregular rectangles or hexagons in <110> direction. The bubbles are thus likely to be octahedrons with possible irregularities like edge truncations. Furthermore, Electron Energy Loss Spectrometry measurements demonstrate the presence of He inside these bubbles after annealing cycles. Lastly, comparison of the D implanted areas and non-irradiated with D areas revealed that presence of D does not play a role in bubbles shape changes during annealing. Our results should help to better understanding of the impact of He irradiation and thermal annealing on the fundamental physical properties of W.