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# Defect production and deuterium bulk retention in quasi-homogeneously damaged tungsten

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Tungsten (W) is foreseen as the leading plasma facing material (PFM) for future fusion reactors due to its advantageous thermal mechanical properties and relatively low solubility of tritium (T). W-PFM in fusion reactors will experience intense radiation by 14 MeV-peaked neutrons (n), which have long mean free paths on the order of centimeters in solids. T retention in W may greatly increase owing to the T trapping effects of defects created by neutrons throughout the W bulk. Therefore, T bulk retention in n-irradiated W becomes a significant safety concern. Recently, heavy ions are widely used as surrogates for neutrons to investigate the influence of n-produced defects on T retention. However, the damaged layer of heavy ions is usually limited to a few micrometers beneath the specimen surface and the damage profile is strongly peaked. Hence the effects of homogeneously distributed traps on T retention in W have not been fully understood. In this study, by using ultra-high energy ions and special sample irradiation techniques, we produced a quasi-homogeneous distribution of defects in bulk W; then the deuterium (D, a surrogate of T) retention mechanisms in the damaged W are investigated.

The high-energy heavy-ion irradiation was performed at Heavy-ion Research Facility in Lanzhou. Annealed W foils were irradiated with 122 MeV 20Ne ions in a terminal chamber where an energy degrader for defect distribution tailoring was used. SRIM calculation showed that a quasi-homogeneous distribution of atomic displacement damage to 0.16 dpa within a depth of 50 μm was produced in W. Then results from positron annihilation lifetime characterizing exhibited an extra long positron lifetime component of ˜400 ps in the irradiated W, indicating the formation of large vacancy clusters. After that, the sample was exposed to D2 gas at 773 K. Thermal desorption spectra featured a high D release peak at ˜1010 K and a broad D desorption temperature range (730-1173 K) for the irradiated W, which was very different from the non-tailored W sample (much narrow desorption window). Further transmission electron microscopy characterizing (under and over-focus pairs) showed a large amount of voids with a diameter of ˜1 nm in the irradiated W. These voids could be the large vacancy clusters formed by heavy ion irradiation and should be the main reason to the high temperature desorption of D. However, whether the broad D desorption window is related to the quasi-homogenous distribution of voids should be further studied.

## Eligible for student paper award?

No

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