Contribution ID: **85** Type: **not specified**

Mitigation of blistering effect on hydrogen transportation in ion-damaged tungsten

Wednesday, 6 October 2021 11:20 (30 minutes)

The effect of ion-induced damage on blistering and deuterium retention has been investigated in heavy-ion damaged tungsten (W) and a reference undamaged W sample with exposure to D plasma (40 eV, 10^{22} $m^{-2}s^{-1}$) at 550 K. Different damage depths are realized via copper (Cu) ion irradiation with energies of 1, 3, and 6 MeV on W samples with the same calculated peak damage level of 0.5 dpa. The Cu ion irradiation is shown to give rise to a reduction in blister density in W samples, and such a phenomenon becomes more pronounced as the damage depth increases. The D-rich region (with a D concentration larger than 0.5 at.%) in the near-surface extends inward and the total D retention increases with the increasing damage depth. A combined investigation using nuclear reaction analysis and thermal desorption spectroscopy reveals that D accumulates also at a depth beyond 7.4 μm which is far beyond the damage depth, and D retention at a depth beyond 7.4 μm rises with the damage depth. It suggests that the D diffusion flux into the bulk in the damaged case is higher than that in the undamaged case during the D plasma exposure. This phenomenon is attributed to the difference in the surface blister density, which alters the inward D diffusion flux by affecting the re-emission of D from the surface, and the D trapping at blisters in the blistering-relevant depth.

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Session Classification: Retention