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Deuterium retention in tungsten exposed to KSTAR plasmas

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Tungsten (W) is considered to be the most viable armor material for the plasma-facing components (PFC) of a fusion reactor [1]. The work under fusion plasma will lead to modification of W that would change, in turn, its erosion properties, subsequent redeposition on surface, and would influence gas inventory (tritium, T) in material. Hydrogen (H) in W easily diffuses deep into W bulk even from the redeposited layers to the W substrate [2], namely, bulk T retention in W is a major safety concern. Erosion, deposition and deuterium (D) retention were investigated by installing marker tiles exposed to EAST plasmas in our previous work [3]. KSTAR is a superconducting tokamak with first wall fully covered by graphite tiles, and has planned a major upgrade to W first wall (coatings and bulk W-PFC) [4]. In this paper, D retention in bulk tungsten applying marker and redeposited surface have also been discussed.
7 sets of tungten samples were installed in the lower divertor region and center column at the high field side during the 2015 KSTAR compaign, in which 2 sets were mounted at central divertor where could be observed by divertor IR camera from the top. Each set includes 2 maker W samples for erosion measurement and 2 polycrystalline W samples for retention study. To make sure that the marker layers could be measured after a long term plasma exposure with a possible change of the surface, SIMNRA are used in advance to design the marker including the variety of element, the thickness of the marker layer and the surface roughness. Tungsten coatings were then deposited on graphite substrate by magnetron sputtering as marker layers with a thickness of 400±10 nm. The roughness of the substract is around 0.1 μm. And 4 deposited tungsten samples with different porosities were exposed in 2016 KSTAR compaign by divertor manipulator.
Surface morphologies and the compositions were characterized by standard surface analysis techniques, including scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). Rutherford backscattering spectroscopy (RBS) were used to measure the change in depth of the markers and deduce the net amount of erosion/ possible deposition on the samples. And the retention profiles were obtained by Nuclear reaction analysis (NRA) and thermal desorption spectroscopy (TDS).

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Eligible for student paper award?

No

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