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Synergetic effects of He ions irradiation and oxidation on W

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Tungsten (W) is foreseen as one of the most promising plasma facing materials (PFM) of fusion devices. As oxygen exists as a contamination in the vacuum chamber of tokamak, W oxide can form at the surface of W due to good chemical affinity between W and oxygen. W oxide film will inevitably interact with helium (He) ions, which are formed by the deuterium –tritium (D-T) fusion reaction. Many studies have found that He ions irradiation causes degradation of W physical and mechanical properties, such as the thermal conductivity (TC), which is related to the surface modification of W. Surface morphology of W will be changed by the oxidation too. Thus He ions irradiation and oxidation might synergistically degrade the W physical and mechanical properties. However, the synergetic effects of He ions irradiation and oxidation on W are not understood. In this study, thin WO₃ film was produced by thermal oxidation on the surface of pure W samples. The samples were sequentially irradiated by the He ions. The morphology of W after He ions irradiation and oxidation were observed. Finally, TC of He ions implanted layer of W with an oxide film was measured.

In the oxidation process, WO₃ film was produced on the surface of rolled W by thermal oxidation at 673 K and at an oxygen pressure of 590 torr for 90 min. X-ray diffraction confirmed the main phase of the oxide was WO₃. A damaged layer in the near surface region of W with an oxide film was produced by He ions at room temperature. The dose were simulated by SRIM. Three dose were implanted and damaged layer of average 0.1, 0.5 and 1 dpa were obtained. The morphology of the samples before and after irradiation was observed by scanning electron microscope. The TC of the implanted layer was measured by front heating transient thermosreflectance method. The surface morphology and TC of the He ions implanted layer were compared and analyzed.

Eligible for student paper award?

Yes

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