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P2.123 Sublimation of advanced tungsten alloys under DEMO relevant accidental conditions

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Future fusion power plants require the development of a first wall armor material withstanding extreme particle and heat loads. Considering safety, the formation of long-lived radioactive isotopes when irradiated with neutrons and a tritium inventory has to be prevented. As tungsten (W) meets these safety requirements, has a low erosion rate, high melting point, and high thermal conductivity, it is a promising candidate for the first wall armor.

There is another important safety consideration: in a loss of coolant accident, cooling systems fail and air ingress into the vacuum vessel may occur. Due to the nuclear decay heat, temperatures in the range from 1200 K to 1450 K for several weeks are predicted in such a scenario: the radioactive W oxidizes and volatilizes, posing a severe hazard for the environment. For a successful future fusion power plant like DEMO, a new material is required. The new material should preserve the advantages of W coupled with suppressed sublimation in case of an accident.

Currently an alloy containing W, ~12 weight % chromium, and ~0.6 weight % yttrium consolidated by Field Assisted Sintering Technology is investigated and shows promising results. During exposures to deuterium plasma, erosion yields are similar to pure W. Moreover, the oxidation resistance is significantly improved: complete mechanical destruction is avoided for at least three weeks.

The major goal is to control the sublimation which is responsible for a release of radioactivity. In this work sublimation rates are measured explicitly for the first time in humid air. WO3 sublimates at a rate of 5 $g/m^2/h$ at 1273 K in humid air. At the same conditions the alloy suppresses sublimation by a factor of 35 as compared to that of pure W.

The results and consequences are discussed. Further, the mechanisms yielding the improved oxidation resistance are analyzed and discussed.

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