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Effect of Helium Ions Energy on Molybdenum Surfaces Under Extreme Conditions

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ABSTRACT

Plasma facing components (PFCs) in fusion devices must be able to withstand high temperatures and erosion due to incident energetic ion radiations. Tungsten has become the material of choice for PFCs due to its high strength, thermal conductivity, and low erosion rate. However, its surface deteriorates significantly under helium ion irradiation in fusion-like conditions and forms nanoscopic fiber-like structures, or fuzz. Fuzz is brittle in nature and has relatively lower thermal conductivity than that of the bulk material. Small amounts of fuzz may lead to excessive contamination of the plasma, preventing the fusion reaction from taking place. Despite recent efforts, the physical mechanism of the surface deterioration is still not clear. This necessitates finding alternative materials for PFCs. In this report, the effect of helium ion energy on molybdenum surfaces is investigated. Helium ion irradiations on mirror finished polished molybdenum samples are performed as a function of helium ion energy from 100-1600eV with fixed values of ion-flux (7.2×10^{20} ions m^{-2} s^{-1}), ion-fluence (2.6×10^{24} ions m^{-2}), and temperature (923K). The surface modifications were studied using scanning electron and atomic force microscopy along with X-ray photoelectron spectroscopy and optical-reflectivity measurements. Reduction in the "protrusion" of fuzz from the surface and fuzz density at increased energy have been seen from microscopy and optical reflectivity studies. These findings further the understanding of fuzz formation on high-Z refractory metals for fusion applications.

KEYWORDS

Nuclear Fusion, Molybdenum, Low Energy Helium Ion Irradiation, Fuzz, Nanostructures