CAPABILITIES OF NANOSTRUCTURED TUNGSTEN FOR PLASMA FACING MATERIAL

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One of the bottle necks for fusion to become a reality is the lack of materials able to withstand the harsh conditions taken place in a reactor environment. In particular, plasma facing materials (PFM) have to resist large radiation fluxes and thermal loads [1]. Nowadays, tungsten is one of the most attractive materials proposed for PFM. However, it is known that the irradiation of tungsten with H leads to surface blistering and subsequent cracking and exfoliation [2] which is unacceptable. In particular, these effects have been observed to be more severe when W is subjected to pulse irradiation [3].

One option to delay the appearance of blistering and exfoliation is the use of nanostructured materials [4,5]. The behavior of these materials under irradiation is very much dominated by the large density of grain boundaries, which at room temperature act as (i) annihilation centers for Frenkel pairs (self-healing behavior) [6] and (ii) pinning centers for hydrogen[7]. These two facts may drive the delay (shift to higher irradiation fluences) of the formation of blisters. In spite of these facts, the study of the role of grain boundaries in hydrogen behavior is very relevant.

We show the thermal loads and stress values that the W amour has to withstand in the HiPER scenario [8] (direct drive, evacuated chamber, and dry wall) as calculated by finite elements. Next, we discuss the influence of the steel surface termination on the adhesion of tungsten to the steel. Then, we present experimental results on the physical properties (morphology, microstructure, mechanical properties…) prior to and after (single (H), sequential (C+H) and simultaneous (C and H)) irradiation of nanostructured W coatings deposited by sputtering [9,10], standing out the role of grain boundaries on the light species (H and He) behavior. We compare multi-scale computer simulation and experimental results, discussing about the influence of grain boundaries on the radiation response of tungsten [11]. Finally, we show the influence of pulsed irradiation on the radiation-induced damage in W [12].

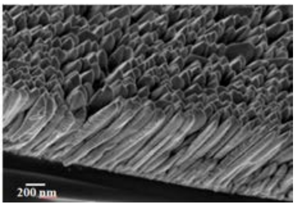

Fig. 1.- SEM image of a polycrystalline pure α-phase nanostructured W coating deposited by sputtering at the Institute of Nuclear Fusion (UPM, Spain).

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