Capabilities and limitations of nanostructured tungsten as a plasma facing material: atomistic damage and thermal loads

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One of the bottlenecks for fusion to become a reality is the lack of materials able to withstand the harsh conditions occurring in a reactor environment. In particular, plasma facing materials (PFM) have to resist large radiation fluxes and thermal loads. Nowadays, tungsten is one of the most attractive materials proposed for PFM. However, its irradiation with light species (H and He) leads to surface blistering and subsequent cracking and exfoliation.

One possible option to improve the radiation-resistance of PFMs in relation with the atomistic damage and light species behavior is the use of nanostructured materials. Here, we will report about experimental and multiscale computer simulation results, showing the role played by grain boundaries on this issue [1-6], and concluding that nanostructured W (NW) exhibits a better radiation resistance than coarse grained W(CGW) in the studied temperature range.

The other main concern is related to the capability of PFM to withstand large thermal loads. On this topic, firstly we will present the calculation of the radiation fluxes, temperature enhancements, and mechanical stresses that W will undergo working under the different scenarios predicted for HiPER [7]. Then, we will show the results of an experimental campaign wherein NW samples have been irradiated under different conditions (heat flux parameter and number of pulses) in a small plasma focus device [8] located at the Comisión Chilena de Energía Nuclear.

Finally, the advantages and limitations of NW to be used as a PFM will be discussed.

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