ANALYSIS OF DISPLACEMENT DAMAGE IN MATERIALS IN NUCLEAR FUSION FACILITIES (DEMO, IFMIF AND TECHNOFUSIÓN)

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Materials for future fusion reactors (ITER, DEMO) will be exposed to an extraordinary hostile environment as a consequence of the intense radiation field created during the nuclear reaction. The study of the neutron radiation effects, produced in the materials is one of the main research topics under study nowadays. Indeed, the level of damage expected in fusion conditions is such that the exact performance of materials and components under these extreme irradiation conditions is still unknown. To predict the evolution of defects—and thus the performance of materials—under these extreme conditions, it is therefore essential to properly determine the generation of displacement damage in the materials.

Therefore, thermonuclear fusion requires the development of several research facilities, in addition to ITER, needed to develop the technologies for future fusion reactors (DEMO). Among the priority areas identified by international fusion programmes, the future International Fusion Materials Irradiation Facility (IFMIF) facility will be a special irradiation tool for the qualification of promising materials for fusion reactors [1]. To achieve this objective, IFMIF spectrum must produce the displacement damage per atom (dpa), primary knock-on atom (PKA) spectrum and gaseous elements by transmutation reactions (He, H) as closely as possible to the ones expected in the fusion reactors (DEMO).

On the other hand, the recently proposed TechnoFusión facility[2] aims to be a technological support for IFMIF, ITER and DEMO facilities. In the Material Irradiation Experimental Area (MIEA) of TechnoFusión, the effects of neutrons and gamma radiation on fusion materials will be simulated by irradiating them with ion and electron accelerators. Therefore, it will play an essential role in the selection of functional and structural materials for fusion reactors.

In this work the irradiation parameters of fusion candidate materials for fusion reactors have been studied and then, the suitability of some experimental facilities such as IFMIF and TechnoFusión to perform relevant test with these material have been assessed.

The neutron fluxes present in different irradiation modules of IFMIF were calculated with the neutron transport McDeLicious code [3]. In parallel, the energy differential cross sections of PKA were calculated using the NJOY code (version 99.304) [4]. After that, the damage generated by the PKA spectra was analyzed using the binary collision approximation MARLOWE code [5] and custom analysis codes. Finally, to analyze the ions effects in different irradiation conditions in the TechnoFusión irradiation area the SRIM [6] and Marlowe codes have been used.

The results have been compared with the expected ones for a DEMO HCLL reactor.

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