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FTP/P7-12: Self-healing of Radiation Damage by Coupled Motion of Grain Boundaries in Tungsten Divertor Plates under Reactor Conditions

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Radiation damage by fusion neutrons can significantly degrade material properties. In a fusion reactor, long-lasting radiation-induced defects such as vacancies, vacancy clusters, and voids introduce additional nuclear safety complication in terms of trap ites for excessive tritium retention. This is especially true in the divertor/first wall of a tokamak like ITER, where extreme thermal stress is also present. Here we use molecular dynamics simulations to elucidate a self-mitigating mechanism in which the large thermal stress can facilitate the recombination of the neutron-collision-cascade-induced vacancies and interstitials through coupled grain boundary (GB) motion in a bcc tungsten under fusion reactor conditions. Specifically, our simulations reveal that for a number of tungsten GBs, absorbing the fast-moving interstitials can help activate coupled GB motion at reduced mechanical stress; the migrating GB then sweeps up the less-mobile vacancies, facilitating vacancy-interstitial recombination inside the GB. We examine the stress-induced mobility characteristics of a number of GBs in W to investigate the likelihood of this cenario.

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