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Nucleation and growth of helium-vacancy clusters in ferritic-martensitic steels – effect of dpa rate

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Fe-12Cr model alloy implanted by helium ions was investigated in a context of Fe-9Cr steel irradiated in a mixed neutron-proton spectrum of spallation target. Application of pulsed low-energy positron beam enabled a careful selection of a region in the Bragg peak with the He concentration and displacement damage comparable to spallation conditions. The investigated samples, irradiated in Swiss Spallation Neutron Source – SINQ received up to 20dpa and 2000appm He in 2 years. A similar dose was obtained in the implanted samples in 72 hours. Despite a major acceleration of the displacement damage production, the positron lifetime data were found to be relatively comparable. However, the implanted samples show a more significant trapping at vacancy clusters with lifetime 200-280ps. Also, the absolute value of the positron lifetimes in this range of clusters was found to be larger in He-implanted samples. This suggests a higher concentration of vacancy clusters containing less helium in these samples, comparing to the spallation ones. More defects surviving cascade collisions can be explained by a presence of interstitial helium in the matrix, it's fast migration into radiation-induced vacancies and stabilization of these defects against recombination.