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Swift heavy ion irradiation damage in advanced nanostructured alloys

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The most promising materials for operation under high fluxes of high-energetic irradiations are complex heterogeneous systems strengthened by nanoscale inclusions and phases. Energy loses in such structures is nontrivial. Objects of this study are two titanium alloys (Ti-5Al-4V-2Vr and Ti-6Al-4V) and ODS Eurofer steel.
The effect of irradiation at room temperature on the microstructure was studied by high-resolution transmission electron microscopy with energy-dispersive spectroscopy. Investigation of the initial state of titanium alloys revealed bimodal grain distribution: a large number of hardening β-phases enriched in vanadium inside α-phases. Irradiation with Au ions (4.8 MeV/nucleon, up to 1×10^13 cm^-2) leads to the formation of inclusions in the α phase with an average size of 2±1 nm. These features are coherent with the matrix, aligned along the irradiation direction and can be ascribed to pre-precipitates of the β phase.
Irradiation of ODS Eurofer with swift Au (4.8 MeV/nucleon; 1×10^11 and 5×10^12 cm^-2) and Xe (1.2 MeV/nucleon; 1×10^13 и 1×10^14 cm^-2) ions led to the formation of amorphous areas within large (>8 nm) oxide particles . These features are probably tracks produced along the ion paths. The average size of the observed tracks is 3±1 nm, and their density correlates with the total ion fluence. An amorphous transition layer was observed at the interface of large oxide particles after irradiation with Au ions.

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