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SWIFT HEAVY ION TRACKS IN NANOCRYSTALLINE Y4Al2O9 AND Y2Ti2O7*

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Radiation stability of Y-Al-O and Y-Ti-O compounds which are key ingredients in oxide dispersion strengthened (ODS) steels as promise materials for nuclear applications, is a subject of extensive irradiation testing with various radiation sources. Most corresponding literature data focus on radiation damage produced by neutron and charged particle radiation in elastic collisions and much less is known about defects formed via relaxation of dense electronic excitations associated with high-energy, heavy ion irradiation. As known, (Y,Ti) and (Y,Al) nanooxides may retain crystallinity up to very high damage doses, sometimes more than 100 dpa [1]. At the same time, certain types of precipitates such as Y-Ti-O, may be easily amorphized by heavy ions of fission fragment energies via the formation of amorphous latent tracks produced by heavy ions of fission fragment energies at relatively low ion fluences of about 10^{13} cm^{-2} [2–4]. Contrary, $Y_4Al_2O_9$ (YAM) nanoparticles have demonstrated much higher resistance to dense electronic excitations effects that stimulates further research. This work is aimed at comparative high-resolution transmission electron microscopy (HRTEM) examination of Xe and Bi ion track parameters in both isolated and non-isolated (embedded into ferrite matrix) $Y_4Al_2O_9$ (YAM) and $Y_2Ti_2O_7$ nanoparticles.

The samples were irradiated with swift Bi and Xe ions with energies ranging from 148 to 714 MeV at electronic stopping powers from 2 to 35 keV/nm at the IC-100, U-400 and DC-60 cyclotrons at FLNR JINR (Dubna, Russia) and Astana Branch of Institute of Nuclear Physics (Nur-Sultan, Kazakhstan). The ion fluence corresponded to the "individual tracks" regime was 5×10^{11} cm^{-2}. Structural analysis was performed using Talos™ F200i S/TEM and JEOL ARM-200F TEM operating at 200 kV.

As was found, the track diameter in isolated nanoparticles of yttrium titanate for close levels of electron energy losses is much larger than in the same nanoparticles embedded in a metal (ferrite) matrix [3, 4]. Latent tracks in YAM have been revealed in isolated particles only alloy starting from the threshold energy loss 6.2 keV/nm [5]. It is suggested that different structural response of isolated and non-isolated nano-oxides as well parameters of the track regions is largely determined by peculiarities of the heat transfer processes in the nanostructured materials.

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