Review
of theme "Radiation physics, radiochemistry, and nanotechnology investigations using beams of accelerated heavy ions"

Because of my area of expertise is condensed matter physics, I will focus in review of theme 1131 the results in radiation material science with high energy heavy ion beams. First of all, collaborative teems involved in the theme implementation, have achieved evident considerable progress in studies of ion tracks in radiation-resistant insulators using molecular dynamic and high resolution transmission electron microscopy. Comprehensive simulations enabled them to identify recrystallization as the dominant mechanism governing formation of detected tracks in oxides like Al_2O_3, MgO, $Y_3Al_5O_{12}$ and nitrides –Si_3N_4. Another impressive result concerns the crystal lattice recovery as a sequence of ion track interference during irradiation in track overlapping regime that is of significant practical importance for simulation of fission product impact in inert matrix fuel hosts. For the first time, swift heavy ion induced tracks have been studied in the same material in different structural state – crystalline, amorphous and radiation amorphized silicon nitride. These data are applied to verify the applicability of atomistic mechanisms of latent track formation.

A potential of high energy heavy ions as an efficient tool for modification of two dimensional materials has been evidenced in graphene oxide films which structure and properties were studied over a broad range of ion energies and fluences. In particular, fabrication of conductive nanosized reduced graphene oxide spots, accompanied by the formation of sp-hybridized carbon chains was demonstrated. It was found that high energy heavy ion impact results in formation of graphene quantum dots in a nonconducting matrix of graphene oxide and fluorinated graphene. Both the number density and the diameter of dots can be tailored by a suitable choice of ion type, fluence, and energy.

It is pleasure to note that recently installed in Nanocenter of FLNR state of art high resolution transmission electron microscope Talos FEI200i significantly extends experimental possibilities in microstructural examination of materials irradiated/modified with swift heavy ion beams. Unique combination of FLNR JINR cyclotrons and modern analytical equipment will definitely serve for successful realization of ongoing and planned projects in radiation material science.

As a good estimate of growing interest of JINR participating countries in applied research using the FLNR facilities, demonstrating close cooperation, is continuously increasing number of joint publications in highly ranked journal and invited reports presented at regular international conferences in radiation solid state physics like Swift Heavy Ions in Matter (SHIM) and Radiation Effects in Insulators (REI).

I strongly recommend prolongation of theme 1131 “Radiation physics, radiochemistry, and nanotechnology investigations using beams of accelerated heavy ions” for next two years 2022-2023.

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