

Liquid-like phase formation in Gd₂Zr₂O₇ by extremely ionizing irradiation

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Isometric Gd₂Zr₂O₇ with the ordered, pyrochlore structure has an extremely high resistance to radiation-induced amorphization. Ion-beam irradiations at keV to GeV energies result in a disordered, defect-fluorite structure that remains crystalline to very large fluences. However, we report liquid-like phase formation of droplet-like surface hillocks and quenched molten tracks in Gd₂Zr₂O₇. The extremely high energy density of 12-MeV C₆₀ clusters creates tracks with substantial volumes of amorphous material, accompanied by the formation of nanocrystals of the disordered, defect-fluorite structure. This is the first evidence of irradiation-induced amorphization of Gd₂Zr₂O₇. In contrast, irradiation of Gd₂Zr₂O₇ pyrochlore with swift heavy ions of U resulted in an order-disorder transformation to defect-fluorite without any evidence of amorphization. Thermal-spike calculations highlight the dominance of the effect of deposited energy density, controlled by the projectile velocity, as compared with the energy loss.