Effects of irradiation-induced structural disordering in zirconate pyrochlores at high pressures

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Abstract: The effects of swift heavy ion irradiation-induced disordering on zirconate compounds (A\textsubscript{2}Zr\textsubscript{2}O\textsubscript{7} where A = Sm, Er, and Nd) at high pressures are investigated using synchrotron X-ray diffraction (XRD). Irradiation experiments were performed at the GSI Helmholtz Center with \textsuperscript{197}Au ions accelerated to energy of 2.2 GeV. Angle dispersive synchrotron powder X-ray diffraction measurements were completed at the Advanced Photon Source at Argonne National Laboratory, where samples were pressurized up to \textasciitilde 60 GPa using-diamond anvil cells. Analysis of the XRD data demonstrate that: (1) Sm\textsubscript{2}Zr\textsubscript{2}O\textsubscript{7} and Nd\textsubscript{2}Zr\textsubscript{2}O\textsubscript{7} undergo a phase transformation from ordered pyrochlore to a disordered defect-fluorite with swift heavy ion irradiation; 2) energetics of disordering lower the pressure transition point in pyrochlores Sm\textsubscript{2}Zr\textsubscript{2}O\textsubscript{7} and Nd\textsubscript{2}Zr\textsubscript{2}O\textsubscript{7} and; 3) swift heavy ion irradiation increases the pressure transition point in a defect-fluorite Er\textsubscript{2}Zr\textsubscript{2}O\textsubscript{7} by introducing more interstitials. The effects of disordering in different zirconate compositions under high pressure are explained in terms of the variation in phase space with A-site cation substitution.