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Insight into the order-disorder transition of irradiated pyrochlore solid solutions as potential nuclear waste forms

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Pyrochlores ($A_2B_2O_7$), a common mineral that can uptake large quantities of actinides, are studied as potential nuclear waste forms to immobilize radionuclides. Many have studied pyrochlore solid solutions where different cations on the A or B site are mixed to imitate waste loading of e.g. Pu within the pyrochlore structure. As a response to irradiation or self-irradiation, zirconate (B=Zr) pyrochlores are known to undergo an order/disorder phase transition into a disordered defect fluorite structure while titanate (B=Ti) pyrochlores become amorphous, however the dominating factor towards phase transition of each is unclear in a solid solution. To gain insight into order-disorder processes, the stress and strain of $Nd_2Zr_2O_7$ and $Er_2Ti_2O_7$ endmembers and a $(ErNd)_2(TiZr)_2O_7$ solid solution were examined. Prior and upon irradiation $Nd_2Zr_2O_7$ and $Er_2Ti_2O_7$ both showed no strain. With regards to $(ErNd)_2(TiZr)_2O_7$, it appears that the synthesis method employed was not sufficient to achieve a 50:50 ratio of A and B cations according to the diffraction results. However, the solid solution contained strain while $Nd_2Zr_2O_7$ and $Er_2Ti_2O_7$ was strain free. Further synthesis approaches of $(ErNd)_2(TiZr)_2O_7$ solid solution members are under way to understand the irradiation response of such mixed A and B site pyrochlores.