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Phase transformation pathways of Ln_2O_3 irradiated by ultrafast laser[1] DYLAN RITTMAN, Stanford University, JONATHAN SOLOMON, University of California–Berkeley, CURTIS CHEN, CAMERON TRACY, Stanford University, STEVEN YALISOVE, University of Michigan, MARK ASTA, University of California–Berkeley, WENDY MAO, RODNEY EWING, Stanford University —
Ultrafast laser irradiation induces highly non-equilibrium conditions in materials through intense electronic excitation over very short timescales. Here, we show that ultrafast laser irradiation drives an irreversible cubic-to-monoclinic phase transformation in Ln_2O_3 (Ln = Er-Lu). A combination of grazing incidence X-ray diffraction and transmission electron microscopy is used to characterize the amount and depth-dependence of the phase transformation. Results indicate that—although all materials experience the same transformation—it is achieved through different damage mechanisms (pressure vs. thermal), and the short timescales associated with damage provides non-equilibrium routes of material modification. Ab initio molecular dynamics are used to isolate the effects of electronic excitations, and results are shown to be consistent with the trend in radiation resistance observed experimentally. Overall, this study provides a path to gain insight into the relationship between a material's equilibrium phase diagram and its behavior under highly non-equilibrium conditions.

[1]DOE/BES

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