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Light-Driven Ferroelectric Polarization Dynamics Probed with Time-Resolved X-ray Scattering D. DARANCIANG, Stanford University, M. HIGHLAND, H. WEN, Argonne National Lab, N. BRANDT, H. HWANG, M.I.T., J. LARSSON, Lund University, K. SOKOLOWSKI-TINTEN, University of Duisberg-Essen, D. REIS, SLAC, K. NELSON, M.I.T., P. FUOSS, G.B. STEPHENSON, Argonne National Lab, A.M. LINDENBERG, SLAC — We report femtosecond resolution time-resolved x-ray scattering measurements of dynamical changes in the polarization of PbTiO3 (PTO) nanolayers on SrTiO3 (STO) and DyScO3 (DSO) substrates under 400 nm, 40 fs optical excitation. For PTO on STO, an optically-induced polarization enhancement occurs on picosecond timescales that can be associated with a carrier-induced screening of the depolarization field. For PTO on DSO, qualitatively different effects are observed, indicating that the light initially couples to c-domains. We also observe optically-driven ferroelectric to paraelectric phase transitions (and vice versa) near the Curie temperature. The optical response of PTO on STO in the monodomain phase is consistent with a bulk photovoltaic effect. Optical excitation in the stripe phase at 515 C drives strains of order 1 percent, with an associated non-thermal disordering of the stripe domains. For PTO on DSO, temperature-dependent in-plane and out-of-plane structural dynamics are simultaneously captured, allowing the complex coupling between a- and c-domain motions to be mapped out.

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