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The ultrafast response of polar vortices under optical excitation[1]

VLADIMIR STOICA, YAKUN YUAN, Pennsylvania State University, ZIJIAN HONG, Materials Science and Engineering, Pennsylvania State University, AJAY YADAV, ANOOP DAMODARAN, University of California, Berkeley, YI ZHU, HUA ZHOU, DONALD WALKO, JOHN FREELAND, XIAOYI ZHANG, HAIDAN WEN, APS, Argonne National Laboratory , LONG-QING CHEN, Pennsylvania State University, RAMAMOORTHY RAMESH, University of California, Berkeley, VENKATRAMAN GOPALAN, Pennsylvania State University — Polar vortices were recently discovered in $PbTiO_3$-$SrTiO_3$ superlattices [1], stabilized at the nanoscale in the presence of depolarizing fields and mechanical stresses. We have found that these exotic structures, non-existent in the bulk ferroelectrics, possess rich ultrafast responses to fs laser excitation, which is attractive for high-density information storage and nanoscale actuation. Using optical pulse excitation above the bandgap of $PbTiO_3$ layers and structural and second harmonic generation probes of ferroelectric order dynamics, a series of reversible and irreversible nano-ordering transitions were observed. X-ray diffraction and diffuse scattering on nanodomains aided the phase identification during time-resolved measurements. In this talk, we will discuss the dynamic interplay between collinear and toroidal ferroelectric domains aided by understanding from phase field modelling. [1] A.K. Yadav, R. Ramesh et el., "Observation of Polar Vortices in Oxide Superlattices", accepted, Nature (2015).

[1]DE-SC0012375, DE-AC02-06CH11357, U.S Department of Energy, Office of Science, Office of Basic Energy Sciences

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