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Time-Resolved Studies of Polarization Switching in Pb(Zr,Ti)O_3 Capacitors

ALEXEI GRIGORIEV, The University of Tulsa

The space and time scales of polarization switching in ferroelectric oxides are fundamentally coupled by the speed of elastic deformations that is approximately the speed of sound. Studying this fast polarization dynamics is essential for understanding the relationships between structure and properties of ferroelectric and multiferroic materials. In last several years, new opportunities have been created for synthesizing ultrathin ferroelectric films and for probing fast structural dynamics in these materials at the nanometer scale. Polarization switching dynamics of Pb(Zr,Ti)O_3 ferroelectric thin films, which have a large magnitude of switchable polarization and relatively large piezoelectric coefficients, have been comprehensively investigated at millisecond and microsecond time scales. In this talk, I will discuss new regimes of polarization dynamics and piezoelectric strain that can be probed at the nanosecond time scale in Pb(Zr,Ti)O_3 thin film capacitors using time-resolved x-ray microdiffraction. Using this approach, we have visualized the motion of domain walls during polarization switching, tested piezoelectric strain predictions at strains up to nearly 3%, and found an unusual stability of unswitched polarization in ultrathin films at the nanosecond time scale.