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Probing the Atomic Structure and Dynamics of Ferroelectric Domain Walls during Electrical Switching in Real Time[1]

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The ferroelectric switching occurs through the nucleation and growth of favorably oriented domains and is mediated by defects and interfaces. Dislocations, for example, are known to destroy ferroelectric order; neighboring grains and interfaces subject the ferroelectric to localized strain, electric fields, or the screening of electric fields. Thus, it is critical to understand how the ferroelectric domain forms, grows, and interacts with structural defects. This talk presents the nanoscale ferroelectric switching of $BiFeO_3$ and $PbZr_{0.2}Ti_{0.8}O_3$ thin films under an applied electric field using in situ transmission electron microscopy (TEM). We follow the kinetics and dynamics of ferroelectric switching in real time and at sub-angstrom spatial resolution. We observed localized nucleation events at the electrode interface, domain wall pinning on point defects, the formation of ferroelectric domains localized to the ferroelectric/electrode interface, and domain wall pinning by dislocations. Through a quantitative analysis of aberration-corrected TEM images we found that there is a strong structural coupling between ferroelectric film and substrate, resulting a polarization reduction in the ferroelectric layer and inducing a polar displacement in substrate.

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