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Domain dynamics during ferroelectric switching XIAOQING PAN, PENG GAO, CHRISTOPHER NELSON, JACOB JOKISAARI, Department of Materials Science and Engineering University of Michigan, Ann Arbor, Michigan 48109, SEUNG-HYUB BAEK, CHUNG-WUNG BARK, CHANG-BEOM EOM, Department of Materials Science and Engineering, University of Wisconsin, Madison, Wisconsin 53706, DARRELL SCHLOM, Department of Materials Science and Engineering Cornell University, Ithaca, NY 14853 — Ferroelectric materials are characterized by a spontaneous polarization that can be reoriented by an applied electric field. The ability to form and manipulate domains at the nanometer scale is key to device applications such as nonvolatile memories. The ferroelectric switching is mediated by defects and interfaces. Thus, it is critical to understand how the domain forms, grows, and interacts with defects. Here we show the nanoscale switching of a tetragonal $PbZr_{0.2}Ti_{0.8}O_3$ thin film under an applied electric field using *in situ* transmission electron microscopy. We found that the intrinsic electric fields formed at ferroelectric/electrode interfaces determine the nucleation sites and growth rates of domains and the orientation and mobility of domain walls, while dislocations exert a weak pinning force on domain wall motion. We also show that localized 180° polarization switching initially form domain walls along unstable planes. After removal of the external field, they tend to relax to low energy orientations. In sufficiently small domains this process results in complete backswitching. Our results suggest that even thermodynamically favored domains are still subject to retention loss, which must be mitigated by overcoming a critical domain size.

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