Polarization Dynamics in Ferroelectric Capacitors: Local Perspective on Emergent Collective Behavior and Memory Effects

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Functional properties of ferroelectric materials depend both on the residual domain states and on the mobility of domain walls in response to the applied electric and stress fi elds. This paper reviews the use of multidimensional scanning probe microscopy to assess these factors in the time- and voltage domains, with an emphasis on the manner in which domain walls respond collectively to stimuli. It is found that in many $PbZr_{1-x}Ti_xO_3$-based capacitors, domain wall motion is correlated over length scales that exceed the domain and grain sizes by orders of magnitude, suggesting emergent collective electromechanical behavior. The role of mechanical boundary conditions and fi eld history on the domain wall contributions and the stability of the ferroelectric domain state are discussed.