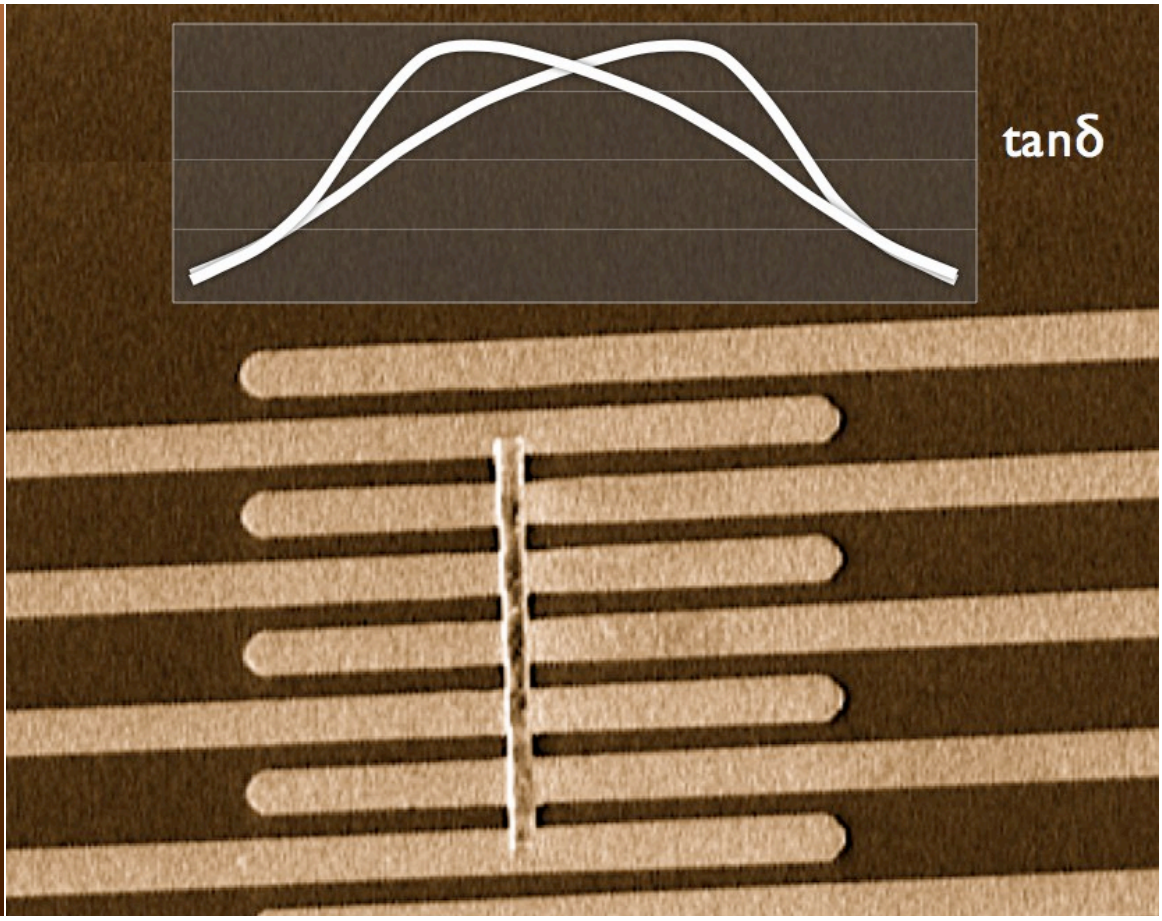
FERRO, UNBOUND

Penn State MRSEC



Integrated PZT microtubes provide the first proof of substrate constraints on domain wall mobility in ferroelectric films

Hollow tubes feel the field
the power of freedom

IRG3

Previous experiments on thin layers of so-called ferroelectric materials, which change shape and polarize in response to electric fields (like iron does in a magnetic field), are typically performed on samples that are bound to substrates. These substrates restrict and constrain the motions of the atoms in the ferroelectric, preventing certain modes of deformation in response to the electric field. MRSEC researchers have produced free-standing hollow tubes of ferroelectric PZT, and integrated these tubes with lithographic contacts. When an electric field is applied to these contacts, the tubes respond by changing shape using a mechanism not seen extensively in thin films bound to substrates - via motion of boundaries between regions with different distortions.. When ferroelectric films are mounted on substrates, the boundaries between these domains are clamped by the substrate underneath and so cannot move. A plot of the loss angle δ versus the applied electric field shows a memory effect: the curve does not retrace itself when the field is reversed. This so-called "hysteresis" is a hallmark of ferroelectricity, and provides the first direct proof of ferroelectricity in unconstrained PZT microtubes. These integrated ferroelectric tubes could form the basis of miniaturized sensors and actuators.