Superdomain structures in (101)-oriented $Pb(Zr_{0.2},Ti_{0.8})O_3$ thin films

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Ferroelectrics are utilized in a wide spectrum of functional electronics, such as sensors, energy converters, non-volatile memories, due to the well-known coupled spontaneous polarization and intrinsic piezoelectric effect. Their large piezoelectric response and switchable polarizations (writable and erasable characteristics) were widely studied through a few decades.

The performance of abovementioned properties and functionalities is directly related to the multi-domain structures and dynamics of ferroelastic domain transition in ferroelectrics. $Pb(Zr_{0.2},Ti_{0.8})O_3$ (PZT) thin films, the well-known ferroelectric material, exhibit two-domain structures called *a/c* domains. These ferroelastic domains endue the systems with enhanced piezoelectricity, resulting from the high mobility of domain wall movement and correlation between a/c domains under the external applied electric field. In this study, we utilized the growth of PZT thin films grown on (110)-oriented $SrTiO_3$ (STO) substrates to reveal the relationship between macroscopic domain arrangement and microscopic lattice distortion. Upon the (110)-oriented PZT thin films, we unveiled the existence of the superdomains in regular *c*-domain patterns. The comprehensive structure analyzing and electric domains arrangement were carried out by X-ray diffractometry and piezoresponce force microscopy. These superdomains are also switchable in a local region about 100 nm width under external electric field. This study offers a new perspective, suggesting that not only the typical a/c domain transition but also the elastic deformation of these tiny twin domains can serve as key tunabilities of complex domain engineering.