Domain switching behavior of $PbZrO_3/PbTiO_3$ superlattices by Piezo-response force microscopy

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Recently, many studies have been performed on artificial superlattice of perovskite materials for the creation of new functional dielectric materials Insight into the development of polarization and polarization dynamics in superlattice structures is required for understanding of ferroelectric domain switching mechanism The $PbTiO_3$ (PTO) and $PbZrO_3$ (PZO) layers were deposited on LSCO (100)/MgO substrate at 500 ℃ with a various stacking periods by pulsed laser deposition X-ray diffraction (i e , θ-2θ and ϕ scans) patterns indicated the structure of superlattice and the epitaxial growth of PTO/PZO artificial superlattice to the LSCO (100)/MgO(100) substrate X-ray reciprocal space mapping revealed the existence of single c-domain (perfectly c-axis-orientation of superlattice) The morphology and polarization switching behavior of the superlattice were also investigated by scanning probe microscopy (SPM) We have compared the superlattices with $Pb(Zr_{0.5}Ti_{0.5})O_3$ (PZT) thin films with respect to topographic features (roughness and grain size) and local polarization switching behavior The roughness and grain size of the superlattices were smaller than that of PZT thin films The polarization of the superlattice with nano size thickness (50 nm 10 nm) was evaluated by measuring the surface potential using Kelvin force microscopy (KFM) The superlattice exhibited an enhanced surface potential, compared with $PbZr_{0.5}Ti_{0.5}O_3$ single layer thin film indicating that the localized surface charge on superlattice is more stable than that of PZT Piezo-response scanning force microscopy (PFM) revealed that highly anisotropic nano-size polarized domains on the superlattice and domain switching have been achieved in the superlattice The polarized domain size of the superlattice depended on applied pulse voltage and time Nano-size polarized domain as small as 12 nm has been obtained by an applied pulse of -4 V with 1 ms The piezoelectric(d_{33}) hysteresis loop is similar to the shape of polarization-electric field loop The piezoelectric response images and hysteresis loop showed clearly domain switching of superlattice