Dielectric and repolarization properties of $BaTiO_3/BaZrO_3$ ferroelectric superlattices

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Ferroelectric superlattices consisting of several alternating layers of different ferroelectrics or ferroelectric and dielectric demonstrate better functional characteristics than single-component thin films or may have new properties that are not observed in individual layers.

In the present work we study multilayer structure consisting of 32 alternating pairs of $BaTiO_3/BaZrO_3$ epitaxial layers with a period of 13.32 nm on MgO single crystal substrate with the conductive compound LSCO ($La_{0.5}Sr_{0.5}CoO_3$) sublayer obtained by pulsed laser deposition. The sprayed layers surface quality was controlled by fast electron diffraction technique. The results of X-ray diffraction studies (CoKα radiation) showed structural perfection of superlattices without the presence of impurity phases. According to the X-ray phase analysis, was determined the parameter of the unit cell of the obtained superlattice in the normal to the substrate plane direction: a = 4.0838 Å.

Temperature measurements of the main dielectric parameters, such as polarization, coercive field and dielectric constant, have shown the existence of a ferroelectric phase transition at a temperature of 393 °C that is much higher than for $BaTiO_3$ ferroelectric.

The polarization switching study was conducted by dielectric hysteresis loops and switching currents using the Merz method. According to the switching currents data, the region of weak and strong fields was studied. It is shown that the magnitude of the threshold field separating these regions corresponds to the coercive field and decreases as it approaches the Curie point.

The study of switching currents in weak fields revealed that the integral characteristics of switching, and, consequently, domain boundaries movement speed do not obey a strictly exponential dependence on the field strength. This leads to the appearance of a dynamic indicator μ for the switching current power dependence (the velocity of the domain boundaries) on the electric field strength, which magnitude is less than one and changes slightly when approaching the phase transition point.

On the basis of the switching time for the region of strong fields was calculated the mobility of the domain boundaries at various temperatures. The switching time increases with increasing of the temperature. That means a decrease of the domain boundaries mobility, probably due to the critical deceleration of polarization relaxation near the Curie point.