Forward Domain Growth in Uniaxial Ferroelectrics

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The growth of single domain in polar direction ("forward domain growth") has been studied experimentally by local polarization reversal on non-polar surfaces of uniaxial ferroelectrics with high spatial resolution. The original mechanism of domain growth by kinetic approach allowed us to explain the domain growth in the areas with negligible value of applied electric field.

The forward growth of the isolated domains with charged domain walls is one of the main stages of the domain structure evolution during polarization reversal from the single domain state in any ferroelectric [1], but it still was not studied systematically with high enough precision due to low spatial resolution of the used experimental methods. In our experiments the forward domain growth has been studied for the first time with high spatial resolution by local polarization reversal non-polar cuts (Y- and X-cuts) of $LiNbO_3$ single crystals by conductive tip of scanning probe microscope [2-4]. The obtained wedge-like domain shape and large domain length differ drastically from the theoretical prediction [5]. The domain patterns have been visualized by piezoelectric force microscopy, scanning electron microscopy (after selective chemical etching), and confocal Raman microscopy.

The obtained results have been discussed in the framework of the kinetic approach to the domain growth based on the analogy of the domain structure evolution with the first order phase transformation (crystal growth) [1]. We have attributed the domain growth in the area with negligible value of the applied electric field to the self-maintained domain wall motion as a result of interaction of the charged elementary kinks [6]. The ineffective screening of depolarizing field leads to change of the domain shape and formation of the isolated nanodomains. The obtained knowledge is very useful for development of domain engineering and domain wall engineering. It was applied successively for domain patterning.

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