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Field Induced Evolution of Regular and Random 2D Domain Structures and Shape of Isolated Domains in $LiNbO_3$ and $LiTaO_3$

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Static domain patterns produced by application of the external electric field in single crystals of congruent, stoichiometric and MgO doped lithium niobate $LiNbO_3$ (**LN**) and lithium tantalate $LiTaO_3$ (**LT**) were investigated experimentally. The study of the domain kinetics by computer simulation and by switching of the model structure showed applicability of the kinetic approach to explanation of the experimentally observed evolution of domain shape and domain structure.

The step-by-step domain growth was realized during the model experiment. The evolution of two-dimensional (**2D**) domain patterns produced by application of external electric field using lithographic **2D** electrode grating has been investigated in congruent **LN**. It was shown that the domain kinetics is governed by merging of individual domains and the formed macro-scale domains are similar to the ones obtained in real samples including full variety of shapes from triangles to hexagons and even concave ones. The domain shape details were easily distinguished by optical microscopy for used 10-μm-period grating.

Computer simulation in terms of cellular automata using simple local switching rules for step-by-step domain growth allows us to obtain the domain patterns very similar to the domain images observed experimentally. Proposed kinetic model allows us to explain all of observed domain shapes both in macro-and micro-scales. It was shown that the domain shape is strongly affected by such experimental conditions as electric field pulse parameters and screening properties. Several original scenarios of the domain structure evolution were revealed experimentally and the decisive role of the retardation of the screening process was clearly demonstrated.

It was shown that the domain evolution during decay of the highly-nonequilibrium state represents a self-organizing process, in which the screening plays the role of feedback during polarization reversal. For short electric pulses the screening is ineffective and uncompensated depolarization field drastically change the domain kinetics thus producing the equidistant arranged arrays of small sub-micron (nano-scale) domains.

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