Nanoscale physics

Effect of a high-frequency electric field on the ferroelectric nanoscale domain structure formation upon second order phase transition

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The creation of nanoscale ferroelectric domain structures is one of the most important areas of nanodomain engineering, as these materials have a wide application. Understanding of the processes of formation and ordering of nanodomain structures plays an important fundamental and applied role. Therefore, the efforts of many researchers aimed to study the kinetics of ordering of these objects under the influence of external effects [1,2].

The kinetics of the formation of 180° nanodomains in a high-frequency electric field was considered in the framework of the phenomenological Ginzburg-Landau model using the ferroelectric crystals that undergo a second-order ferroelectric phase transition. The system of the evolutionary equations, which allows us to observe the evolution of the ordering of domain structure at all stages, was obtained.

The asymptotic analysis of the system based on the phase portrait conception showed that the formation of monodomain and polydomain conditions of ordering is possible for particular frequencies of the electric field applied to the ferroelectric after quenching. The quantitative analysis revealed that the formed polydomain (regular) structures are thermodynamically stable and steady to the external effects. It was established that the formation of such patterns has a threshold character, which means that the system aims to form the regular structure above some frequency of the electric field. Its value depends on the type of ferroelectric crystal. For example, the threshold frequency is equal to $4.7 \cdot 10^{13}$ Hz for tantalate lithium crystal ($LiTaO_3$).

1. *V.Ya. Shur at al.* Formation of self-organized nanodomain patterns during spontaneous backswitching in lithium niobate // Ferroelectrics.-2001.-**253**.-P. 105-114.
2. *K.-D. Liss, M. Kaiser at al.* Kinetics of the field induced commensurate to ferroelectric phase transition in thiourea//J. Phys. D: Appl. Phys.-2003.-**36**.-P. A172-A176.