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Influence of mesoscopic nanostructures on physical properties and functional parameters in ferroelectrics with coexisting phases

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Inhomogeneous states of coexisting domains of the ferroelectric and antiferroelectric phases in solid solutions of perovskite complex oxides cause a number of interesting physical effects. PbZ_{r1}-yTi_yO_3 based solid solutions are chosen as an example. These compounds have a small difference in the free energies of the ferroelectric and antiferroelectric states. As a result, the inhomogeneous state of domains with the sizes of the order of 20 to 30 *μm* is realized in a wide interval of solid solutions compositions. The concentration of elastic stresses along the coherent interphase boundaries leads to the local decomposition of solid solution because the equivalent lattice positions are occupied by ions with different sizes. The local decomposition is responsible for the formation of segregates near the interphase boundaries separating domains of the coexisting phases. The sizes of these segregates are of the order of 8 to 15 *nm*. Manifestation of these mesoscopic structures in piezoelectric and other properties of the above-mentioned compounds has been studied in details. Our special attention has been paid to the kinetics of their formation and to the mechanisms of control of the formation segregates. Controllably created nanoscale structures of segregates in substances with coexisting ferroelectric and antiferroelectric phases lead to new possibilities in applications of these compounds as materials with extremely high piezoelectric parameters, substances with negative refractive index, and materials allowing effective control of piezoelectric parameters by external electric field.

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