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Effect of disorder on the piezoelectric properties of ferroelectrics

MARCEL PORTA, TURAB LOOKMAN, AVADH SAXENA, Los Alamos National Laboratory — We develop a Ginzburg-Landau model for ferroelectrics which includes the polarization-strain coupling, the electrostatic interaction, and a quenched random compressional stress field generated by point defects. The strain field and its associated elastic energy are obtained in terms of the stress field and the electric polarization by energy minimization subjected to elastic compatibility. The model is applied to the computation of the piezoelectric response of $BaTiO_3$ in the vicinity of the cubic to tetragonal phase transition, as a function of temperature and the applied electric field in the polar direction. In the clean limit we obtain the divergence of the piezoelectric tensor at the critical point. Similar results are obtained in the presence of a small amount of disorder, the effect of which is a translation of the critical point in the temperature-electric field phase diagram. For large values of the disorder the piezoelectric response loses its critical properties.

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