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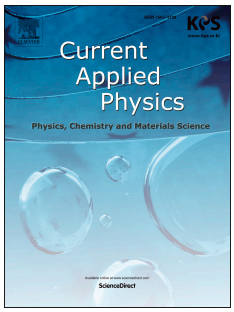

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Effects of oxygen deficiency on the acoustic anomalies and phase transition behaviors of barium titanate single crystals

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Abstract

The acoustic behaviors of oxygen-reduced barium titanate ($BaTiO_{3-\delta}$) single crystals with δ~0.04 were investigated as a function of temperature by using Brillouin spectroscopy. The longitudinal acoustic mode of the moderately-reduced $BaTiO_3$ showed two pronounced anomalies at approximately 112°C and -11°C, which correspond to the cubic-tetragonal and tetragonal-orthorhombic phase transition temperature, respectively. These temperatures were lower by more than 10°C compared to those of the pure $BaTiO_3$ suggesting that the disorder introduced by oxygen vacancies lowers the phase transition temperatures. The paraelectric phase of the reduced $BaTiO_3$ were characterized by substantial softening of the longitudinal acoustic mode and the growth of central peaks centered at zero frequency. These anomalies were observed in a certain temperature range above the Curie temperature, indicating that pretransitional precursor polar clusters exist in the cubic phase and that their dynamics are responsible for the acoustic anomalies caused by electrostrictive coupling between the strain and the polarization. The relaxation time of the precursor polar clusters derived from the central peak exhibited a critical slowing-down behavior showing that their dynamics becomes more sluggish as temperature