

MAR06-2005-003153

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Pressure-Induced Ferroelectric-to-Relaxor Crossover in PSN and Isomorphs¹

EUGENE VENTURINI, Sandia National Laboratories

We discuss the influences of pressure (P) and bias field on the dielectric properties and phase behavior of a single crystal of the chemically-disordered ABB'O₃ perovskite Pb(Sc_{0.5}Nb_{0.5})O₃ or PSN. On cooling from high temperatures (T), PSN first enters a relaxor (R) state and then spontaneously transforms to a ferroelectric (FE) phase at a temperature T_c substantially below the maximum in the dielectric susceptibility. The R state indicates the presence of polar nanoregions, arising from the B-site chemical disorder, that increase in size with decreasing T. At ambient P, these regions grow to macroscopic size, leading to a first-order FE transition at T_c. Hydrostatic P offers a unique method to systematically decrease the dielectric polarizability of PSN by reducing the unit cell volume and, hence, increasing the frequency of the soft transverse optic phonon modes. As P increases, the size of the polar regions decreases, enhancing the R state at the expense of the FE phase. It appears that the FE phase vanishes somewhat above the highest P reached in the experiments, making the R state the ground state of the crystal at reduced volume. This suggests a T-P phase diagram with a T_c(P) phase line that terminates between 10 and 15 kbar in a manner akin to a critical point; however, in the case of PSN this feature represents a FE-to-R crossover. In contrast, a biasing electric field favors the FE phase over the R state, and the data indicate that the R state vanishes above 5 kV/cm. Additional insight is provided by comparison to dielectric results on isomorphous Pb(Sc_{0.5}Ta_{0.5})O₃ in both its compositionally ordered and disordered forms.

¹With G.A. Samara and R.K. Grubbs, Sandia Labs, Y. Bing and Z.-G. Ye, Simon Fraser Univ. Work at Sandia supported by Division of Materials Sciences and Engineering, Office of Basic Energy Sciences, U.S. Dept. of Energy, under contract DE-AC04-94AL85000.