Weakly Coupled Relaxor Behavior of $BaTiO_3$-$BiScO_3$ Ceramics

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Abstract: The structural and dielectric properties of (1-x)$BaTiO_3$-x$BiScO_3$ (x=0-0.5) ceramics were investigated to acquire a better understanding of the binary system, including determination of the symmetry of the phases, the associated dielectric properties, and the differences in the roles of Bi_2O_3 and $BiScO_3$ substitutions in a $BaTiO_3$ solid solution. The solubility limit for $BiScO_3$ into the $BaTiO_3$ perovskite structure was determined to be about x=0.4. A systematic structural change from the ferroelectric tetragonal phase to a pseudo-cubic one was observed at about x=0.05-0.075 at room temperature. Dielectric measurements revealed a gradual change from proper ferroelectric behavior in pure $BaTiO_3$ to highly diffusive and dispersive relaxor-like characteristics from 10 to 40 mol% $BiScO_3$. Several of the compositions showed high relative permittivities with low-temperature coefficients of capacitance over a wide range of temperature. Quantification of the relaxation behavior was obtained through the Vogel-Fulcher model, which yielded an activation energy of 0.2-0.3 eV. The attempt characteristic frequency was 10^{13} Hz and the freezing temperature, T_f, ranged from -177 º to -93 ºC as a function of composition. The high coercive fields, low remanent polarization, and high activation energies suggest that in the $BiScO_3$-$BaTiO_3$ solid solutions, the polarization in nanopolar regions is weakly coupled from region to region, limiting the ability to obtain long-range dipole ordering in these relaxors under field-cooled conditions.