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Structural, dielectric, electromechanical, piezoelectric, elastic and ferroelectric properties of lanthanum and sodium Co-substituted barium titanate ceramics

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ABSTRACT

In this paper, the polycrystalline ceramics $Ba_{(1-x)}(La, Na)_xTiO_3$ $0 \le x \le 0.08$ were synthesized by microwave assisted heating of the starting materials. Room temperature X-ray diffraction along with Rietveld refinement analysis confirmed the formation of single-phase polycrystalline compound with the tetragonal crystal structure. A dense microstructure with several grains having different size distribution throughout the sintered pellet has been observed. The incorporation of La^{3+} and Na^{+} ions in $BaTiO_3$ enhanced the room temperature relative permittivity. The studies of the temperature dependence of dielectric permittivity indicate ferroelectric-paraelectric phase transition with a clear shift in the Curie temperature (Tc) of $BaTiO_3$ towards lower temperature side on co-substitution. The co-substituted sample with x=0.08 exhibited superior dielectric constant (ε'=4226) with low dielectric loss (tanδ=0.0113) which is highly essential for the fabrication of ceramic capacitors. Resonance and antiresonance characteristics of impedance and phase for poled $Ba_{(1-x)}(La,Na)_xTiO_3$ samples have been investigated in the frequency range of 300 kHz-1 MHz. Based on IRE standards for piezoelectric ceramics the piezoelectric response has been discussed. The room temperature P-E loop is investigated at an applied electric field of 80kV/cm at 33Hz frequency using Precision Premier II.

Keywords: Co-substitution; Grain size; Electromechanical; Piezoelectric; Elastic, Diffuse phase transition; Ferroelectric.