Investigation of Electrical Properties in a New Lead-free (100-x)($Li_{0.12}Na_{0.88}$)NbO_3-$x$$BaTiO_3$ ($0 \leq x \leq 40$) Piezoelectric System

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In this paper, new lead-free piezoelectric solid-solution between $Li_{0.12}Na_{0.88}NbO_3$ (LNN) and $BaTiO_3$ (BT), (100-x)$Li_{0.12}Na_{0.88}NbO_3$-$x$$BaTiO_3$ ($0 \leq x \leq 40$) is investigated for high-piezoelectric performance. The ceramics are synthesized using conventional ceramics processing route. A morphotropic phase boundary (MPB), separating orthorhombic and tetragonal phases, for the $BaTiO_3$ content, x = 10-12.5 is observed from structural analysis. A partial phase diagram is constructed from temperature-dependent permittivity data for this new system. Interestingly a nearly vertical temperature-independent MPB is observed. Improved electrical properties, ε_r = 8842 at T_m and 795 at room-temperature, d_{33} = 30 pC/N, k_p = 12.0 %, Q_m = 162, P_r = 11.2 μC/cm^2, E_c = 19.2 kV/cm, d^*_{33} = 174 pm/V substantiate existence of MPB. High values are attributed to the ease of polarization rotation due to coexistence of orthorhombic and tetragonal phases. The results show that these compositions are potential candidates for piezoelectric vibrators and ultrasonic transducer applications. Further, the sample with x = 25, also exhibited high dielectric permittivity, ε_r = 2400, and low dielectric loss, $tan\delta$ = 0.033 at room-temperature which could find applications in capacitors (X7R/Z5U).