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Effect of Manganese Doping on Ferroelectric Properties of (K0.485Na0.5Li0.015)(Nb0.98V0.02)O3 Lead-Free Piezoceramic

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Abstract : Alkaline niobate (Na_{0.5}K_{0.5})NbO₃ ceramic system has attracted major attention in view of its potential for replacing the highly toxic but superior lead zirconate titanate (PZT) system for piezoelectric applications. Recently, a more detailed study of this system reveals that the ferroelectric and piezoelectric properties are optimized in the Li- and V-modified system having the composition (K_{0.485}Na_{0.5}Li_{0.015})(Nb_{0.98}V_{0.02})O₃. In the present work, we further study the pyroelectric behaviour of this composition along with another doped with Mn⁴⁺. So, (K_{0.485}Na_{0.5}Li_{0.015})(Nb_{0.98}V_{0.02})O₃+ x MnO₂ (x = 0, and 0.01 wt. %) ceramic compositions were synthesized by conventional ceramic processing route. X-ray diffraction study reveals that both the undoped and Mn⁴⁺-doped ceramic samples prepared crystallize into a perovskite structure having orthorhombic symmetry. Dielectric study indicates that Mn⁴⁺ doping has little effect on both the Curie temperature (T_c) and tetragonal-orthorhombic phase transition temperature (T_{ot}). The bulk density, room-temperature dielectric constant (ε_{RT}), and room-c The room-temperature coercive field (E_c) is observed to be lower in Mn⁴⁺ doped sample. The detailed analysis of the P-E hysteresis loops over the range of temperature from about room temperature to T_{ot} points out that enhanced ferroelectric properties exist in this temperature range with better thermal stability for the Mn⁴⁺ doped ceramic. The study reveals that small traces of Mn⁴⁺ can modify (K_{0.485}Na_{0.5}Li_{0.015})(Nb_{0.98}V_{0.02})O₃system so as to improve its ferroelectric properties with good thermal stability over a wide range of temperature.

Keywords : ceramics, dielectric properties, ferroelectric properties, lead-free, sintering, thermal stability
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