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Electrical and Piezoelectric Properties of Vanadium-Modified Lead-Free $(K_{0.5}Na_{0.5})NbO_3$ Ceramics

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Abstract : During the last decade, there has been a significant growth in developing lead-free piezoelectric ceramics which have the potential to replace the currently dominant but highly superior lead-based piezoelectric materials such as PZT. Among the lead-free piezoelectrics, (K0.5Na0.5)NbO3 - based piezoceramics are promising candidates due to their superior piezoelectric properties and high Curie temperatures. In this work, (K0.5Na0.5)(Nb1-xVx)O3 powders with x varying the range 0 to 0.05 were synthesized from the raw materials K2CO3, Na2CO3, Nb2O5, and V2O5. These powders were ball milled with high-energy Retsch PM 100 ball mill using isopropanol as the medium at the speed of 200rpm for a duration of 8h. The milled powders were sintered at 1080oC for 1h. The crystalline phase of all the calcined powders and corresponding ceramics prepared was found to be perovskite with orthorhombic symmetry. The ceramic with V5+ content of x=0.03 exhibits the maximum values in density of 4.292 g/cc, room temperature dielectric constant (εr) of 432, and piezoelectric charge constant (d33) of 93pC/N. For this sample, the dielectric tan δ loss remains relatively low over a wide temperature range. The temperature dependence of P-E hysteresis loops has been investigated for the ceramic composition with x = 0.03.

Keywords : dielectric properties, ferroelectric properties, perovskie, piezoelectric properties
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