Improved Resistivity in Bismuth Deficient Morphotropic Phase Boundary 0.88BNT-0.08BKT-0.04BT Ceramics

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In the lead-free composition $(Bi_{0.5}Na_{0.5})TiO_3$, the A-site is occupied by both Bi^{3+} and Na^{+}. Non-stoichiometry of the A-site cations has a strong influence on piezoelectric properties. Modifying the stoichiometry can be used to improve properties similar to donor or acceptor doping. Bismuth excess results in soft properties with higher d_{33}, lower coercive field, improved resistivity and decreased depolarization temperature. Bismuth deficiency induces oxygen vacancies resulting in hard properties.

In this work $0.88Bi_{0.50-x}Na_{0.50}TiO_3 - 0.08Bi_{0.50-x}K_{0.50}TiO_3 - 0.04BaTiO_3$ (BNKBT88-xBi) ceramics with bismuth deficiency $x \leq 0.02$ have been prepared. The Bi-deficient ceramics have a mechanical quality factor of 1200 and coercive field of 48kV/cm for 2% Bi-deficiency, as well as increased depolarization temperature compared to stoichiometric BNKBT88. However, the high mobility of oxygen vacancies causes decreased resistivity above room temperature that makes poling difficult and limits the use these ceramics for high power transducer application. Bismuth deficient BNKBT88 was sintered at 900ºC using a combination of Bi_2O_3, CuO, B_2O_3, and Li_2CO_3 as sintering aids. The low temperature sintered BNKBT88-2.0Bi had increased resistivity and a mechanical quality factor of 775. Bismuth oxide addition is expected to improve resistivity while preserving hard properties when added to calcined Bi-deficient BNKBT88 prior to sintering at 1150ºC.