Structural phase, phase transitions and electrical behaviors of KNLNTS-based ceramics prepared via the solid state combustion technique

C. Kornphom [1] and T. Bongkarn[2,3,*]

[1] *Department of Physics and General Science, Faculty of Science and Technology, Chiang Mai Rajabhat University, Chiang Mai, 50300, Thailand*
[2] *Department of Physics, Faculty of Science, Naresuan University, Phitsanulok, 65000, Thailand*
[3] *Research Center for Academic Excellence in Applied Physics, Faculty of Science, Naresuan University, Phitsanulok, 65000, Thailand*

[*] *corresponding author, E-mail: researchcmu@yahoo.com*

Abstract

$(1-x)[(K_{0.44}Na_{0.52}Li_{0.04})(Nb_{0.84}Ta_{0.10}Sb_{0.06})O_3]$-$x[(Ba_{0.85}Ca_{0.15})(Ti_{0.90}Zr_{0.10})O_3]$; (abbreviate to (1-x)KNLNTS-xBCTZ) lead-free piezoelectric ceramics were prepared via the solid state combustion technique and the effects of adding BCTZ compound ($0 \le x \le 0.030$ wt.%) on the phase formation, morphology and electrical behavior of the compound ceramics were investigated. The X-ray diffraction (XRD) results at room temperature of all samples exhibited a single perovskite phase and the BCTZ efficiently diffused into the KNLNTS lattice during the sintering process to produce a solid solution. The crystal structure of these ceramics changed from O+T phases to higher T phase ($0 \le x \le 0.020$) and then began to change to a cubic phase when the x content increased from 0.025 to 0.030. A polymorphic phase transition (PPT) of (1-x)KNLNTS-xBCTZ ceramics was observed at an x content of 0.015 and the ratio of the orthorhombic and tetragonal phase was close to equal. Adding BCTZ compound at a ratio ≤ 0.015 promoted better morphology and higher densification. When the BCTZ compound was > 0.015, the microstructure and density of the samples deteriorated. The T_{O-T} and T_C of (1-x)KNLNTS-xBCTZ samples reduced continuously with increasing x content. Moreover, the (1-x)KNLNTS-xBCTZ showed a typical relaxor ferroelectric behavior with high BCTZ content. The optimum electrical properties, such as; the highest dielectric behavior (ε_r at T_r = 2194 and ε_m at T_C = 6812), excellent ferroelectric properties (P_r = 27.9 μC/cm^2 and E_C= 9.9 kV/cm) and the highest d_{33} (295 pC/N) were obtained by the sample with x content of 0.015 wt%, this sample composition was confirmed to be in the PPT region. The addition BCTZ is a new alternative for improving densification, microstructure, ferroelectric and piezoelectric properties of KNLNTS ceramics.

Keywords: KNN-based, BNKLLT, ferroelectric, piezoelectric, combustion technique