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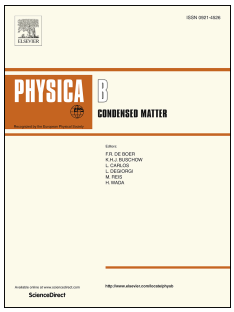

Dielectric relaxation phenomenon and conductivity in lead-free ceramics

Imen Krad, Nissrine Zaiter, Olivier Bidault, Adel Megrich, Mohamed El Maaoui

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Dielectric relaxation phenomenon and conductivity in Lead-free ceramics

Imen. Krad [a, c *], Nissrine. Zaiter [b], Olivier. Bidault [c], Adel. Megrich [a], Mohamed. El Maaoui [a]

[a] Laboratory of Applied Mineral Chemistry, URCMA, University of Tunis El Manar, 2092 Tunis, Tunisia

[b] Institute of Molecular Chemistry, ICMUB, UMR 5260 CNRS, University of Burgundy Franche Comte, 9 Avenue Alain-Savary, BP 47870, 21078 Dijon cedex, France

[c] Laboratory of Interdisciplinary Carnot, ICB, UMR 6303 CNRS, University of Burgundy Franche Comte, 9 Avenue Alain Savary, BP 47870, 21078 Dijon cedex, France

Tel: 0033635219575 e-mail: kradimen@gmail.com

Abstract

Relaxation phenomena and electric conductivity of (1-x) $KNbO_3$-x$K_{0.5}Bi_{0.5}TiO_3$ system where x=0, 0.025, 0.05, 0.075, 0.1, 0.2, 0.3 have been studied at high temperature. A relaxation behavior was observed in temperature range 400K ≤ T ≤ 550K for orthorhombic solid solutions at room temperature. The activation energy (E_a) of this phenomenon was range from 0.68 eV for x = 0 to 0.489 eV for x = 0.075 with $\tau_0=10^{-13}$ s. The relaxation was attributed to hopping of oxygen vacancies for solid solutions x≤0.075. Substitution by $K_{0.5}Bi_{0.5}TiO_3$ does not affect the electrical conductivity of $KNbO_3$ too much, while the mobility of species such as oxygen vacancies and oxygen ions allow the increase of the conductivity σ_{ac} at high temperatures.

Keywords: (1-x)$KNbO_3$-x$K_{0.5}Bi_{0.5}TiO_3$, relaxation phenomenon, electric conductivity, oxygen vacancies

1. Introduction

The synthesis of lead-free materials is a research area that is followed by the majority of researchers around the world because of unequalled properties of the reference piezoelectric compound: $PbZrTiO_3$ (PZT). Many research studied the structural and physical properties for the $PbZr_{(1-x)}Ti_xO_3$ family [1,2]. A development of new materials competing with the PZT in their dielectric and piezoelectric properties need the search for new combinations of ions or substitutions of the different ions in the cationic sites of the crystal lattice. ABO_3 perovskites were renewed many attention for here interesting physical properties. A substitution of either A-ions or/and B-ions present a revolution in innovation to the electronics industry such as dynamic access memory, sensor, actuator, voltage controlled oscillators and telecommunication technologies [3]. Lead free $KNbO_3$ and $K_{0.5}Bi_{0.5}TiO_3$ compounds have been developed in recent years due to their dielectric and piezoelectric properties [4-7]. A high relative density about 98% was obtained for $KNbO_3$ and $K_{0.5}Bi_{0.5}TiO_3$ ceramics syntheses by hydrothermal method [8, 9] and the dielectric measurements of these ceramics at room temperature reported a good ε_r about 540 and 780 respectively with low tang$\delta \cong 0{,}03$ at 1kHz frequency. This results were are better than those obtained by other synthetic chemical voices such as solid state[10, 11], sol-gel [12, 13] for they both perovskites. The A/B sites substitution of KN was effected in order to improve the structural and dielectric properties at high temperature. A relaxation phenomenon and dielectric conductivity were reported in many complex ceramics [14-16] at a function of temperature. In this article, we report dielectric relaxation and electrical conductivity response of (1-x)$KNbO_3$- x$K_{0.5}Bi_{0.5}TiO_3$ (1-