

Impedance spectroscopy of lead-free (1-x-y)Bi_{0.5}Na_{0.5}TiO₃-xBi_{0.5}K_{0.5}TiO₃-yBi_{0.5}Li_{0.5}TiO₃ piezoelectric ceramics

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ABSTRACT

The AC complex impedance spectroscopy technique has been used to characterize electrical parameters of polycrystalline sample of (1-x-y)Bi_{0.5}Na_{0.5}TiO₃-xBi_{0.5}K_{0.5}TiO₃-yBi_{0.5}Li_{0.5}TiO₃ (0.90-xBNT-xBKT-0.10BLT and 0.80-yBNT-0.20BKT-yBLT) lead-free ferroelectric ceramics with $0.18 \leq x \leq 0.26$ and $0 \leq y \leq 0.12$ in a wide frequency range at different temperatures. These samples were prepared by combustion technique. The crushing sintered pellets exhibited pseudocubic symmetry in all the samples. Impedance measurement on 0.90-xBNT-xBKT-0.10BLT and 0.80-yBNT-0.20BKT-yBLT in the temperature range of 470–560°C as a function of frequency has been analyzed. The bulk resistivity of ceramics decrease with increase temperature similar to semiconductor, and the Cole-Cole (Nyquist) plot presented negative temperature coefficient of resistance (NTCR). The activation energies of bulk and grain boundary for composition addition of BKT(x) and BLT (y) ceramics were found to be ~ 0.5–0.7 eV, which suggested a conduction mechanisms dominated by extrinsic defects.

ARTICLE HISTORY

Received 13 May 2016
Accepted 6 October 2016

KEYWORDS

(1-x-y)BNT-xBKT-yBLT);
impedance spectroscopy;
ferroelectric ceramics

1. Introduction

Piezoelectric ceramics have been widely used in various devices such as sensors and actuator because of their superior properties [1–2]. These piezoelectric ceramics are mostly based on PZT ceramics, which contain more than 60% of lead. It is well known that lead is varying toxic substance and environmental problem due to its high vapor pressure during sintering process. Therefore, it is very urgent to develop lead-free piezoelectric ceramics with excellent properties to replace PZT based ceramic [3–5]. The newly discovered lead-free (1-x-y)Bi_{0.5}Na_{0.5}TiO₃-xBi_{0.5}K_{0.5}TiO₃-yBi_{0.5}Li_{0.5}TiO₃ ceramics (abbreviate to BNT-BKT-BLT) have

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