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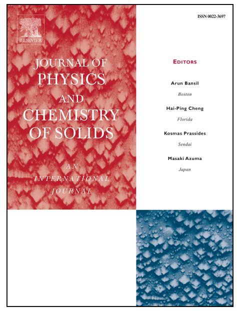

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Relaxation Processes and Conduction Mechanism in Bismuth Ferrite Lead Titanate Composites

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Abstract: In this study, samarium (Sm)-doped multiferroic composites of $0.8BiSm_xFe_{1-x}O_3$-$0.2PbTiO_3$ where x = 0.05, 0.10, 0.15, and 0.20 were prepared via the conventional solid state reaction route. The electrical properties of these composites were analyzed using an impedance analyzer over a wide range of temperatures and frequencies (10^2–10^6 Hz). The impedance and modulus analyses confirmed the presence of both bulk and grain boundary effects in the materials. The temperature dependence of the impedance and the modulus spectrum indicated the negative temperature coefficient of the resistance behavior. The dielectric relaxation exhibited non-Debye type behavior and it was temperature dependent. The relaxation time (τ) and DC conductivity followed an Arrhenius type behavior. The frequency-dependent AC conductivity obeyed Jonscher's power law. The correlated barrier hopping model was appropriate for understand the conduction mechanism in the composites considered.

Keywords: AC Conductivity; Complex Impedance Spectroscopy; Correlated Barrier Hopping Model; DC Conductivity; Relaxation Phenomena

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1. Introduction

Multiferroic bismuth ferrite ($BiFeO_3$) has many possible technological applications in emerging areas such as high storage memory devices, actuators, transducers, and spintronics [1-6], and thus it has a promising future. This material also has good dielectric and electrical properties [7-9]. However, high current leakage and low electrical resistivity are the main limitations that restrict its possible applications in devices. In order to overcome these problems, rare earth elements have been doped in the A or B site, while composites have also been prepared with other perovskites [10, 11]. Bismuth ferrite lead titanate is a multiferroic composite with a ferroelectric Curie temperature of T_c ~ 635°C [12]. Furthermore, changing the concentrations of $BiFeO_3$ and $PbTiO_3$ in (1–x)$BiFeO_3$-x$PbTiO_3$ greatly affects the physical properties of the composite. The composite 0.7 $BiFeO_3$-$0.3PbTiO_3$ exhibits a morphotropic phase boundary (MPB) between the rhombohedral (R3c) and tetragonal (P4mm) phases with enhanced electrical properties [13]. The material $0.8BiFeO_3$-$0.2PbTiO_3$ is very close to the MPB so its physical properties have been explored previously. It was reported that doping with samarium (Sm) at the A or B site of ABO_3 significantly changed its physical properties [14-16]. A distorted rhombohedral crystal structure was confirmed by