ABSTRACT

Various (1-*x*) $Ba_{0.95}D_{0.05}TiO_3$ + *x*$Li_{0.1}Cu_{0.1}Co_{0.1}Zn_{0.6}Fe_{2.1}O_4$ composites (where, D = Sr, Ca; *x*=0.0, 0.1, 0.2, 0.3, 0.4, 0.8, and 1.0) were synthesized and studied in detail. The X-ray diffraction patterns of $Ba_{0.95}D_{0.05}TiO_3$ (BSTO/BCTO) confirm the perovskite structure with P4mm space group, and $Li_{0.1}Cu_{0.1}Co_{0.1}Zn_{0.6}Fe_{2.1}O_4$ (LCCZFO) confirm the cubic spinel structure with Fd-3m space group. In the composites both phases are coexisting without any third phase. The lattice parameters are found almost constant and density is found to decrease with LCCZFO content. The Field Emission Scanning Electron Microscopy images confirm that the grain distributions are homogeneous and the average grain size increased with the increasing LCCZFO content in the composites. The dielectric constant for both series of composites remains almost constant throughout the studied frequency range. Temperature dependent dielectric constant ($\acute{\varepsilon}$) shows a peak at 397 K for BSTO, 423 K for BCTO and 543 K for LCCZFO. In impedance spectra analysis, the non-Debye type dipole relaxations have been found. At the same time the grain boundary resistance also found to decrease with increasing LCCZFO content in the Nyquist plots both for BSTO and BCTO series. The linearity in the $\log(\sigma_{AC})$ versus $\log(\omega)$ plot (20Hz-120MHz) indicates that conduction is mainly due to small polaron hopping. The real part of initial permeability and saturation magnetization increases with increasing LCCZFO content. The ferroelectric behavior is observed for the composites up to *x* = 0.40. The magnetoelectric voltage coefficient (α_{ME}) increases with increasing LCCZFO content up to x= 0.20 and then decreased for further increasing of x. The maximum _$_{ME}$ is found (287 $mVcm^{-1}Oe^{-1}$) for 0.80
$Ba_{0.95}Ca_{0.05}TiO_3$ + 0.20 *x*$Li_{0.1}Cu_{0.1}Co_{0.1}Zn_{0.6}Fe_{2.1}O_4$ composite. It is found that for some of the composites both ferromagnetic and ferroelectric hysteresis loops exist at room temperature. Therefore, it can be concluded that, the composites have the multiferroic nature. The present study can be helpful to design multi-functional materials like hetero-structured read/write memory, switching and sensing devices.

Publications

1. “Improvement of microstructure, initial permeability, magnetization and dielectric properties of nanocrystalline $Li_xCu_{0.1}Co_{0.1}Zn_{0.8-2x}Fe_{2+x}O_4$” Roksana Parvin, A. A. Momin, A.K.M. Akther Hossain, Journal of Magnetism and Magnetic Materials,Vol. 401, pp.760-769 (2016) (Elsevier).

2. “Structural, morphological and magnetic properties variation of nickel-manganese ferrites with lithium substitution” A. A. Momin, Roksana Parvin, A.K.M. Akther Hossain Journal of Magnetism and Magnetic Materials,Vol. 423, pp.124-132 (2017).

3. “Interplay between the ferrimagnetic and ferroelectric phases on the large ME coupling of $x Li_{0.1}Ni_{0.2}Mn_{0.6}\ Fe_{2.1}O_4$ + (1-x) $Bi_{0.8}\ Dy_{0.2}FeO_3$ composites” A. A. Momin, Roksana Parvin, M. Shahjahan, Md. Fakhrul Islam, Hidekazu Tanaka, and A. K. M. Akther Hossain, Journal of Materials Science: Materials in Electronics, Vol. 31(1), pp.511-525 (2020).

4. “Investigation of magnetic and ferroelectric properties along with the ME coupling behavior for asserting a room temperature bi-phase composite as Multiferroics” Roksana Parvin, A. A. Momin, M. A. Zubair, M. A. Matin and A. K. M. Akther Hossain, Journal of Electroceramics, pp. 1-19 (2020).

5. “Structural, magnetic and electrical properties of multiferroic $x Li_{0.1}Ni_{0.2}Mn_{0.6}Fe_{2.1}O_4$ + (1- x) $Bi_{0.8}Y_{0.2}FeO_3$ composites” A. A. Momin, Roksana Parvin, Md. Fakhrul Islam, A. K. M. Akther Hossain, Journal of Magnetism and Magnetic Materials, p. 167708 (2021).