ABSTRACT

The present research work reports on synthesis of Fe^{3+}-$3d^5$ spin doped bismuth ferrites $Bi_{1-x}Fe_{1+x}O_{3,}$ $x\leq1$, with a bonded GO-like surface layer and their characterization with thermal, magnetic, dielectric, electrical, and optical properties. A basic idea behind selecting this unique series of magnetoelectric materials includes both technological and fundamental aspects. A joint surface layer modulates the magnetism with a localized distribution of electronic charges so it tunes the magnetodielectric and other useful properties for memory devices, catalysts, photovoltaics, and other devices.

The structural in terms of X-ray diffraction and microstructure, thermal, magnetic, dielectric, electrical, and optical properties on the $Bi_{1-x}Fe_{1+x}O_{3,}$ $x\leq1$, samples prepared under selective experimental conditions are presented in four different Chapters 3-6. The work is supported with a general introduction in Chapter-1 on the basic research interest and overview of different types of magnetoelectric materials, typical properties of bismuth ferrite, a statement of the problem, a literature review along with the motivation behind choosing the present research work, and several intriguing properties and applications of such materials. The sample preparations and measurements/analyses of selective properties are briefed in Chapter-2. A novel synthesis involving microwave assisted self-combustion of adequate precursors with camphor (fuel) is adapted to obtain the ferrites of small crystallites with an inbuilt GO-surface layer of it promptly tunes the functional properties. The results of the phase formation and structural analysis of the various $Bi_{1-x}Fe_{1+x}O_{3,}$ $x\leq1$, samples are described in Chapters-3, while those of the magnetic properties are described in Chapter-4. It is demonstrated that a bonded GO-like surface layer integrates the surface spins in small crystallites so as it promotes the magnetic properties in small core-shell magnets.

The $Fe^{3+}\rightarrow Bi^{3+}$ substitution is shown to stabilize a solid solution $Bi_{1-x}Fe_{1+x}O_{3,}$ $x\leq0.8$, with selective phases and tailored properties. The interplay of the spins of respective phases provides novel magnetic features as reflected in the hysteresis loops and ZFC-FC curves. The electrical and dielectric properties of the various $Bi_{1-x}Fe_{1+x}O_{3,}$ $x\leq1$, samples are described in Chapter-5. The magnetoelectric coupling strengthens on the Fe^{3+}-$3d^5$ doping. Furthermore, it promptly controls the dielectric-loss, a value as small as 0.05 achieved on $x\rightarrow 0.8$. Temperature dependent impendence describes an electronic conduction permeated through an electron-spin coupling. Chapter-6 describes the electronic absorption and emission, IR, Raman, and XPS spectra of the various samples. The XPS bands in Fe^{3+}, Bi^{3+}, O^{2-} and C^{4-} species and IR bands in the oxygen polygons confer the results of forming $BiFeO_3$ and/or Fe_2O_3 with a bonded GO-like surface layer. A summary of the work and important implications achieved in this work are reported in the last Chapter-7 along with future scope of the work in this series.

Keywords: Self-combustion synthesis, Bismuth ferrites, Bonded surface-layer, Magnetoelectrics, Magnetics, Hysteresis loops, Optical properties, Energy materials