ABSTRACT

The present research work has been undertaken with a view of synthesizing a new series of colossal magnetoresistance (CMR) materials of $(La_{1-x}Eu_x)_{0.67}Ca_{0.33}MnO_3$ (x = 0-1) with emphasis on the functional properties. A chemical method has been explored involving a chemical dispersion of the metal salts through polymer molecules of polyvinyl alcohol and sucrose in a rheological solution in order to obtain a single phase compound of selective compositions (x = 0, 0.1, 0.2, 0.4, 0.5, 0.6 and 1.0) in a granular structure with controlled shape of nanoplates (or discs). Such small crystallites represent single magnetic domains. The aim of this work is two fold: one from the application point of view of such materials and the other from fundamental aspects. In application part, the main objective is to develop a large magnetoresistance (MR) in low magnetic fields with useful magnetic properties, whereas in the fundamental part, the motive is to analyze thermal, structural, magnetic, transport, and optical properties in correlation to the microstructure.

The structural (in terms of X-ray diffraction and microstructure), magnetic, transport, and optical properties obtained for the synthesized materials under selective experimental conditions are presented in four different Chapters 3-6. Chapter-1 provides a general introduction on the basic research interest and overview of the physics of different MR materials, a statement of the problem, review of the literature along with motivation behind choosing this research work, important properties and possible applications of such magnetoceramics. Chapter-2 presents experimental details of the synthesis process and characterization methods adopted for evaluating the different properties. Chapter-3 describes the phase formation and microstructural analysis of the products of varied compositions. Chapters-4 deals with studies on the effects of partial $La^{3+} \rightarrow Eu^{3+}$ substitution on the magnetic properties of the granular nanostructure. The saturation magnetization M_s decreases regularly on increasing $La^{3+} \rightarrow Eu^{3+}$ substitution, converting a ferromagnetic → ferrimagnetic transformation. An H_c-value (coercivity) as large as 619 Oe is obtained along with moderate M_s = 35.3 emu/g and remnant M_r/M_s = 0.22 (measured at 10 K) in a specific composition of x = 0.4 Eu^{3+}-content (annealed at 873 K) exhibiting unusually large MR and exchange bias effect. The substitution suppresses the T_C from 270 K at x = 0 to 90 K at x = 0.6. The electrical and magnetotransport properties as described in Chapter-5 demonstrate the effect of a partial $La^{3+} \rightarrow Eu^{3+}$ substitution on the electronic transport in correlation to the magnetism. The metal-insulator transition temperature 270 K (x = 0) drops to 77 K upon the substitution (x = 0.4). An MR-value as large as (-) ~ 100% is found for a specific composition of x = 0.4 (measured at 100 K in 80 kOe field). Chapter-6 deals with vibrational, electronic, EPR and XPS spectra for the various samples. A partial Eu^{3+} substitution controls the $Mn^{3+} \rightarrow Mn^{4+}$ conversation. Strong light-emission incurs in the electronic transitions in the Mn^{3+}/Mn^{4+} and O^{2-} species in support with the phonons. A summary and conclusion of the major findings of this work are briefed in Chapter-7 along with its future scope of work.

Keywords: CMR materials; Chemical process; Magnetic and transport properties; Magnetoelectronics; Granular ceramics; Optical properties

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