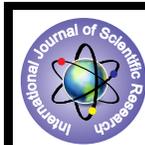


Synthesis of Nanostructured bulk $\text{La}_{0.4}\text{Pr}_{0.3}\text{Ba}_{0.3}\text{MnO}_3$ Manganite Materials Using Cost Effective Sol Gel Method



Physics

KEYWORDS : Nanomaterials, Perovskite Structure, Zener Double Exchange

Bharat R. Kataria

Department of Physics, Government Science College – Zalod-Gujarat- INDIA

J H Markna

Department of Nanotechnology, VVP Engineering College, Rajkot-Gujarat- INDIA.

ABSTRACT

In the recent year, due to scientific and industrial interest, nanostructured manganite nanoparticles have attracted a lot of interest, special due to its applications in computer read head, memory devices, MRAM and as infrared sensors. The present study focused, on the cost effective synthesis technique nanostructured particles of $\text{La}_{0.4}\text{Pr}_{0.3}\text{Ba}_{0.3}\text{MnO}_3$ (LPBMO) manganite. The structural composition and particle size were determined by X-rays and FULLPROF program, reveals that the particles have size in order to 90 nm. The synthesis method, reported in current work might be useful for industrial production of LPBMO manganite nanoparticles.

INTRODUCTION

The LaMnO_3 manganite possesses ABO_3 type perovskite structure and is an antiferromagnetic insulator (AFI) below 170 K. On substituting divalent cations at trivalent La^{3+} , the resulting compositions $\text{La}_{1-x}\text{A}_x\text{MnO}_3$ (where, A is divalent cation) display interesting correlated transport, magnetic and magnetoresistive properties. The physical properties of these compounds are determined by three main factors; i) the divalent doping (substitution) at the La-site (which determines the ratio of $\text{Mn}^{3+}/\text{Mn}^{4+}$) ii) the average A-site cation radius and iii) size-disorder at the A-site [1-3]. Depending upon these factors, the exchange interaction between the Mn^{3+} and Mn^{4+} ions via oxygen, largely known as Zener Double Exchange (ZDE), comes into play and drives the material to exhibit insulator to metal transition (IT) and paramagnetic to ferromagnetic transition (TC). In the vicinity of IT, the resistivity drops by a large magnitude on the application of an external magnetic field, thus making the material to display a large negative magnetoresistance (MR).

The observation of colossal magnetoresistance (CMR) effect in the $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3$ (LCMO) manganite thin films sparked the growth and development of spin-electronics based studies in this material. It has also opened up a new direction for research and development in the field of thin film and multilayer structures of LCMO and its variants [1, 2]. The development of new spin-electronic devices such as magnetic random access memories (MRAM) to be used in conjunction with or as replacements for EEPROM (electrically erasable programmable read-only memory), flash memories in computer applications and uncooled infrared imaging systems were possible due to the growth and studies on rare earth doped manganite thin films and multilayers [3, 4]. It is well known that, the physical properties of thin films are governed by the strain induced due to the lattice mismatch occurring between the film and the single crystal substrate. It is therefore of prime interest to control the internal microstructure after deposition in order to understand the changes in both magnetic and electrical properties. Pulsed Laser Deposition (PLD) technique has been abundantly applied for the deposition of the high quality manganite thin films and multilayer. It has played a significant role in advancing the understanding of the physics of thin film structures. There is an appreciable effect of the growth parameters (such as temperature, pressure, and target-to-substrate distance) on both internal microstructure and surface morphology [5-7]. The strain in the manganite films is expected to create the magnetic anisotropy and a dead layer, which modifies the Low Field Magnetoresistance (LFMR) very effectively and can result in to loss of the spin polarization [8].

SYNTHESIS

Polycrystalline nano structured sample of $\text{La}_{0.4}\text{Pr}_{0.3}\text{Ba}_{0.3}\text{MnO}_3$ (LPBMO) was synthesized by using standard sol-gel method.

In that first, high purity Lanthanum, Barium, Praseodymium and Manganese acetate hydrate are taken as precursor solution and dissolved stoichiometric ratio in acetic acid and distilled water (1:1 by volume) followed by the stirring at elevated temperature (80°C, 20 min) to obtain a clear solution of 0.4M which was used to prepare dried powder. Obtain powder was calcined at 950°C for 24 hours. The samples were ground, palletized and sintered in a temperature range of 1000°C - 1100°C with several intermediate grindings. Structural refinement was carried out by rietveld fitting of the XRD patterns using standard FULLPROF program [7,8,9,10]. Fig. 1 shows a typical rietveld refined XRD pattern of LPBMO sample showing a good agreement between the fitted and experimental patterns.

RESULTS AND DISCUSSION

The XRD pattern (Figure 1) of the Polycrystalline nano structured sample of $\text{La}_{0.4}\text{Pr}_{0.3}\text{Ba}_{0.3}\text{MnO}_3$ (LPBMO) shows the single phase crystal structure with monoclinic structure. The intensities and positions of the peaks are in good agreement with literature values. No peaks of impurity are found in the XRD pattern. The broadening of the peaks indicates that the crystal size is small. The average size of the nanoparticles is estimated to be 90 nm according to the Debye-Scherrer formula (shown in Table 1). $D = k\lambda/\beta\cos\theta$, where, D is the particle size (nm), is a constant equal to 0.94 & λ is the wave length of X-ray radiation (1.5406 Å), β is the full-width at half maximum (FWHM) of the peak and 2θ is the Bragg angle (in degree).

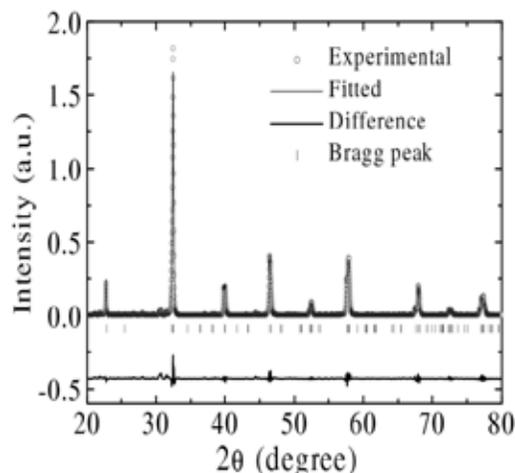


Figure 1: Rietveld fitted XRD pattern for nano structured LPBMO manganite sample.

The analysis of the XRD data of nano structured LPBMO manganite prepared by sol gel technique reveals that, sample crystal-

lizes in a distorted orthorhombic structure (space group: Pnma, no. 62) with the refined cell parameters, $a = 5.416(2) \text{ \AA}$, $b = 7.629(2) \text{ \AA}$ and $c = 5.446(2) \text{ \AA}$.

Sample	FWHM	Grain size
$\text{La}_{0.4}\text{Pr}_{0.3}\text{Ba}_{0.3}\text{MnO}_3$	0.99nm	90nm

CONCLUSION

In this communication, we have prepared nano structured manganese particles with a size of 90 nm by a cost effective sol-gel synthesis technique, and it is also simple and industrial applicable technique. As it is an easy, fast and does not involve any harmful and environmentally toxic chemicals..

REFERENCE

1. A. P. Ramirez, J. Phys.: Condens. Matter 9, 8171 (1997). | 2. J. M. D. Coey and M. Viret, Adv. Phys. 48 167 (1999). | 3. E. Doggio, T. Hotta and A. Moreo, Physics Report 344 1 (2001). | 4. Ravi Kumar, R. J. Choudhary, S. I. Patil, Shahid Hussain, J. P. Srivastava and S. K. Malik, Appl. Phys. Lett. 86 222501 (2005). | 5. G. Szenes, Phys. Rev. B 51 8026 (1995). | 6. J. F. Ziegler and J. P. Biersack, Program SRIM (2003), <http://www.srim.org>. | 7. D. S. Rana, K. R. Mavani, C. M. Thaker, D. G. Kuberkar, Darshan C. Kundaliya and S. K. Malik, Journal of Mag. and Mat. 271 215- 223 (2004). | 8. J. Rodriguez_Carvajal, FULLPROF version 3.0 Laboratoire Leon Brillouin, CEA-CNRS, (1995). | 9. A-M Haghiri-Gosnet and J-P Renard, J. Phys. D: Appl. Phys. 36 R127-R150 (2003). | 10. J. H. Markna, R. N. Parmar, D. G. Kuberkar, Ravi Kumar, D. S. Rana and S. K. Malik, Appl. Phys. Lett. 88 152503 (2005). |