St. Joseph's Journal of Humanities and Science (Volume 4 Issue 1 January 2017) 122-126

St. Joseph's Journal of Humanities and Science
ISSN: 2347 - 5331
http://sjctnc.edu.in/6107-2/

MAGNETOCALORIC, SUPERCONDUCTING TRACE OF $LaBiCuO_3$ AND COBALT DOPED $LaBiCuO_3$ COMPOUNDS

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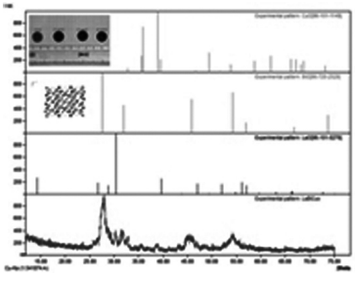
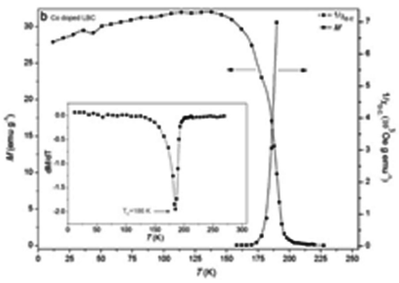
Abstract

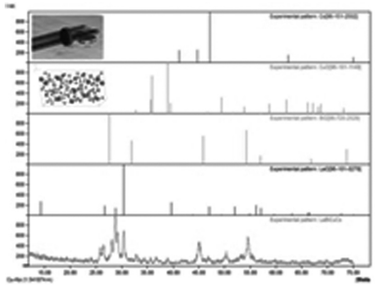
In this work, the structural and magnetic properties of the polycrystalline $LaBiCuO_3$ and $LaBiCuO_3$: Co Compounds prepared by Wet-Chemical method were investigated. The structural properties were investigated by x-ray diffraction. The magnetic properties were identified by VSM and the thermal activities were identified through DTA-TGA analysis. The XRD results showed that both samples Crystallized in the hexagonal symmetry with R3c phase groups. The VSM results showed that both samples lies in the Wasp ferromagnetic and the trace of superconducting nature. The TGA graphical analysis showed that both samples have high stability up to the 786°C. The phase change occurred more than 500°C and 600°C. The melting point of the sample lies around 816°C. These findings make both LBC and LCBC compounds as good candidates for practical magnetic refrigeration.

Keywords: Magnetic Materials, Magnetic properties, Wet Chemical methods.

Graphical Abstract







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INTRODUCTION

During the last few decades the Magnetocaloric (MCA) activities of the Magnetic material have drawn major attention because of the temperature reducing nature from the environments. MCA acquiesce a exclusive mode of obtaining the refrigeration in huge temperature interval including ultra low room temperature (1). The heat radiated from the magnetic system into environment through the isothermal process, only when the Magnetic entropy decreases. Hence decreasing the magnetic field, the entropy increases and heat absorbed through adiabatic process.

Comparing the gas refrigeration and magnetic refrigeration system to Environment-gracious, the MRS is doing vital role and hence it to be attracted attention in recent years (2, 3). This attraction has been studied large variety of the magnetic poly crystalline materials from the researchers. Other than this, the preparation methods, highest chemical stability, lower eddy current, thermal behaviours, and the hysteresis report (4, 5) are better upliftment from the rare earth metal based alloys also booted the vigorous enrolment to have the magnetic refrigeration materials as the present research of the researchers (6,7,8).

Among the magnetic materials the La and Bi based serious are having excellent thermal conductivity and the Dia-magnetic nature and its susceptibility. And also the superconductivity values have been very closer to the room temperature. This material exhibits its transition to Ferro and ferric magnetic natures like one like another. The theoretical transition explanation has explained in the basis of zenar's double exchange theory (9).

There are lot of research serious about lanthanum and bismuth raises the understanding level in these sample selections, hence we selected La and Bi combinational based components to get this refrigeration. As the results, reported that these combination effectively doing their work in MCR.

EXPERIMENTAL PROCEDURE

The polycrystalline materials LaBiCuO and Cobalt doped parental poly crystals has been prepared via wet chemical method. The molecular ratios 1:2:3 and (1:2:3):1 has been taken for evaluation from La_2O_3: Cu $(NO_3)2.3H_2O$: $(BiO_2).CO_3$ and 1% $Co(NO_3)2.6H_2O$ doped with the Parental Polycrystalline material. The wetted centrifuged samples have been collected and dried in muffle Furnace at 120° C for 5 hours. The harvested sample from furnace, annealed about 550°C for 5 hours. The sample has been examined the DSC-TGA analysis to identify the crystalline phase change identification, this samples have been pelleted at the pressure of 100 gauss and annealed again 815°C for 6 hours. The Structural properties, Photo luminesence, VSM Characterise have been identified to confirm the nature habited of the Polycrystalline samples.

CHARACTERISATIONS

TGA-DSC Analysis

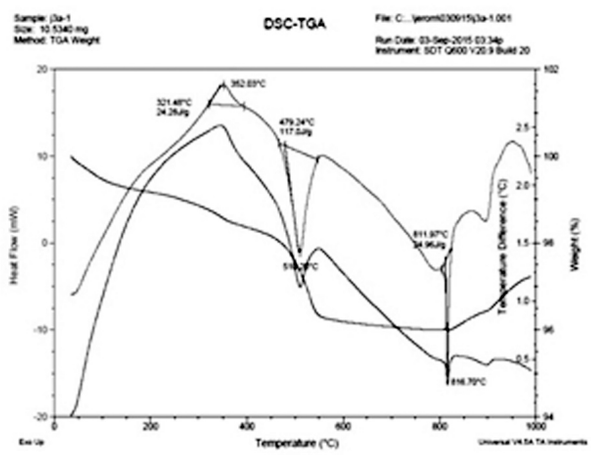

Figure.1: DSC-TGA Graph of LBC and Co:LBC

The thermal behaviour of the samples in Fig.1 have been analysed through the DSC-TGA analysers named SDT Q600 V20.9 Build 20. It reveals that there is crystalline phase change at 580oC and the sharp melting points at 510 OC and 816.70OC can confirms that the material posses crystalline nature. And the stability of this polycrystalline nature stable up to 510oC. One can try to get the single crystalline nature at exactly 816oC for parental and when Cobalt doped to the parent material the melting points has got slight decrement.

Powder Diffraction Study

Parental polycrystalline and Cobalt doped material's structure nature has been identified by powder X-ray diffraction analyser. The XRD patterns are indexed in Fig.2a and 2b. The three material phases have been confirmed by the crystalline refinements done in Match3

and Retrieved in Full proof software. The result reveals that, the La, Bi, Cu and Co phases ***(2θ=30.24°, 31.80°, 53.79° and 45.02°)*** have been perfectly matches with the preferred reference patterns (10-13) JCPDS cards *96-101-0279, 96-720-2529, 96-101-1149 and 96-151-2502.* Similarly the cobalt doped material also confirm with the same reference indexed.

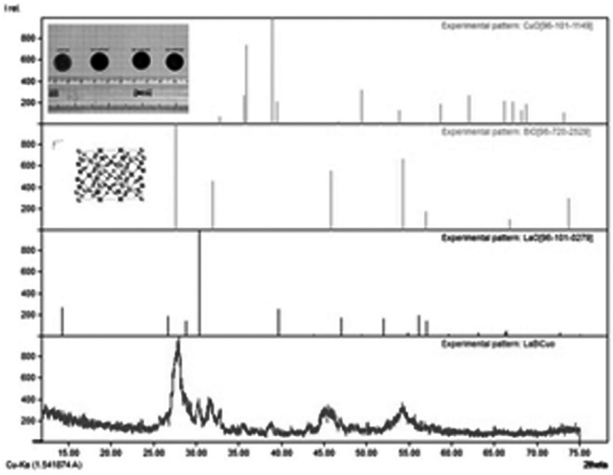

Figure 2a: La Bi CuO Polycrystalline XRD Pattern

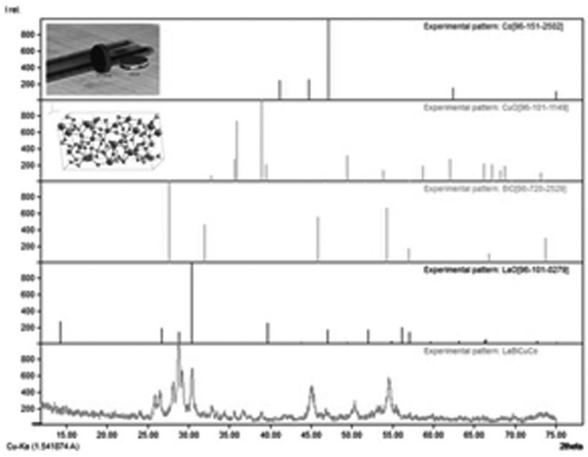

Figure 2b:Co Doped LaBiCuO XRD Pattern

Magnetic Property

The magnetic performances of the materials in Fig 3a and 3b have been investigated through VSM instruments. The results of this, confirms the magneto caloric activities as well as the superconducting nature of the materials. The parental and Cobalt doped materials have Wasp Ferromagnetic natures. The Total Area, Coercivity (Hci), Magnetization (Ms) and the Retentivity (Mr) of hysteresis loop of cobalt doped LBC material are 6.3307 erg/g, 56.964 G, 21.742E-3 emu/g and 1.1235E-3 emu/g. It has been 40% reducible from the un-doped LBC's values. The dipole conformation has been identified from fig.4a and 4b. The Curie temperature confirms that it transit to paramagnetism and below this, it act as Wasp Ferro magnetic nature. This is the essential quality of the super conducting material as well as the Magnetocaloric materials. The reported paper confirms the magneto caloric activities by changing the temperature and magnetic fields. Hence this present research has followed same path and confirm the same nature.

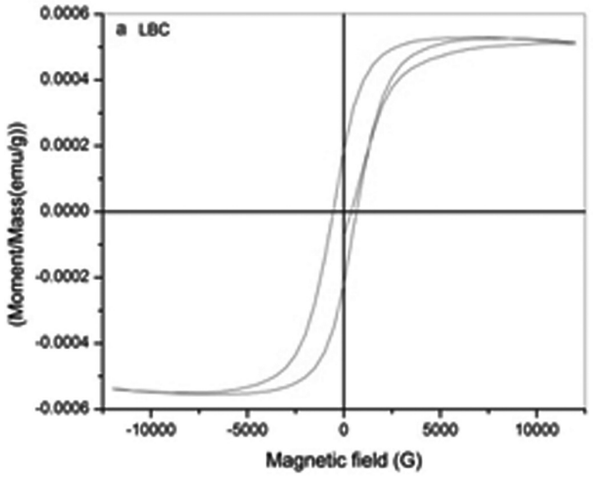

Figure 3a: Hysteresis of LBC

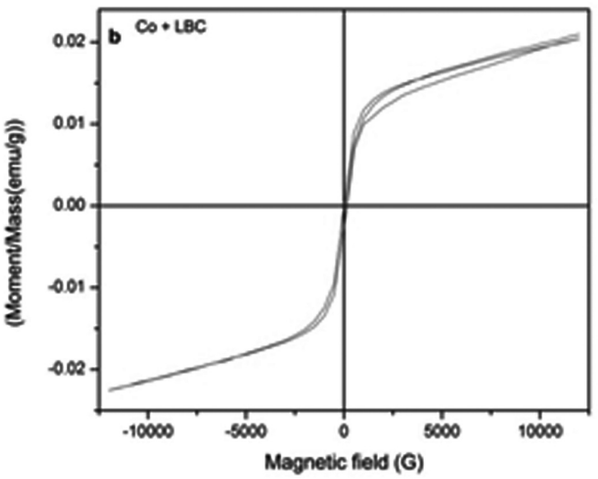

Figure 3b: Hysteresis of Cobalt Doped LBC

Fig 4a and 4b of temperature dependence magnetisation *M (T)* curves under 25mT magnetic field condition has been applied for both LBC and LBC with Cobalt samples.

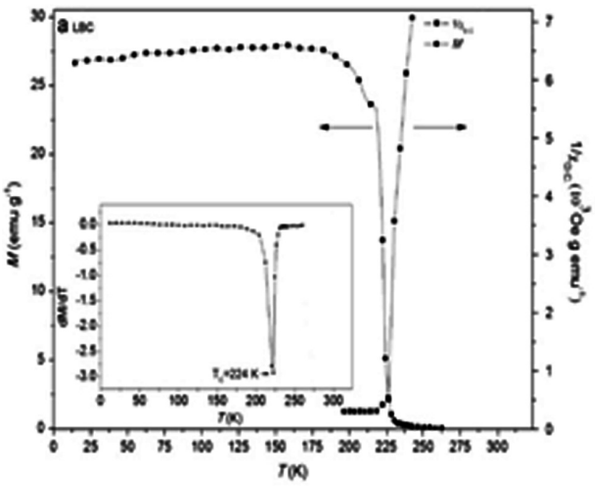

Figure 4a: M(T) Undre 25mT for LaBiCuO

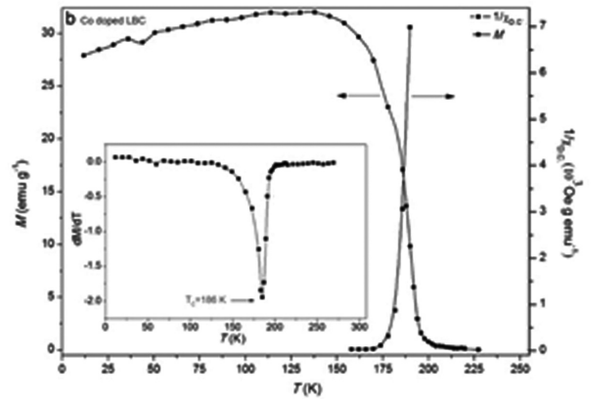

Figure 4b : M(T) Undre 25mT for Co+LaBiCuO

It clearly seen that both samples exhibits a single magnetic phase transactions. At below the Curie transition T_C, the sample behaves like ferromagnetic and above it behaved like paramagnetic materials. The transition temperature deduced from the minimum of *dM/dT* verses *T* curves, some literature findings (14) are listed about $T_C(K)$ values at 214, 300, 306, 262 for $La_{0.95}Ag_{0.05}MnO_3$, $La_{0.80}Ag_{0.20}MnO_3$, $La_{0.75}Ag_{0.30}MnO_3$ and $La_{0.85}Ag_{0.15}MnO_3$, the present research listed that the T_C are 224 and 186 respectively. As compared with the present research work the T_C has been reduced from 224 to 186 by the addition of Cobalt in LBC. The reason of reducing at T_C can attribute to weakening effect (15)

The Plot of inverse susceptibility $1/\chi$ verses *T* are also shown in the right axis of fig 4a and 4b. It shows the linear behaviours with temperature above T_C and can also fit to the cuire-weiss law. The effective magnetic moments has been calculated form that and it has also reduces considerably. This is because of the doping element presence in the materials.

CONCLUSION

The investigation on structural, Magnetic and the magneto caloric properties of the polycrystalline LBC and Cobalt doped LBC has been done by wet chemical method. The XRD result reveals that the samples are crystalline in rhombohedral structure. And the unit cell and lattice parameters are decreases to the effect of doping elements. The ferromagnetic to paramagnetic phase transitions were observed at $T_c \sim 224$ and 186 for LBC and Co doped LBC respectively. All these results indicates the both samples are good to magnetic refrigeration a super conducting applications.

Acknowledgements

The research fund of Christ college of Engineering and technology, Pondicherry, Supported this work under the file no CCET/RDC/2015-001. The Authors thanks also Dr.A.Ravichandran, Director, Christ College of engineering and technology, and the Faculties of Mechanical Engineering, Physics and Chemistry for their Technical and Moral supports.

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