Accepted Manuscript

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PII: S0925-8388(18)32319-3

DOI: 10.1016/j.jallcom.2018.06.198

Reference: JALCOM 46534

To appear in: *Journal of Alloys and Compounds*

Received Date: 23 January 2018

Revised Date: 31 May 2018

Accepted Date: 18 June 2018

Please cite this article as: J.A. Silva, M.O.S. Xavier, E.J.R. Plaza, J.C.P. Campoy, A theoretical approach to study the magnetic and magnetocaloric properties in lanthanum manganites, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.06.198.

A theoretical approach to study the magnetic and magnetocaloric properties in lanthanum manganites

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Abstract

We studied the magnetic and magnetocaloric properties of (La, A)MnO_3 (A = divalent metal) compounds on basis of the double-exchange Kubo-Ohata model considering magnetoelastic interactions. The adequacy of the calculations is demonstrated by comparison with experimental magnetization curves for the $La_{0.69}Pb_{0.31}MnO_3$ and $La_{0.75}Ca_{0.25}MnO_3$ compounds. For the case of divalent admixture $La_{2/3}(Ca_{1-x}Sr_x)_{1/3}MnO_3$ we calculated successfully the isothermal magnetocaloric potential for this series of compounds. Additionally, we showed a correlation between the compressibility and the η-parameter which defines the order of the transition.

Introduction

The magnetocaloric effect is the change in the temperature of a magnetic material subjected to a change in the applied magnetic field and is especially important around the magnetic ordering temperature. The adiabatic change of temperature and isothermal change of entropy are used to quantify this effect. It is desirable a broad range of the operating temperatures as well as low magnetic fields for domestic applications. This magnetothermal effect, known since 1881 when Warburg reported reversible field-induced temperature changes in pure iron, is the basis to obtain cryogenic temperatures. Nowadays, many families of magnetocaloric materials has been characterized [**1**,**2**] and proposed as solid refrigerants for the room-temperature region. Large effects are attached to the coupling between structure and magnetic order as in $Gd_5Ge_2Si_2$ [**3**] which shows undesirable thermal hysteresis related to first order magnetic transition. To avoid hysteresis a second-order nature of the transition connected to other phenomena could be attractive to guarantee, at the same time, an adequate magnetocaloric intensity.

The interest in transition-metal oxides has increased substantially in the last years due to the interplay between their several degrees of freedom. In the simple $LaMnO_3$ an