Journal of Alloys and Compounds 510 (2012) 125–133

Contents lists available at SciVerse ScienceDirect

Journal of Alloys and Compounds

journal homepage: www.elsevier.com/locate/jallcom

Effect of frozen spin on the magnetocaloric property of $La_{0.7}Ca_{0.3}CoO_3$ polycrystalline and single crystal samples

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ARTICLE INFO

Article history:
Received 14 March 2011
Received in revised form 30 August 2011
Accepted 30 August 2011
Available online 10 September 2011

Keywords:
Exchange-bias
Memory effect
Frozen spin
Magnetocaloric effect
Cluster-spin-glass

ABSTRACT

Polycrystalline (PC) and single crystalline (SC) samples of $La_{0.7}Ca_{0.3}CoO_3$ (LCCO) with the perovskite structure were synthesized by conventional solid-state reaction and the floating-zone growth method. We conducted isothermal magnetization measurements of the PC and SC samples at temperatures from 2.8 K to 140 K, and evaluated the magnetic entropy change ($-\Delta S_M$) under zero field cooling (ZFC) and field cooling (FC) to 2.8 K. An interesting result has been obtained, where the $-\Delta S_M$–T curves in the low temperature range show totally different features between the ZFC and FC cooling procedures. The $-\Delta S_M$ shows a large inverse irreversibility value for the ZFC process, while the $-\Delta S_M$ also shows a normal positive value, but one that is slightly larger at 2.8 K for the FC process for both samples. We also present the results of a comprehensive investigation of the magnetic properties of the LCCO system. Systematic measurements have been conducted on DC magnetization, AC susceptibility, and exchange-bias. These findings suggest that complex structural phases, including ferromagnetic and spin-glass/cluster-spin-glass (SG/CSG)) states and their transitions, exist in PC samples, while there is a much simpler magnetic phase regime in SC samples. It was also of interest to discover that the CSG induced a magnetic field memory effect and an exchange-bias-like effect.