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A study on the magnetic properties of Gd-Sr based low bandwidth manganites in their bulk and thin film forms and evidence for magnetization reversal in bulk $Gd_{0.7}Sr_{0.3}MnO_3$

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Abstract

A study on the magnetic properties of both bulk and thin film forms of charge ordered Gd-Sr manganites belonging to the series $Gd_{1-x}Sr_xMnO_3$ (x= 0.3, 0.5, 0.6) was performed. In the case of bulk, it is found that the Gd moments order anti parallel to the manganese spins giving rise to a ferrimagnetic behaviour. A spin glass transition due to the competing ferromagnetic (FM) and antiferromagnetic (AFM) interactions is observed at around 42K. Bulk form of $Gd_{0.7}Sr_{0.3}MnO_3$ exhibits magnetization reversal for applied fields of 25 Oe and 50 Oe at very low temperatures. In $Gd_{1-x}Sr_xMnO_3$ thin films, coercivity is found to be lower when compared to their bulk counterparts. Thin film $Gd_{0.7}Sr_{0.3}MnO_3$ exhibit both glassy and ferrimagnetic behaviour for an applied magnetic field of 200 Oe similar to bulk. While for x= 0.5 and 0.6, coercivity is lower and therefore the applied magnetic field of 200 Oe is large enough to suppress both the glassy and ferrimagnetic phases in thin films. Reduced coercivity of thin films when compared to bulk has been attributed to the grain size effect.

Key words: magnetization reversal, spin glass, manganites, ferrimagnetic

1. INTRODUCTION

Manganites with perovskite structure have been extensively studied due to the complex interplay between the spin, charge and orbital degrees of freedom inherent in these systems. They are of potential use in device applications, especially, in spin valves used in the magnetic storage industry in the form of magneto resistive heads, magnetic sensors and infrared detectors [1-5]. The mixed valent perovskite manganites belonging to $R_{1-x}A_xMnO_3$ (R-rare earth metal, A-divalent cation) series assume importance due to their rich physics in these classes of compounds other than applications. When rare earth ions are substituted with divalent cations, the antiferromagnetic phase of insulating parent compound $RMnO_3$ is progressively destroyed and transforms into a ferromagnet through an intermediate canted structure [6-7]. This is due to the competing interaction between antiferromagnetic (AFM) and ferromagnetic (FM) spin ordering of Mn^{3+} and Mn^{4+} ions [8]. The electrical and magnetic properties of these mixed valent perovskite manganites strongly depend on the

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