Substrate effect on low-field transport properties of La–Pb–Mn–O granular-type thin films

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This paper studied the low-field tunnel-type transport characteristics of polycrystalline and c-axis-oriented La0.7Pb0.3MnO3 (LPMO) thin films. Polycrystalline thin films were fabricated on SiO2/Si(100) substrate (film A), on SiO2/Si substrate with yttria-stabilized zirconia (YSZ) buffer layer (film B), and on c-axis-oriented thin film grown on LaAlO3(001) (LAO) single crystal substrate (film C) using the soft-chemical deposition method. A YSZ buffer layer acts as a barrier against inter-diffusion. As a result, it decreases the amount of dead layers generated from the interface and helps to produce qualitative films for application of magnetoresistive elements. The magnetoresistance (MR) ratio was 0.52%, 0.7%, and 0.4% for film A, film B, and film C under the applied field of 500 Oe at 300 K, respectively. The polycrystalline film had denser boundaries than the c-axis oriented film, i.e., the polycrystalline film gave more effective potential barrier regions than the c-axis oriented film.

1 Introduction

Colossal magnetoresistance (CMR) in manganese oxide materials has been studied during the last few years. In particular, many efforts have been focused on understanding the magnetotransport properties of the manganese perovskite oxides La1−xAxMnO3 (A = Ba, Sr, Ca, Pb, or vacancies). In general, large magnetoresistance changes are obtained only under a strong field, thereby severely limiting their practical utility. On the other hand, the discovery of grain boundary and interface as a factor of low-field magnetoresistance has stimulated renewed interest in polycrystalline samples [1–3]. The low-field magnetoresistance in polycrystalline materials is governed by the spin-polarized transport across grain boundaries. The CMR and extremely high degree of spin polarization [4, 5], which are important in exploiting the spin-polarized electron transport, make manganese perovskites preferential candidates for technological applications. In the present work, we investigated the low-field tunnel-type magnetoresistance (MR) characteristics of La0.7Pb0.3MnO3 (LPMO) thin films deposited on different substrates, as well as the enhancement of MR property by inserting an intermediate layer.

2 Experimental

La0.7Pb0.3MnO3 polycrystalline thin films were fabricated on SiO2/Si(100) substrate, on SiO2/Si substrate with yttria-stabilized zirconia (YSZ) buffer layer, and on c-axis-oriented thin film grown on LaAlO3(001) (LAO) single crystal substrate using the soft-chemical deposition method. La(CH3CO2)3 · xH2O, Pb(CH3CO2)2 · 3H2O, and Mn(CH3CO2)2 · 4H2O were used as starting materials and dissolved in acetic acid, ethanol, and distilled water. Ethylene glycol was added to the solution as a drying control chemical agent, in order to restrict the cracking of thin films before spin coating. The solution was ready for spin coating at the molarity of 0.2.

The LPMO films were deposited by spin coating at 4000 rpm for 30 s. They were then dried on a hot plate in three stages between each coating. The deposited LPMO films were crystallized in the temperature range of 600–900 °C. The crystalline structures of the LPMO films were characterized using X-ray

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