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Investigation of the Properties of Ba-Substituted $La_{0.7}Sr_{0.3-x}Ba_xMnO_3$ Perovskite Manganite Films for Resistive Switching Applications

SUN GYU CHOI,[1] HONG-SUB LEE,[1] GEUN YOUNG YEOM,[2] and HYUNG-HO PARK[1,3]

1.—Department of Materials Science and Engineering, Yonsei University, Seoul 120-749, Korea. 2.—Department of Materials Science and Engineering, Sungkyunkwan University, Suwon, Kyunggi-do 440-746, Korea. 3.—e-mail: hhpark@yonsei.ac.kr

$La_{0.7}Sr_{0.3-x}Ba_xMnO_3$ (LSBMO: x = 0.09, 0.18, and 0.27) thin films were prepared on Pt-coated Si substrates using a radiofrequency magnetron sputtering technique at a substrate heating temperature of 450°C. The effects of varying the amount of substituted Ba^{2+} on the physical, chemical, and electrical properties of the perovskite manganite films were systematically investigated. X-ray diffraction showed that the growth orientation and crystallinity of films were not affected by the amount of substituted Ba cations. Raman spectroscopy was used to determine the tilt of MnO_6 octahedra and the Jahn–Teller-type distortion variation of the manganite films. The change in covalent characteristics of Mn–O bonds with increasing amounts of Ba^{2+} substituent was analyzed by x-ray photoelectron spectroscopy, specifically to examine the effects of bond characteristics on the resistive switching properties of LSBMO. The resistance of the LSBMO films increased with increasing Ba^{2+} content due to an increase in the covalent nature of Mn–O bonds. The resistive switching ratio increased with increasing Ba^{2+} amount, and relationships among resistive switching, Jahn–Teller distortion, and Mn–O bond character of LSBMO films were interpreted.

Key words: $La_{0.7}Sr_{0.3-x}Ba_xMnO_3$, Jahn–Teller distortion, XPS, Raman, resistive switching

INTRODUCTION

Resistive random-access memory (ReRAM) is a nonvolatile memory that can change its resistance between two reversible high- and low-resistance states with applied voltage pulses. ReRAM has garnered attention due to its simple metal–insulator–metal (MIM) structure, low power consumption, and fast operation speed.[1,2] Resistive switching behavior has been observed in various transition-metal oxides, such as mixed-valence perovskite manganites, especially with $Ln_{1-x}A_xMnO_3$ (where Ln are trivalent lanthanide cations and A are divalent alkaline-earth cations).[3] Perovskite manganite films exhibit bipolar resistive switching behavior without a "forming process," and thus can be understood in terms of an interface-type resistive switching model. In the case of interface-type resistive switching, a resistance change occurs at the interface between the metal electrodes and the oxide. Recent studies have demonstrated that, in the case of clockwise switching, redox between the reactive metal electrode and the resistive switching material in the vicinity of the interface is the main cause of interface-type resistive switching.[4–6] The reduction of interface regions of $Ln_{0.7}A_{0.3}MnO_3$ releases electrons, which can then occupy chemically doped holes in the Mn 3d $e_g^1 \uparrow$ band, resulting in increased resistance of the reduced region.[7]

The electrical and magnetic properties of perovskite manganite films are affected by lattice deformation

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