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Magneto-transport Properties of $\text{La}_{0.7}\text{Ca}_{0.3-x}\text{Sr}_x\text{MnO}_3$ thin Films Deposited by Pulsed Electron Deposition (PED)

Nam hee Ka, Young-Min Kang, Dae-Gil Yoo, A. N. Ulyanov, and Sang-Im Yoo*

Department of Materials Science and Engineering, Seoul National University, Seoul 151-744, Korea

*Corresponding author: Sang-Im Yoo, e-mail: siyoo@snu.ac.kr

We report the magneto-transport properties of $\text{La}_{0.7}\text{Ca}_{0.3-x}\text{Sr}_x\text{MnO}_3$ ($x = 0, 0.075, 0.1, 0.125, 0.15, 0.3$) thin films obtained by pulsed electron beam deposition (PED) on (100) LaAlO_3 substrate. Microstructure analysis by SEM and AFM revealed that all film surfaces were composed of dense outgrowths ranging from a few nano to micron size. The properties of the films are presented in Table 1. With increasing x from 0 to 0.3, Curie temperature (T_C) of the films was increased from 202 to 339 K. The resistivity of film was decreased with increasing x while both T_{MI} and T_{max} were increased. The resistivity decrease with increasing x may be attributed to a tendency of the charge carrier delocalization when larger Sr^{2+} cations substitute Ca^{2+} ions. High MR ratios of 13 ~ 17% around room temperature were obtained for the films of $x = 0.10, 0.125, 0.15$. These results are promising for the application of these films as room temperature MR sensors.

Table 1. Curie temperature (T_C), metal-insulator transition temperature (T_{MI}), temperature of maximum magnetoresistance (T_{max}), and Magnetoresistance ($\text{MR} = [R(0T) - R(T)] / R(0) \times 100\%$) of $\text{La}_{0.7}\text{Ca}_{0.3-x}\text{Sr}_x\text{MnO}_3$ films.

| x | T_C (K) | T_{MI} (K) | T_{max} (K) | MR (%) |
|-------|-----------|--------------|---------------|--------|
| 0 | 202 | 212 | 197 | 70.8 |
| 0.075 | 272 | 290 | 263 | 29.5 |
| 0.10 | 300 | 312 | 285 | 17.7 |
| 0.125 | 318 | 340 | 306 | 15.9 |
| 0.15 | 328 | 342 | 306 | 13.7 |
| 0.30 | 339 | 366 | 338 | 6.4 |

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Hopping in Uranium Doped One-Dimensional Antiferromagnet Ca_2CuO_3

Phung Quoc Thanh^{1,2}, Seong-Cho Yu, and Hoang Nam Nhat^{1*}

¹Faculty of Physics, College of Science, Vietnam National University, 334 Nguyen Trai, Hanoi, Vietnam

²Department of Physics, Chungbuk National University, Cheongju 361-763, Republic of Korea

*Corresponding author: Hoang Nam Nhat, e-mail: namnhat@gmail.com

Recently, the uranium doping in piezoelectric ceramics and oxide based optical materials showed the significant improvements in the desired properties of these materials [1]. The doping of a small amount of the oxygen-rich uranium oxide U_5O_7 in the strongly anisotropic, $S=1/2$ one-dimensional (1D) antiferromagnet system Ca_2CuO_3 induced a large change in resistance while preserving its covalent insulator state. Besides the clear changes in magnetic properties and optical transitions (where a new peak was seen in visible region) the strong correlation between doping content and resistance appeared as an additional important aspect of this doping.

Unlike in the undoped system where the conduction mechanism seems to couple with the 1D character of the spin transport along Cu-O chains in a similar variable range hopping regime as observed in a quasi 1D spin-ladder CaCu_2O_3 [2], the conduction mechanism here followed mainly from the three-dimensional (3D) hopping among the uranium dopant sites. All doped compounds demonstrated the continuous semiconductor-like behavior with preserving covalent insulator state from room temperature down to low temperature region. Their conduction mechanism was identified as the thermally activated phonon-assisted hopping regime and the parameter α , which is characteristic for the hopping probability, was determined to be 0.18\AA^{-1} . This value manifests the relatively stronger hopping probability for Ca_2CuO_3 in comparison with other uranium doped ceramics [1].

This work is supported by a Research Project No. QGTD 2009 and QT 08-10 from Vietnam National University.

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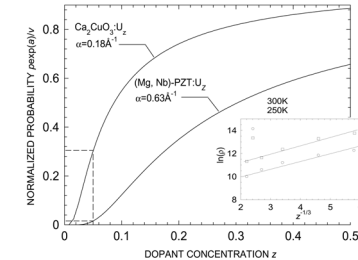


Fig. 1. The normalized hopping probability and the dependence of resistivity on doping uranium content (the inset).