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Optical Investigation on the Electronic Structure of $La_{1-x}Sr_xCoO_3$ with Complexity of Orbital Ordering and Ferromagnetism

Y. K. Seo[1], D. J. Lee[1], Y. S. Lee[1]*, T. Miyazato[2], Y. Onose[2], A. Asamitsu[2], Y. Tokura[2], and K. Yamaura[3]

[1]Department of Physics, Soongsil University, Seoul, Korea
[2]Cryogenic Research Center (CRC), University of Tokyo, Tokyo, Japan
[3]Department of Applied Physics, University of Tokyo, Tokyo, Japan
[4]NIMS, Tsukuba, Japan

*Corresponding author: Y. S. Lee, e-mail: ylee@ssu.ac.krylee@ssu.ac.kr

Perovskite Co-oxides have attracted much attention due to the complex interplay among charge, spin, and orbital with comparable energy scales between the magnetic exchange and crystal field splitting. Thermal excitation and charge carrier doping for the nonmagnetic ground state of $LaCoO_3$ allow peculiar magnetic interaction and electron-phonon coupling which lead to magnetic transition, orbital ordering, and insulator-metal transition. To get some spectroscopic understanding on these phenomena, we have performed optical measurements of single crystalline $La_{1-x}Sr_xCoO_3$ for x = 0.18 - 0.30 in a wide photon energy region. While the ground states of all samples are ferromagnetic, electric properties varies from insulating to metallic with the increasing x, which are clearly identified in temperature-dependent optical conductivity spectra. These spectral features are compared with those of ferromagnetic $SrCoO_3$ with single valence of Co ions +4 and the intermediated spin state. Our findings are discussed in terms of dynamic orbital ordering and related magnetic correlation.

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Fabrication and Characterization of $(1-x)BiFeO_3$-$xBaTiO_3$ Ceramics Prepared by Solid State Reaction Method

S. Chandarak[1]*, M. Unruan[1], T. Sareein[1], A. Ngamjarurojana[1], S. Maensiri[2], P. Laoratanakul[3], S. Ananta[1], and R. Yimnirun[1]

[1]Department of Physics, Faculty of Science, Chiang Mai University, 50200, Thailand.
[2]Department of Physics, Faculty of Science, Khon Kaen University, 40002, Thailand.
[3]National Metal and Materials Technology Center (MTEC), Pathumthani 12120, Thailand

*Corresponding author. Tel.: +66-53-941921 ext 445; fax: +66-53-943445. E-mail address: Pinky_pure58@hotmail.com

Bismuth ferrite ($BiFeO_3$) - based materials are expected to have both ferroelectricity and ferromagnetism simultaneously. $BiFeO_3$ is a representative material which has ferroelectric (T_C : 1103 K) and antiferromagnetic (T_N : 634 K) properties. The crystallographic structure of $BiFeO_3$ is a rhombohedrally distorted perovskite structure. In addition, it is also known to exhibit weak ferromagnetism at room temperature due to a residual moment from a canted spin structure. The preparation of pure $BiFeO_3$ in the bulk form without traces of impurities has been a difficult task. Therefore, $BiFeO_3$-ABO_3 solid solution systems have attracted great attention as a means to increase structural stability. Furthermore, another serious problem of $BiFeO_3$-based ceramics is their low electrical resistivity, which affects the measurement of ferroelectric (dielectric) properties at ambient temperatures. $BaTiO_3$ is a prototype ferroelectric material with several excellent ferroelectric properties, and is expected that when mixed with $BiFeO_3$ both ferroelectricity and ferromagnetism can still exist in the compound formed.

In this study, $BiFeO_3$-$BaTiO_3$ ceramics have been fabricated by a solid state reaction method. The effects of $BaTiO_3$ content in $(1-x)BiFeO_3$-$xBaTiO_3$ (x = 0.1, 0.2, 0.25, 0.3, 0.4, 0.5) system on crystal structure, magnetic properties, dielectric and ferroelectric properties were investigated. Perovskite $BiFeO_3$ was stabilized through the formation of a solid solution with $BaTiO_3$. Rhombohedrally distorted structure $(1-x)BiFeO_3$-$xBaTiO_3$ ceramics showed very hard ferromagnetism at x = 0.25. Dielectric and ferroelectric properties of $BiFeO_3$-$BaTiO_3$ system also changed significantly with $BaTiO_3$ content. It was found that the maximum dielectric and ferroelectric properties were exhibited in $BiFeO_3$-$BaTiO_3$ system at x = 0.25. This confirmed the