Materials Science

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Charge and Orbital order in $Bi_{1-x}Sr_xMnO_3$

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Introduction

$Bi_{1-x}Sr_xMnO_3$ crystallizes in the perovskite structure. The charge ordering phase transition temperature of this system (~ 600 K) is the highest among all the perovskite manganese oxides[1]. In order to investigate orbital and charge ordering in $Bi_{1-x}Sr_xMnO_3$, we grew large single crystals and measured synchrotron x-ray diffraction.

Results and Discussion

A single crystal of $Bi_{1-x}Sr_xMnO_3$ with x = 0.47 which we measured was grown from a Bi_2O_3 self-flux. Synchrotron x-ray diffraction measurements were performed using a 4-circle diffractometer on BL4C, Photon Factory.

We have measured x-ray diffraction around (2, 1, 0) and (2, 1.5, 0) in the reciprocal space at various temperatures. The modulation wave number q of superstructure was determined from diffraction profiles measured along $\boldsymbol{b}^*$ direction using a scintillation counter. Integrated intensities of the reflections were obtained from x-ray oscillation photographs recorded by a CCD camera. As shown in figure 1, superlattice reflections at (2, 1, 0) and (2, 2-q, 0) (q = 0.5) are observed below 483 K. These reflections are attributed to charge and orbital ordering, respectively [2]. Above 483 K, the (2, 1, 0) reflection originating from the charge ordering disappears. In addition, the q value decreases from 0.5 with increasing temperature. The commensurate-incommensurate transition in $Bi_{1-x}Sr_xMnO_3$ at the charge ordering temperature is in a sharp contrast to that in $Pr_{0.5}Ca_{0.5}MnO_3$[3,4], where the incommensurate commensurate transition occurs below the charge ordering transition temperature.

Figure 2 shows a resonant x-ray scattering spectrum at (0, 2-q, 0) T = 513 K. The super lattice reflection is only detected near Mn K-edge. This result indicates the Mn d-orbital ordering with the incommensurate wave number. This orbital ordering with no charge ordering can be expected as a formation of Zener polaron [5].

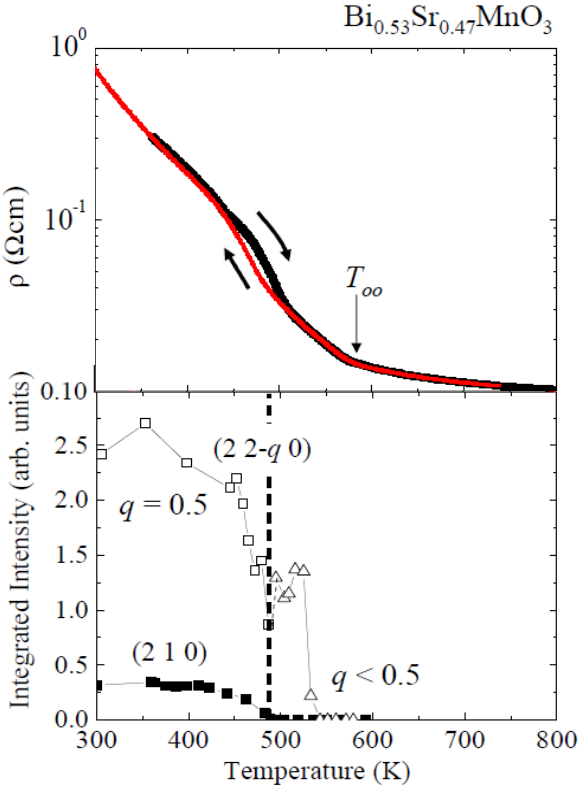

Figure 1. Temperature dependence of resistivity and integrated intensities of superlattice reflections.

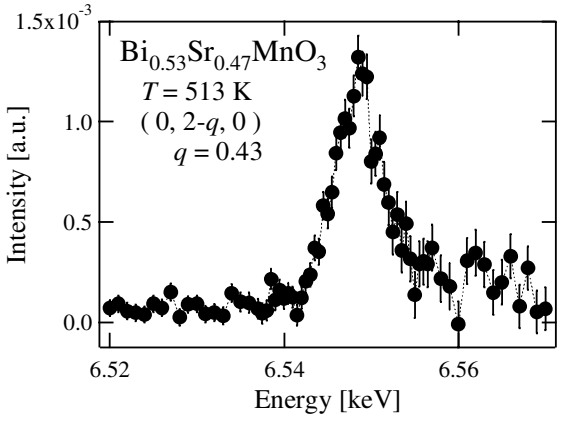

Figure 2. A resonant x-ray scattering spectrum at (0, 2-q, 0) near Mn K-edge.

References

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