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Magneto-Optical Effects and Electrical Resistivity of $\text{La}_{0.8-x}\text{Bi}_x\text{Sr}_{0.2}\text{MnO}_3$ Films

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Abstract. In $\text{La}_{0.8-x}\text{Bi}_x\text{Sr}_{0.2}\text{MnO}_3$ films ($x=0 \sim 0.3$) prepared by a laser deposition technique, Magneto-Circular Dichroism (MCD) spectra between 1.5 to 6 eV and temperature dependence of resistivity were investigated. In the films without Bi, three optical transitions between 3 and 5 eV in MCD spectra are confirmed by the fitting. The Bi-doping makes shift these three transitions to higher energy and induces a new transition which shifts to lower energy by increasing of doping content. These transitions are ascribed to the charge transfer transitions from O2p to Mn d (e_g).

1. INTRODUCTION

The LaMnO_3 is known as an antiferromagnetic insulator. Doping holes makes it a ferromagnetic metal and a structural phase transition from the orthorhombic to the rhombohedral structure take place [1]. The transition to the ferromagnetic metal is thought to be due to the double exchange interaction between Mn^{3+} and Mn^{4+} through the doped holes. It is known that by doping the Bismuth to this system the electrical resistivity and magneto-optical effect change [2], but the details is not clear. In this paper we report the MCD spectra and the resistivity of Bi-doped $\text{La}_{0.8}\text{Sr}_{0.2}\text{MnO}_3$ films by a laser deposition technique and discuss their structures.

2. RESULTS AND DISCUSSION

Figure 1 shows the temperature dependence of the electrical resistivity of $\text{La}_{0.8-x}\text{Bi}_x\text{Sr}_{0.2}\text{MnO}_3$ films ($x=0 \sim 0.3$). The resistivity of the films with $x=0$ shows the same temperature-dependence as reported for the bulk specimens [1]. The Curie temperature T_c from a magnetization measurements was nearly equal to the peak in the curve of Fig.1. Figure shows that the peak decreases with increase of Bi. These results shows that for a fixed temperature the metal-insulator transition occurs by Bi-doping. The transition is believed to arise from the increase of Mn-O-Mn bonding angle [3]. Figure 2 shows the MCD spectra at the temperature T of 20 K and in the applied field H of 10 kOe. These spectra have many peaks. Such magnetic contributions to the optical spectra may be attributed to the transitions related with 3d levels. The position of each peak did not change with temperatures below T_c . This figure shows that the energy of each peak systematically changes with Bi contents.

In order to estimate the energies of the electron transition, the fitting of spectra was tried. MCD spectrum of the film with $x=0$ was well reproduced by three dispersions with the centers at 3.1 eV, 3.9 eV and 4.7 eV, respectively. Figure 3 shows the dispersions obtained from fitting for the MCD spectrum of $x=0$ and their synthesizing

Fig. 1 Temperature dependence of the resistivity for films with various Bi contents x .

Fig. 2 MCD spectra of films with various Bi contents x at $T=20$ K and $H=10$ kOe.

Fig.4 Dispersions obtained from fitting for MCD spectrum of $x=0.1$ and their synthesizing curve. Measured MCD spectrum is also shown.

Fig.3 Dispersions obtained from fitting for MCD spectrum of $x=0$ and their synthesizing curve. Measured MCD spectrum is also shown.

Fig.5 Bi content dependence of the transition energy determined by the center of each dispersion fitting.

curve. We named these dispersions as dispersion I, II and III. For the film with Bi ($x \neq 0$), the spectra were well explained by four dispersions. Figure 4 shows the fitting results for $x=0.1$. The three dispersions, I, II and III shift to higher energy as increasing Bi content, but the new dispersion, IV shifts to lower energy. Figure 5 shows the Bi content dependence of the transition energy determined by the center of each dispersion fitting. These dispersions I, II and III may be ascribed to the charge transfer transition from O2p to Mn d (e_g), judging from the band structure of LaMnO_3 ⁴⁾ and $\text{La}_{1-x}\text{Ba}_x\text{MnO}_3$ ⁵⁾. Dispersion IV, which newly appears by Bi-doping and shifts to lower energy with increase of Bi content, is also considered as the charge transfer transition from O2p to Mn d (e_g). The shift to lower energy may be ascribed to the decrease of the band width due to the metal-insulator transition.

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