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Study on the electronic structure of $(R,Sr)CoO_3$ by means of high resolution photoemission spectroscopy

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Thermoelectric properties of cobalt oxides are recently attracting much attention. It was pointed out that the degeneracy of 3*d* electrons determines the Seebeck coefficient (S) if strong correlation is important for enhancing the thermopower, and S depends on the average valence and the spin state of cobalt. We studied the thermoelectric properties of $R_{1-x}Sr_xCoO_3$ (R=La, Pr, Nd, Sm) because a systematic study with varying the amount of carrier is easy and the spin state of Co^{3+} depends on R, at least for the Sr-undoped composition. It was found that S follows well the predication of the theory based on strong correlation for R=La when x is small. The carrier dependence of S was much stronger for R=Pr, Nd, and Sm, which suggests that the stability of the intermediate spin state of Co^{3+} increases with x. However, S deviated from the theoretical curve when Sr content was increased beyond x=0.05.

An alternative approach for understanding thermopower is based on the Fermi-liquid picture. The thermopower of a metal may be estimated using the Boltzmann equation on the base of the electronic structure. In the present work, therefore, we used high-resolution photoemission spectroscopy and x-ray absorption spectroscopy techniques to study the electronic structure of $R_{1-x}Sr_xCoO_3$, which has to be elucidated to be able to discuss the thermoelectric power based on the Fermi-liquid picture. We especially focused on the electronic structure near the Fermi energy (E_F) and employed the resonance technique to study the electronic structure that determines the electronic transport properties. Figure 1 shows the on- and off-resonance spectra measured near the Co 2*p*-3*d* core-absorption threshold at 300 K. It is obvious that the intensity of the whole valence band is enhanced for the on-resonance spectrum, indicating that the states originating from Co and O are well hybridized. However, the enhancement of the peak near E_F at about 1 eV is comparatively weaker than the states at higher binding energy, indicating that the states near E_F have a relatively stronger oxygen character. With Sr doping, the electronic structure shows an almost rigid shift toward E_F, but a slight broadening of the peak at around 1 eV was observed. A finite intensity at E_F was observed when x was increased, which is consistent with the metallic behavior of resistivity. We also measured the change of the electronic structure with substituting Pr or Nd for La. The R 3*d*-4*f* resonance spectroscopy revealed that the states originating from R 4*f* form a peak at about 1.2 eV and 2.5 eV in binding energy for R=Pr and Nd, respectively.

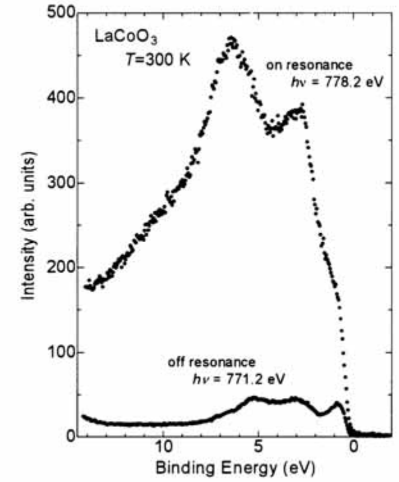

Fig. 1 The on- and off-resonance spectra of $LaCoO_3$ at 300 K.

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Exchange anisotropy of Mn-Pt/NiFe and Mn-Ir/NiFe exchange bias films

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Exchange biasing at a ferromagnetic/antiferromagnetic interface plays an important role in spin valve magnetic heads using giant magnetoresistance (GMR) or tunneling magnetoresistance (TMR) effects. Despite the technological importance of exchange biasing, its detailed mechanism is still unclear, but the magnetic properties at the ferromagnetic/antiferromagnetic interfaces are commonly believed to hold the key to the understanding the exchange coupling. XMCD measurements allow investigating the magnetism of exchange biased system element specifically. We have investigated the exchange anisotropy of NiFe/Mn-Pt and NiFe/Mn-Ir epitaxial bilayers with (001) orientation, and we found the difference of the induced in-plane anisotropy between NiFe/Mn-Pt and NiFe/Mn-Ir bilayers. NiFe/Mn-Pt bilayers have strong 4-fold anisotropy, although NiFe/Mn-Ir bilayers have a quite small[1)]. In this work, we have explored magnetism of Mn and Fe at the interfaces of NiFe/Mn-Pt and NiFe/Mn-Ir by XMCD spectra.

We measured XMCD spectra at Mn and Fe $L_{2,3}$ edges by switching a incident photon helicity at a rate of 1 Hz under a magnetic field applying perpendicular to the film plane. NiFe(3 nm)/$Mn_{100-x}Pt_x$(30 nm) (x=11, 14, 20) and NiFe(3 nm)/$Mn_{80}Ir_{20}$(30 nm) bilayers, of which antiferromagnetic layer was deposited prior to NiFe layer, were prepared by molecular-beam-epitaxy on MgO(001) substrates. From XRD measurements, NiFe, Mn-Pt and Mn-Ir were confirmed to have face-centered-cubic (fcc) structure.

Fig. 1 shows MCD spectra taken at Mn $L_{2,3}$ edges for NiFe/Mn-Pt and NiFe/Mn-Ir bilayers, where MCD intensities are normalized so that the L_3 edge jump of the absorption spectrum will become equal to 1. Although Mn-Pt and Mn-Ir are antiferromagnet which has no net magnetic moment for the bulk, the MCD spectra from uncompensated spins of Mn were clearly seen. This result indicates that Mn moments at the interface between NiFe and antiferromagnetic layer were ferromagnetically aligned because of the exchange coupling. For NiFe/Mn-Pt bilayers, the intensity of MCD at Mn $L_{2,3}$ edges increased with decreasing Mn content. From the torque measurements, the 4-fold anisotropy, which are induced by the exchange coupling between NiFe and Mn-Pt layers, is found to decrease with decreasing Mn content. This may be related to the dependence of MCD intensity on the Mn content in Mn-Pt.

Reference

1) T.Kume *et. al.*, J. Appl. Phys., **93**(10),6599

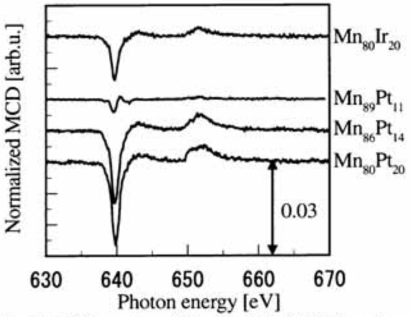

Fig.1 MCD spectra of Mn for Mn-Pt/NiFe and Mn-Ir/NiFe exchange bilayers