Effects of Li-doping on Room-Temperature Ferromagnetic Oxide Thin Films Studied by PES and XAS

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Diluted magnetic semiconductors (DMS) have been extensively investigated in the last decade due to their potential application for the novel magneto-opto-electronics devices.[1] The spintronic materials should have high Curie temperatures, high spin polarization of the charge carriers. There has been considerable recent interest in the design of high Curie temperature DMS with a particular focus on the oxide-based DMS doped with transition metal ions.

We fabricated Li and Mn co-doped NiO (LNMO) thin films ($Li_xNi_{0.98-x}Mn_{0.03}O$, x=0, 0.04, 0.10, 0.20, denoted by LNMO-0, -1, -2, -3) were obtained by a sol-gel spin-coating method on silicon substrates, and measured the core-level photoemission (PES), x-ray absorption (XAS) and resonant photoemission (RPES) spectra in the valence band region at room temperature.

Figure 1 shows the oxygen *K*-edge X-ray absorption spectra of LNMO thin films. The prepeak at ~532 eV can be identified as due to a transition from the O 1*s* state to the empty $3d^9$ state of NiO.[2] In the LNMO-3 sample, there is a new structure ~529.2 eV appeared.

As shown in Fig. 2, the Ni 2*p* core-level photoemission spectra consists of $2p_{3/2}$ and $2p_{1/2}$ main lines and corresponding satellites. The satellite- main-peak structure in the Ni 2*p* spectra is a result of the presence of both the $2p^53d^8$ and

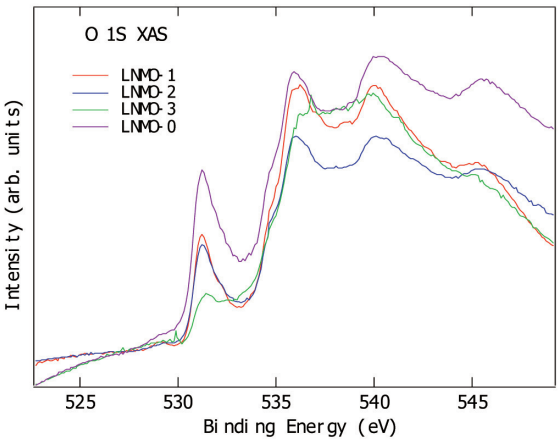

Fig. 1 Oxygen *K*-edge XAS spectra of LNMO thin films

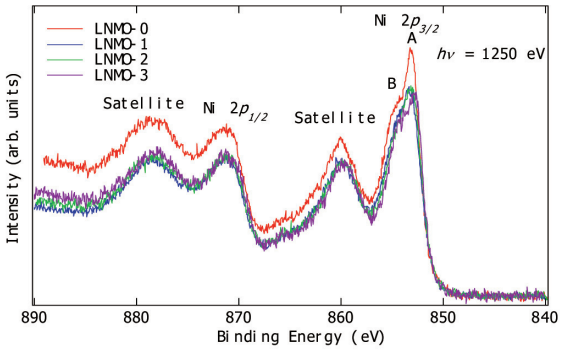

Fig. 2 Ni 2*p* core-level PES of various LNMO films.

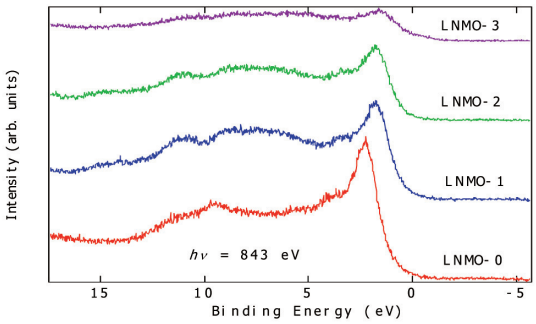

Fig. 3 Valence-band RPES spectra of LNMO films

$2p^5 3d^9\underline{L}$ configuration in the ground state and the final-state charge transfer.[3] With increasing Li concentration, the double-peak structure disappeared, which may be related to defects induced by Li doping and the variation of carrier concentration.

It can be seen that the general shape of the spectra does not change much with Li doping. However, a shift to smaller binding energy of the order of 0.44 eV was observed in going from the undoped to the doped samples, and the further doping have little influence on the peak position.

Refs

[1] H. Ohno, Science, **281**, 951 (1998).

[2] P. Kuiper, et al. Phys. Rev. Lett. **62**, 221 (1989).

[3] S. Hüfner, Adv. Phys. **43**, 183 (1994).