Electronic structure of $La_{0.7}Ce_{0.3}MnO_3$ thin film

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The hole doped manganese oxides of $R_{1-x}A_xMnO_3$ (R = rare-earth cation, A = alkaline earth cation) have generated wide interest for the colossal magnetoresistance (CMR) and their rich phase diagrams arising from the interplay of spin, charge, and orbital degrees of freedom. In these systems, Mn ions can exist in the mixed-valent states, and the double exchange (DE) between spin-aligned Mn^{3+} (t_{2g}^3 e_g^1) and Mn^{4+} (t_{2g}^3) ions through oxygen ions gives rise to metallic conductivity and ferromagnetism below T_C. Recently the metal-insulator (M-I) and ferromagnetic transition and the CMR phenomenon have also been observed in the Ce-doped manganites of $La_{1-x}Ce_xMnO_3$ (LCeMO) [1], where Ce ions are expected to be tetravalent. Then, unlike the hole-doped manganites, electron doping will drive the system to have the mixed-valent Mn^{3+} and Mn^{2+} ions. Experimentally it is crucial to measure LCeMO thin films because the LCeMO forms in the single phase only in the epitaxial thin films. Interestingly the Mn^{2+} -Mn^{3+} mixed-valent state was observed in LCeMO thin films [2]. However, the detailed spectroscopic information on the electronic states at the Fermi energy is lacking for LCeMO, which is important in understanding the underlying physics properly.

In this paper, we have investigated the electronic structure of the epitaxial thin film of LCeMO, using resonant photoemission spectroscopy (RPES) and x-ray absorption spectroscopy (XAS). A very weak Ce 4f resonance is observed in the Ce 4d→4f RPES and the Ce 3d core-level PES and 3d XAS spectra are very similar to those of CeO_2, indicating that Ce ions in LCeMO are nearly tetravalent. The Mn 2p XAS spectrum reveals the existence of divalent Mn^{2+} ions, suggesting the Mn^{2+} and Mn^{3+} mixed-valent states of Mn ions in LCeMO. It is found that the experimental Mn 3d PES and O 1s XAS spectra for LCeMO agree well with the calculated Mn 3d PDOS (partial density of states) obtained in the LSDA+U calculation (U: the Coulomb correlation parameter).

References

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