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Photoemission study of $Zn_{1-x}Co_xO$ as a possible DMS

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Spintronics, which utilizes both the spin and charge degrees of freedom, has become an important field in magnetism. Due to the recent theoretical prediction of possible candidates for diluted magnetic semiconductor (DMS) materials by Dietl et al. [1], Co-doped ZnO system has attracted much attention. There were reports that $Zn_{1-x}Co_xO$ epitaxial thin films exhibited ferromagnetic properties [2,3].

In order to understand the role of the electronic structures in determining the magnetic properties of DMS materials, we have investigated the electronic structures of bulk $Zn_{1-x}Co_xO$ samples using photoemission spectroscopy (PES) and x-ray absorption spectroscopy (XAS). Polycrystalline $Zn_{1-x}Co_xO$ samples ($x \leq 0.2$) were synthesized using the standard solid-state reaction method. The x-ray diffraction (XRD) analysis showed that the samples have the Wurtzite structure with no impurity phases. Magnetic properties of our bulk samples revealed the antiferromagnetic coupling in the Co-Co magnetic interaction [4]. The Co 2p $\rightarrow$ 3d resonant photoemission spectroscopy (RPES) measurements for $Zn_{1-x}Co_xO$ (x=0, 0.1) show that the Co 3d states in $Zn_{1-x}Co_xO$ lie near the top of the O 2p valence band, with a peak around ~3eV binding energy. The measured Co 2p XAS spectrum shows that the Co ions in $Zn_{1-x}Co_xO$ are in the divalent Co^{2+} (d7) states under the tetrahedral symmetry with a small crystal field energy. Our finding indicates that the properly substituted Co ions for Zn sites in $Zn_{1-x}Co_xO$ will not produce the diluted ferromagnetic semiconductor property.

References

[1] T. Dietl. H. Ohno, F. Matsukura, J. Cibert, and D. Ferrand, Science **287**, 1019 (2000).
[2] T. Fukumura, Z. Jin, A. Ohtomo, H. Koinuma, M. Kawasaki, Appl. Phys. Lett. 75, 3366 (1999).
[3] S. W. Jung, S.-J. An, G. C. Yi, C. U. Jung, S. I. Lee, and S. Cho, Appl. Phys. Lett. 80, 4561 (2002).
[4] S. W. Yoon, S.-B. Cho, S. C. Wi, S. Yoon, B. J. Suh, H. K. Song, and Y. J. Shin, J. Appl. Phys. 93, 7879 (2003).