52ND ANNUAL CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS

NOVEMBER 5-9, 2007
TAMPA, FLORIDA

ABSTRACTS

EU-12. Synchrotron radiation spectroscopy study of spinel $FeCr_2X_4$ (X=S, Se). *J. Kang*[1,2], H.J. Lee[1], G. Kim[1], H.S. Kim[1], D.H. Kim[1], S.W. Han[2], S.J. Kim[3], C.S. Kim[3], H.G. Lee[4], J.Y. Kim[4] and B.I. Min[5]*1. Physics, The Catholic University of Korea, Bucheon, South Korea; 2. CSCMR, Seoul National University, Seoul, South Korea; 3. Physics, Kookmin University, Seoul, South Korea; 4. PAL, POSTECH, Pohang, South Korea; 5. Physics, POSTECH, Pohang, South Korea*

The observation of the very large negative magneto-resistance (MR) and the metal-insulator (MI) transition in $FeCr_2S_4$ has invoked much interest in spinel chalcogenides [1]. Rather different magnetic properties have been reported for $FeCr_2S_4$ and $FeCr_2Se_4$: $FeCr_2S_4$ exhibits a ferromagnetic transition at $T_C \approx 172$ K (T_C: a Curie temperature) [1], while $FeCr_2Se_4$ exhibits an anti-ferromagnetic transition at $T_N \approx 218$ K (T_N: a Neel temperature) [2]. In order to understand the origin of their magnetic properties of $FeCr_2X_4$ (X=S, Se), it is important to understand their electronic structures. In this work, we have investigated the electronic structures of $FeCr_2X_4$ (X=S, Se) and the valence states of Fe and Cr ions by using synchrotron-radiation excited spectroscopies, such as soft x-ray absorption spectroscopy (XAS), photoemission spectroscopy (PES), and soft x-ray magnetic circular dichroism (XMCD). The measured T 2p XAS spectra show that Cr ions are nearly trivalent (Cr^{3+}) and that Fe ions are close to divalent (Fe^{2+}), respectively. Interestingly, the Fe 2p XAS spectra of $FeCr_2X_4$ (X=S, Se) are different from those of divalent oxides, but very similar to that of Fe metal, implying the metallic-like bonding of Fe 3d electrons. The T 2p XMCD spectra (T=Fe, Cr), obtained at low temperature (T), provide evidence that the magnetic moments of Cr and Fe ions are aligned antiparallel to each other, and the T-dependent 2p XMCD measurements reveal interesting behavior. Valence-band PES study suggests the importance of the hybridization between the Fe 3d and X p states (X=S, Se).

[1] A. P. Ramirez, et al., Nature 386, 156 (1997). [2] J. H. Kang, et al., J. Appl. Phys. 99, 08F714 (2006).