TF-P018

X-ray Absorption and Emission Study of Co-doped ZnO Thin Films

K. H. Chae[1], S. Gautam[1], J. H. Song[1], M. Subramanian[2], R.Jayavel[2], K. Asokan[3]

[1]KIST, [2]Anna University, [3]Aruna Asaf Ali Marg

The electronic structures of Co-doped ZnO thin films, a dilute magnetic semiconductor (DMS) having possible room temperature ferromagnetism, synthesized with nominal compositions of $Zn_{1-x}Co_xO$ (x = 0.03, 0.05, 0.07, 0.10, and 0.15) by sol-gel method are investigated by using soft x-ray absorption and emission spectroscopy. Structural studies by high flux x-ray diffraction suggest that the doped Co ions occupies the regular Zn sites and all these samples exhibit wurtzite crystal structure similar to that of the parent compound, ZnO. To understand the electronic structure, the near edge x-ray absorption fine structure (NEXAFS) measurement at O *K* has been carried out by using synchrotron beamline at Pohang Light Source and resonant inelastic x-ray scattering (RIXS) measurement at Co $L_{2,3}$ by using synchrotron beamline at Advanced Light Source. The intensity of pre-edge spectral feature at O *K*-edge increases with Co concentration, which clearly reveals that there is a strong hybridization of Co atoms in ZnO matrix. Spectral features of Co $L_{3,2}$-edges NEXAFS measurements exhibit multiple absorption peaks and are similar to those of Co^{2+} ions coordinated in tetrahedral symmetry by four oxygen atoms. Moreover, the observed spectra are similar to atomic multiplet configuration interaction calculations, confirming that Co occurs in the Co^{2+} state in a tetrahedral crystal field. These results clearly demonstrate that Co is in 2+ state substituting at Zn site in ZnO matrix. Co $L_{2,3}$ RIXS measurements show that the excess Co interstitials appeared in the sample and direct exchange interactions with substitutional Co atoms can explain the magnetic interaction in Co doped ZnO. The doping level also appears to play a crucial role for obtaining highly ferromagnetic Co-ZnO films.