Electron-spin-resonance Study of Polycrystalline $Zn_{1-x}Fe_xO$

P. Zhang, T. L. Phan and S. C. Yu*
Department of Physics, Chungbuk National University, Cheongju 361-763, South Korea
*Corresponding author Email: scyu@chungbuk.ac.kr

Dilute magnetic semiconductor (DMS), which can be generated from nonmagnetic semiconductors doped with tiny amount transition metals (such as Cr, Mn, and Fe), sometimes exhibits interesting new properties which the original semiconductor does not perform. As one of the most wide studied semiconductor, pure zinc oxide (ZnO) exhibits many novel optical and electrical properties at room temperature due to the certain band-gap (E_g = 3.37 eV). The doping of transition metals into ZnO can lead to more interesting transport and magnetic properties. This typical dilute magnetic semiconductor is a promising candidate for applications in multi-functional spintronics devices. Therefore, the physical nature of this material system needs to be further studied.

In this work, Electron spin resonance (ESR) was used to study the influence of different doping amount of Fe in ZnO on spin behaviors. The samples of $Zn_{1-x}Fe_xO$ (with x = 0.01-0.3) were prepared by conventional solid reaction method, using fine commercial powders of ZnO(99.9%), Fe_2O_3(99.9%) as precursors. Stoichiometric amounts of these powders were mixed, ground, and calcinated in air at 500℃ for 8 hrs. Then pressed into pellets and sintered at 900℃ for 24 hrs. The final products were ground into powder shape for ESR sample to avoid of anisotropy. The ESR measurement were carried out at 9.45GHz(X-band) using a JEOL-TE300 ESR spectrometer and in the magnetic field range of 0 - 1.0 Tesla.

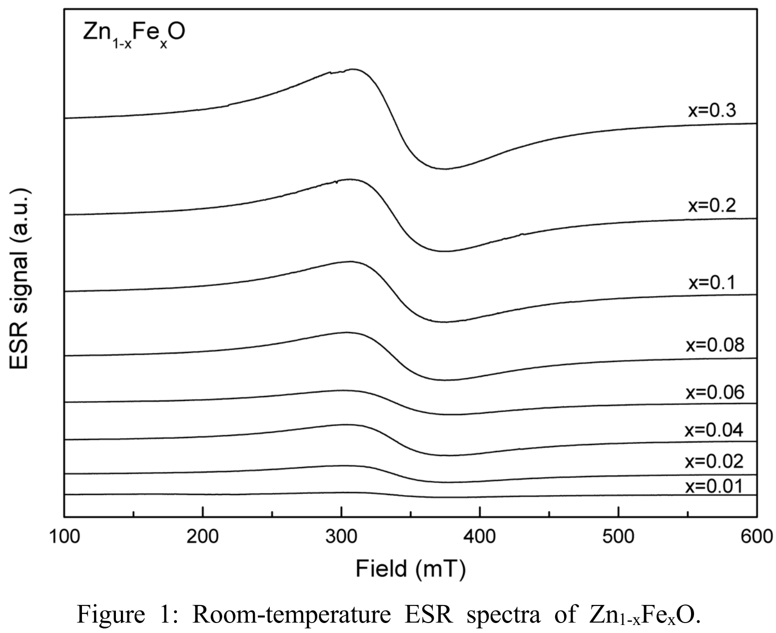

Figure 1: Room-temperature ESR spectra of $Zn_{1-x}Fe_xO$.

It is clear to see from the figure 1 that the feature of ESR signal depends strongly on the Fe content in $Zn_{1-x}Fe_xO$. Every sample gives a symmetric Lorentzian single line at around H_r = 340 mT, corresponding to the effective Lande g factor of about 2.0. This indicates the spin-spin interaction of electrons of Fe ions playing an important role. With increasing the Fe content in $Zn_{1-x}Fe_xO$, the ESR intensity increases, which implies Fe ions incorporated into the Zn site of the ZnO host lattice, and they are considered as paramagnetic centers. According to the ESR study on Mn-doped ZnO ceramic materials[1], the hyperfine line emerges around the resonant field. But in this closely Fe-doped ZnO study, only single broad line exhibited in the ESR spectra, no hyperfine line was found. The combination of x-ray diffraction (XRD) analyses allows us to explain the above ESR data in detail.

References

[1] T.L. Phan, Solid State Commun. **144** (2007), 134-137.