An Co^{2+} EPR study of two types of $Zn_{1-x}Co_xO$ nanoparticles prepared by chemical hydrolysis in diethylene glycol and denaturated alcohol

S.K. Misra[1], S. I. Andronenko[1,2*],S. Srinivasa Rao[3], A. Punnoose[3]
[1] *Physics Department, Concordia University, Montreal, Canada*
[2] *Institute of Physics, Kazan Federal University, Kazan, Russia*
[3]*Department of Physics, Boise State University, Boise, USA*
*sergey.andronenko@gmail.com

An X-band EPR study of two types of ZnO nanoparticles doped with Co^{2+} ions, was carried out at 5 K. Both EPR of localized Co^{2+} ions and FMR lines observed in $Zn_{1-x}Co_xO$ nanoparticles. EPR spectra depends on synthesis conditions and surface morphology of nanoparticles.

EPR investigations, on two types of ZnO nanoparticles, doped with 0.5 – 10 % Co^{2+}, prepared using chemical hydrolysis methods: (i) in diethylene glycol $(CH_2CH_2OH)_2O$) (NC-rod-like samples), and (ii) in denatured ethanol (CH_3CH_2OH) solutions (QC-spherical samples), were carried out at X-band (9.5 GHz) at 5 K. The Fe^{3+} EPR study of these two types of ZnO nanoparticles was fulfilled recently and showed different EPR spectra depending on different solvents used in synthesis. To analyze EPR experimental spectra, they were simulated to study the properties of Co ions at various magnetic sites. The simulations for NC samples revealed that the presence of EPR lines due to: (i) Co^{2+} ions, substituting for Zn^{2+} ions, exhibiting axial Co^{2+} EPR spectrum in crystalline ZnO; (ii) paramagnetic ions in the samples with Co concentration > 0.5% and < 5% (weak signals); (iii) surface oxygen defects. In addition, there were present FMR (ferromagnetic resonance) lines. QC samples exhibit an intense FMR line and an EPR line due to high-spin Co^{2+} ions. FMR line is more intense, than the corresponding line exhibited by NC samples. The EPR spectra varied for sample with different doping concentration and synthesis conditions, in particular, with different solvents. The observed EPR spectra provide clear evidence for the presence of both paramagnetic Co^{2+} ions exhibiting sharp lines, and ferromagnetically coupled ions, exhibiting very broad FMR lines. The study of magnetization proves this conclusion convincingly: there are paramagnetic and ferromagnetic (superparamagnetic) parts of magnetization of ZnO nanoparticles, doped with Co. The magnetic states of these samples as revealed by EPR spectra, as well as the origin of ferromagnetism DMS and the influence of surface morphology on magnetic properties of $Zn_{1-x}Co_xO$ are discussed.

Reference:

1. S.K. Misra, S.I. Andronenko, A. Thurber, A. Punnoose, A. Nalepa, An X- and Q-band Fe^{3+} EPR Study of Nanoparticles of Magnetic Semiconductor $Zn_{1-x}Fe_xO$, JMMM, 2014, Vol. 363, pp. 82-87.