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Absence of room temperature ferromagnetism in transition metal doped ZnO nanocrystalline powders from PAC spectroscopy

An extensive research efforts have been carried out worldwide on searching for room temperature ferromagnetism in transition metal doped ZnO, especially in Mn- and Co-doped ZnO, for its potential use in future spintronic devices. However, the results are not consistent: some studies reported observation of room-temperature ferromagnetism in Mn- and Co-doped ZnO whereas others reported absence of ferromagnetism. The effect of Cu co-doping, a possible pathway for inducing ferromagnetism has also been observed in transition-metal-doped ZnO. It is therefore still questionable whether transition metal doped ZnO is really a ferromagnetic at room temperature!
In the present work, the local structural and electronic environment around 111In probe atoms in pure ZnO, transition metal doped Zn1-xTxO (T=Mn and Co; x=0.01, 0.02, 0.05) and Cu co-doped Zn1-xCoxCu0.01O (x=0.01-0.04) nanocrystalline powders have been monitored on an atomic scale by a perturbed angular correlation (PAC) spectroscopy. For these measurements, the single phase nanocrystalline powders were synthesized at low annealing temperature by sol-gel Pechini method. Phase purity and structure refinement done by means of the Rietveld analysis technique showed that the dopants substitute properly into Zn cation sites. The PAC measurements (Figure 1) exhibited the well known oscillations corresponding to the electric quadrupole interaction only (nu_Q˜31 MHz) which have been attributed to the substitutional incorporation of the 111In probe atoms at the cation sites of ZnO lattice. The present measurements did not reveal any evidence of magnetic ordering down to 77K in pure or doped ZnO nanocrystalline powders. These results are consistent with the recent observation of paramagnetic behavior in transition metal doped ZnO with synchrotron based studies [1,2].

[1] A. Ney, et al., Phys. Rev. Lett. 100, 157201 (2008).
[2] N R S Farley, et al., New Journal of Physics 10, 055012 (2008).

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