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A Comparison between TM: TM Co Doped and TM: RE Co Doped ZnO Based Advanced Materials for Spintronics Applications; Structural, Optical and Magnetic Property Analysis

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Abstract : Owing to the industrial and technological importance, transition metal (TM) doped ZnO has been widely chosen for many practical applications in electronics and optoelectronics. Besides, though still a controversial issue, the reported room temperature ferromagnetism in transition metal doped ZnO has added a feather to its excellence and importance in current semiconductor research for prospective application in Spintronics. Anticipating non controversial and improved optical and magnetic properties, we adopted co doping method to synthesise polycrystalline Mn:TM (Fe,Ni) and Mn:RE(Gd,Sm) co doped ZnO samples by solid state sintering route with compositions Zn1-x (Mn:Fe/Ni)xO and Zn1-x(Mn:Gd/Sm)xO and sintered at two different temperatures. The structure, composition and optical changes induced in ZnO due to co doping and sintering were investigated by XRD, FTIR, UV, PL and ESR studies. X-ray peak profile analysis (XPPA) and Williamson-Hall analysis carried out shows changes in the values of stress, strain, FWHM and the crystallite size in both the co doped systems. FTIR spectra also show the effect of both type of co doping on the stretching and bending bonds of ZnO compound. UV-Vis study demonstrates changes in the absorption band edge as well as the significant change in the optical band gap due to exchange interactions inside the system after co doping. PL studies reveal effect of co doping on UV and visible emission bands in the co doped systems at two different sintering temperatures, indicating the existence of defects in the form of oxygen vacancies. While the TM: TM co doped samples of ZnO exhibit ferromagnetism at room temperature, the TM: RE co doped samples show paramagnetic behaviour. The magnetic behaviours observed are supported by results from Electron Spin resonance (ESR) study; which shows sharp resonance peaks with considerable line width (ΔH) and g values more than 2. Such values are usually found due to the presence of an internal field inside the system giving rise to the shift of resonance field towards the lower field. The g values in this range are assigned to the unpaired electrons trapped in oxygen vacancies. TM: TM co doped ZnO samples exhibit low field absorption peaks in their ESR spectra, which is a new interesting observation. We emphasize that the interesting observations reported in this paper may be considered for the improved futuristic applications of ZnO based materials.

Keywords : co-doping, electro spin resonance, microwave absorption, spintronics
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