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Room temperature ferromagnetism and gas sensing in ZnOnanostructures: Influence of intrinsic defects and Mn, Co, Cu doping

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Abstract

Undoped and transition metal (Cu, Co and Mn) doped ZnO nanostructures were successfully prepared via a microwave-assisted hydrothermal method followed by annealing at 500 °C. Numerous characterization facilities such as X-ray powder diffraction (XRD), field emission scanning electron microscopy (FESEM), and high-resolution transmission electron microscopy (HRTEM) were employed to acquire the structural and morphological information of the prepared ZnO based products. Combination of defect structure analysis based on photoluminescence (PL) and electron paramagnetic resonance (EPR) indicated that co-existing oxygen vacancies (V(subO)) and zinc interstitials (Zni) defects are responsible for the observed ferromagnetism in undoped and transition metal (TM) doped ZnO systems. PL analysis demonstrated that undoped ZnO has more donor defects (V(subO) and Zn(subi)) which are beneficial for gas response enhancement. Undoped ZnO based sensor exhibited a higher sensor response to NH(sub3) gas compared to its counterparts owing to high content of donor defects while transition metal doped sensors showed short response and recovery times compared to undoped ZnO.