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Defect-induced magnetism in undoped and Mn-doped wide band gapzinc oxide grown by aerosol spray pyrolysis

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Abstract

We present a systemic study on the structural, optical and magnetic properties of the un-doped andMn doped ZnO thin films grown by aerosol spray pyrolysis at different deposition times. XRD profilinghas shown that the structures of the prepared products are wurtzite without any evidence of secondphases. Surface morphology analysis revealed that incorporation of Mn in the ZnO matrix results inthe formation of “doughnut-like” structures while the corresponding un-doped ZnO showed permeablestructures only at long deposition time. Optical results demonstrated that Mn-doped ZnO nanostructuresexhibited both the characteristic orange Mn2+ion-related emission at 595 nm and a shoulder around667 nm, denoting that the Mn ions have successfully occupied lattice positions of Zn ions. The chemicalcomposition and charge states of the Mn ions in the doped ZnO nanostructures analysed by the EDX andXPS, also confirmed that Mn2+ions were successfully incorporated onto zinc sites in the ZnO host crystal.With the combination of defect analysis based on PL and XPS, the effect of defects on the nature andorigin of ferromagnetism through EPR was investigated. These findings suggested that zinc and oxygendefects, especially zinc interstitials and singly ionized oxygen vacancies, play a crucial role in mediatingferromagnetism in the undoped ZnO.