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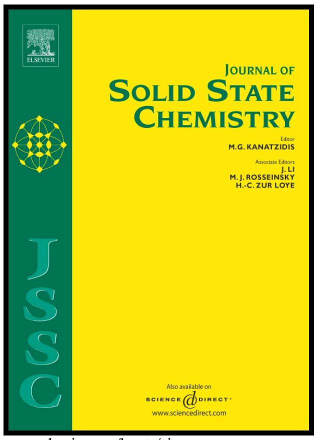

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Understanding lattice defects to influence ferromagnetic order of ZnO nanoparticles by Ni, Cu, Ce ions

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Abstract

Future spintronics technologies based on diluted magnetic semiconductors (DMS) will rely heavily on a sound understanding of the microscopic origins of ferromagnetism in such materials. It remains unclear, however, whether the ferromagnetism in DMS is intrinsic - a precondition for spintronics - or due to dopant clustering. For this, we include a simultaneous doping from transition metal (Ni, Cu) and rare earth (Ce) ions in ZnO nanoparticles that increase the antiferromagnetic ordering to achieve high-T_c ferromagnetism. Rietveld refinement of XRD patterns indicate that the dopant ions in ZnO had a wurtzite structure and the dopants, Ni^{2+}, Cu^{2+}, Ce^{3+} ions, are highly influenced the lattice constants to induce lattice defects. The Ni, Cu, Ce ions in ZnO have nanoparticles formation than nanorods was observed in pure sample. FTIR involve some organic groups to induce lattice defects and the metal-oxygen bonding of Zn, Ni, Cu, Ce and O atoms to confirm wurtzite structure. Raman analysis evaluates the crystalline quality, structural disorder and defects in ZnO lattice with doping. Photoluminescence spectra have strong near-band-edge emission and visible emission bands responsible for defects due to oxygen vacancies. The energy band gap is calculated using Tauc relation. Room temperature ferromagnetism has been described due to bound magnetic polarons formation with Ni^{2+}, Cu^{2+}, Ce^{3+} ions in ZnO via oxygen vacancies. The zero field and field cooling SQUID measurement confirm the strength of antiferromagnetism in ZnO. The field cooling magnetization is studied by Curie-Weiss law that include antiferromagnetic interactions up to low temperature. The XPS spectra have involve +3/+4 oxidation states of Ce ions to influence the observed ferromagnetism.

Keywords: A. magnetically ordered materials; B. chemical synthesis; C. vacancy formation

1. Introduction

Recently, the realization of spin in diluted magnetic semiconductors (DMS), semiconductor with substituted magnetic impurities (Fe, Co, Ni, Cu) has attracted great interest in the design of spintronics devices like spin field-effect transistors, non-volatile memory devices, and programmable logic gates [1-4]. In order to produce DMS in devices, a relatively high concentration of magnetic elements is needed in the semiconductor host, and a

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