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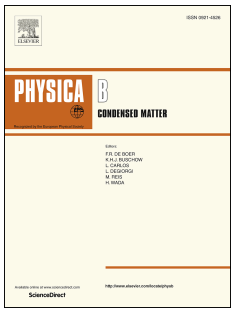

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Influence of Antimony doping on the electronic, optical and luminescent properties of ZnO microrods

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Abstract

We synthesized Sb-doped ZnO (ZnO:Sb) microrods with varying Sb content and carried out a systematic study on their structural, optical and photoluminescent properties. Scanning electron microscopy revealed a hexagonal morphology of the as grown microrods, while the x-ray photoelectron spectroscopy (XPS) and Ultra Violet-Visible spectroscopy results indicated the incorporation of Sb dopants into the ZnO lattice. XPS and x-ray diffraction analysis revealed that all ZnO:Sb microrods with different Sb doping possessed typical wurtzite structure and had no other impurity phases. Furthermore, the XPS results showed that Sb ions are in an oxidation state between 3+ and 5+, indicating the existence of an acceptor complex in the ZnO:Sb microrods. In addition, another deep acceptor originated form 2+ oxygen vacancies was identified. Photoluminescence (PL) measurements confirmed the formation of the (Sb_{Zn}-$2V_{Zn}$) shallow acceptor states in the ZnO:Sb microrods. PL measurements at low temperature showed strong violet luminescence, which is originated from free-electron to acceptor level (FA) transitions. The FA emission showed a slight blue shift with the increase of the temperature. As a result of Sb incorporation into the ZnO lattice, we observed a red shift in the ZnO:Sb nanowires' energy gap with the increase of Sb doping. This red shift is attributed to the formation of acceptor levels inside the ZnO band gap. The identification of this acceptor level in these homogeneous single-phase ZnO:Sb microrods provides strong promise of p-type conductivity of ZnO by Sb doping.

Keywords: ZnO, Sb doped ZnO, XPS spectroscopy, photoluminescence (PL), acceptor complex, energy gap, red shift, p-type conductivity.