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Structure and optical properties of undoped and Mn-doped ZnO(1-x)Sx nano powders prepared by precipitation method

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1. Introduction

With a wide band gap of 3.4 eV and a large exciton binding energy of 60 meV at room temperature, ZnO is attractive for blue and ultra-violet optoelectronic devices, and transparent conducting oxide films for photovoltaic applications. The large excitonic binding energies of ZnO and ZnS could enable efficient excitonic emission at temperatures well above room temperature and therefore lower threshold intensities for optoelectronic devices based on these semiconductors can be expected. Alloying ZnO by incorporating equivalent anions has not been extensively studied. Anion doping in ZnO, i.e., replacing oxygen by sulphur e.g. ZnO(1-x)Sx (ZnOS), has been reported recently [1, 2]. Due to the large electronegativity differences between O and S it would be expected that the bowing parameters of ZnOS are large. The change of anions in ZnO by isoelectronic impurities is important from the viewpoint of band gap engineering. In this work, high-quality undoped and Mn-doped ZnOS nano powders were prepared by the precipitation method.

1. Results

Figure 1 shows the typical XRD pattern of the obtained product. All the strong peaks in this pattern can be readily indexed to hexagonal wurtzite ZnOS structures. ZnOS alloys with a wurtzite structure were achieved for small content of sulphur and no evident phase separation was observed in the investigated composition range as determined by X-ray diffraction. Scanning electron microscopy observations showed the presence of nano-crystallites that decrease in size with Mn-doping. The optical absorption measurements show strong excitonic peak emission without any defect emission in the visible spectrum. The absorption edges of the nano powders shift towards low-energy side with increasing the Mn-dopant content. The presence of the Mn dopant diminishes the excitonic emission. The bandgap energies of the ZnOS nano particles were calculated and found to change from 4.0 to 4.2 eV, showing a nonlinear variation with a bowing behavior that was previously reported. The photoluminescence emission spectra of ZnOS nanoparticles gives four bands centering at about 548 nm, 614 nm, 649 nm and 670 nm, wavelengths. Similar to observations, It has been reported that the dopants of S, Mn can shift the luminescence position of ZnOS nanocrystals.

Are you currently a postgraduate student? (Yes/No)

No

At what level of studies are you currently? (Hons/MSc/PhD)

N/A

Please provide the name and email address of your supervisor.

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