Low temperature photoluminiscence in $ZnS:Mn^{2+}$ nanoparticles

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Abstract

Nanosized inorganic semiconducting materials such as ZnS have elicited recently a great interest for research due to their chemical and physical properties, which differ from those of bulk materials. These important inorganic materials have been studied for a variety of potential applications including photoconductors, solar cells, photoconductors, solar cells, field effect transistors, etc. When doped with transition metal ions, ZnS can become an efficient light emitting material. In this work, the nanocrystalline solid solution $Zn_{(1-x)}Mn_xS$ ($0.010 \le x \le 0.20$) was synthesized by a soft chemistry method. The average size of the luminescent nanoparticles is in the range of the 3-5 nm. A pure single phase with cubic blenda structure was confirmed from X-ray powder diffraction patterns. The UV-visible diffuse reflectance spectra were used to calculate the band gap energy across the compositional series at room temperature. This band gap value decreased from 3.58 eV (for ZnS) to 3.24 eV for $Zn_{0.80}Mn_{0.20}S$. The samples with manganese content between 0.05 and 0.15 showed the photoluminescence effect when they were illuminated with ultraviolet light. We found that the fluorescence intensity showed a maximum for a manganese content of x=0.10. In adition, we will present the photoluminescence behavior as a function of the temperature in the range of 10 K to room temperature. The orange emission from the $^4T_1$-$^6A_1$ transition of Mn^{2+} ions were observed in the Mn-doped samples. It was found that all of these emission bands decrease as temperature increases. The activation energies were estimated for the Mn-orange emissions.