Optical properties of Mn-doped ZnS semiconductor nanoclusters synthesized by a hydrothermal process

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Abstract: Undoped and Mn-doped ZnS nanoclusters have been synthesized by a hydrothermal approach. Various samples of the ZnS:Mn with 0.5, 1, 3, 10 and 20 at.% Mn dopant have been prepared and characterized using X-ray diffraction, energy-dispersive analysis of X-ray, high resolution electron microscopy, UV-vis diffusion reflection, photoluminescence (PL) and photoluminescence excitation (PLE) measurements. All the prepared ZnS nanoclusters possess cubic sphalerite crystal structure with lattice constant a = 5.408 ± 0.011 . The PL spectra of Mn-doped ZnS nanoclusters at room temperature exhibit both the 495 nm blue defect-related emission and the 587 nm orange Mn^{2+} emission. Furthermore, the blue emission is dominant at low temperatures; meanwhile the orange emission is dominant at room temperature. The Mn^{2+} ion-related PL can be excited both at energies near the band-edge of ZnS host (the UV region) and at energies corresponding to the Mn^{2+} ion own excited states (the visible region). An energy schema for the Mn-doped ZnS nanoclusters is proposed to interpret the photoluminescence behaviour.

Author Keywords: Hydrothermal method; Mn-doped ZnS; Nanocluster; Optical properties
Index Keywords: Band edge; Blue emission; Defect-related emission; Energy dispersive analysis; Hydrothermal methods; Hydrothermal process; Low temperatures; Mn-doped; Orange emissions; Photoluminescence excitation; PL spectra; Room temperature; Semiconductor nanoclusters; UV region; Visible region; Crystal structure; Doping (additives); High resolution electron microscopy; Nanoclusters; Optical properties; Photoluminescence; X ray diffraction; X ray diffraction analysis; Zinc sulfide; Manganese

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