Low-Temperature Growth of Nanocrystalline Mn-Doped ZnS Thin Films Prepared by Chemical Bath Deposition and Optical Properties

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Abstract

ZnS:Mn thin films were deposited on quartz, Si (polycrystalline), and glass substrates using a chemical bath deposition (CBD) method in an aqueous solution containing ethylene diamine tetra acetic acid disodium salt (Na2EDTA) as the complexing agent for zinc ions and thioacetamide (TAA) as the sulfide source at temperatures ranging from 50 to 80 °C. ZnS:Mn thin films with thicknesses ranging from 60 to 450 nm were synthesized at various Mn2+/Zn2+ molar ratios ranging from 1 to 4. The effects of the process parameters on the properties of ZnS:Mn films were investigated. The films were characterized by energy-dispersive X-ray spectrometer (EDX), inductively coupled plasma atomic emission spectroscopy (ICP-AES), Rutherford backscattering (RBS), secondary ion mass spectrometry (SIMS), attenuated total reflection-Fourier transform infrared (ATR-FTIR) spectroscopy, X-ray photoelectron spectroscopy (XPS), X-ray diffractometer (XRD), high-resolution transmission electron microscopy (HRTEM), field emission scanning electron microscopy (FE-SEM), ultraviolet -visible light (UV−vis) spectroscopy, and photoluminescence (PL) spectroscopy. The results showed that the deposition time, temperature, and Mn doping concentration can affect the composition, surface morphology, crystallinity, thickness, grain size, and hence, the photoluminescence and transmission spectra of the films. UV−vis transmission spectroscopy showed that the prepared films were highly transparent (>80%) in the visible region. X-ray diffraction showed that the films consisted of small ZnS:Mn nanocrystallites, 3.0−4.7 nm in size, showing quantum size effects. FE-SEM revealed a homogeneous morphology, dense nanostructures, and a narrow grain size distribution.