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Research Article

Effect of Annealing Temperature and Spin Coating Speed on Mn-Doped ZnS Nanocrystals Thin Film by Spin Coating

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ZnS:Mn nanocrystals thin film was fabricated at 300°C and 500°C via the spin coating method. Its sol-gel was spin coated for 20 s at 3000 rpm and 4000 rpm with metal tape being used to mold the shape of the thin film. A different combination of these parameters was used to investigate their influences on the fabrication of the film. Optical and structural characterizations have been performed. Optical characterization was analyzed using UV-visible spectroscopy and photoluminescence spectrophotometer while the structural and compositional analysis of films was measured via field emission scanning electron microscopy and energy dispersive X-ray. From UV-vis spectra, the wavelength of the ZnS:Mn was 250 nm and the band gap was within the range 4.43 eV–4.60 eV. In room temperature PL spectra, there were two emission peaks centered at 460 nm and 590 nm. Under higher annealing temperature and higher speed used in spin coating, an increase of 0.05 eV was observed. It was concluded that the spin coating process is able to synthesize high quality spherical ZnS:Mn nanocrystals. This conventional process can replace other high technology methods due to its synthesis cost.

1. Introduction

ZnS is one of the most studied nanomaterials. It is relatively easy to fabricate the nanomaterial with the intended optical and electrical properties through controlling the shape of its nanostructure [1, 2]. It has a wide energy band gap with a value of 3.68 eV for cubic phase and 3.77 eV for hexagonal phase [3–10]. There are several physical methods (ion sputtering, laser ablation, gas condensation, pyrolysis, etc.) and chemical methods (solvothermal, photochemical, electrochemical, thermolytic, sol-gel, etc.) to synthesize nanocrystalline thin film and to control its crystal size [11]. Sol-gel is a cheap chemical method that fabricates material through the process of phase change from liquid phase (sol) to solid phase (gel) [12–14]. Fabrication that employs this method will usually be entailed by either spin coating or dip coating process followed by heat treatment process. Walker et al. (1995) found that annealing treatment is required to reduce material defects. Annealing treatment is a common procedure in fabrication of nanomaterial to either improve the quality of crystal or stabilize the structure at a temperature [15]. Due to the fact that the dopant is able to extend the capability of a semiconductor compound, this work focused on doped ZnS. Besides, the luminance color of the doped material changes according to the dopant used. The commonly used dopant is manganese ions (Mn^{2+}) and copper ions (Cu^{2+}). Mn^{2+} produces orange emission while Cu^{2+} produces green emission [16–19]. Parameters such as annealing temperature and speed of rotation were used in these experiments to investigate their influence on the fabrication of nanocrystalline thin film. Based on [20–22], the influence of the spin coating speed will affect the band gap of the thin film. The band gap increases roughly with the increase in annealing temperature and spin coating speed. This work aims to identify the characteristics of zinc sulphide doped manganese (ZnS:Mn) fabricated using several combinations of annealing temperatures and speeds of spin coating.