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Effect of Thermal Treatment on the Morphology of ZnS:Mn Nanocrystals

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Abstract: The arrangement, structure and formation of nanocrystals depend on the thermal treatment. This work focuses on the influences of the thermal treatment of manganese-doped zinc sulphide (ZnS:Mn) nanocrystals on their self-arrangement. A film was prepared by the sol gel method and layered by spin coating after 48 hours of stirring. We have found that a nanocrystalline layer of good quality can be obtained if a longer annealing treatment is applied.

Key words: ZnS:Mn % Nanocrystals % Sol gel method % Thermal treatment

INTRODUCTION

Recently, several physical and chemical methods have been used for the fabrication of nanocrystals [1-20]. The development of good nanocrystals with well-aligned morphology is impacted by many factors such as the reactant, concentration, solvent, temperature, interactions between nanoparticles and reaction time [1-7, 20-26]. Some studies reported that the thermal stability of nanocrystalline materials affected the formation of nanocrystals. Thus, the study of nanocrystal thermal stability has been an urgent issue from the viewpoint of practical applications and theoretical research. Here, we developed a convenient sol gel approach assisted by a self-assembly technique for the synthesis of ZnS:Mn nanocrystals. The physical characteristics of ZnS:Mn such as surface properties was determined. The prepared nano ZnS: Mn material was characterized by energy dispersive x-ray (EDX) spectroscopy, UV-Vis spectrometry (Perkin Elmer Lambda 35) and field emission scanning electron microscopy (FE-SEM).

Experimental Part: Mn-doped ZnS nanocrystals were synthesized by a self-assembly technique through the sol-gel method. To prepare nanocrystals of ZnS:Mn, zinc nitrate hexahydrate and manganese acetate were dissolved in a solution of 2-propanol and distilled water. Then, thiourea was added to this solution as the source of sulphur. The solution was mixed using a magnetic stirrer at 300 rpm. After 48 hours of stirring, a clear and transparent sol was obtained. Then, the films were prepared by spin coating on glass slide substrates. Two coated thin film samples were heated from room temperature to 300°C at 3°C/min and 0.5°C/min ramping rates. Afterwards, the thin films remained at the peak temperature for 60 minutes before ramping down at the normal rates. The thin film layers were then inspected under FE-SEM with 3 kV electron energy to determine the morphology of the Mn-doped ZnS in the as-delivered condition. The FE-SEM micrographs displayed rounded particles with a relatively homogeneous and inhomogeneous size distribution.

RESULTS AND DISCUSSION

Optical Properties and Morphology of Nanocrystals after the Annealing Process: The optical properties of the ZnS:Mn nanocrystalline thin films were determined from transmittance and absorbance measurements in the range of 200-1000 nm. Fig. 1 shows the transmission and absorption spectra of nanocrystalline ZnS:Mn thin films.

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