Advance Physics Letter

Structural and UV-irradiated thermoluminescence studies of ZnS: Cu nanoparticles synthesized by wet chemical route method

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Abstract-Pure and copper doped ZnS nanoparticles in powder form were prepared by wet chemical route method by using thioglycerol as a capping agent. The XRD studies indicate that the samples are cubic in nature. The thermoluminescence (TL) behavior of pure and copper doped ZnS has been studied for fixed 10 min UV exposure time; TL glow curve shows a single peak at 165.1°C and 184.3°C temperature respectively. The activation energy (E), order of kinetics (b) and frequency factors (s) have been calculated.

Keyword: ZnS, Cu doped ZnS Absorption spectra, Thioglycerol, Thermoluminescence.

I. INTRODUCTION

Nano range ZnS have been extensively investigated during the last decade due to their application potential for various high-performance and novel displays and devices. It is a promising II–VI compound semiconductor and wide energy band-gap (Eg=3.7 eV) and direct electron transition feature of which ensure the potential applications [1-4]

Synthesis of nanophosphor is generally done by chemical methods. Chemical precipitation in presence of capping agents [5-6], reaction in micro emulsions [7], sol gel reaction, wet chemical precipitation [8-9], solid state reaction [10-14] and auto combustion [14-18] are commonly used techniques for synthesis of nanophosphors. Semi-conductors in nano-crystallized form exhibit markedly different electrical, optical and structural properties as compared to those in the bulk form. Out of these, the ones suited as phosphor host material show considerable size dependent luminescence properties when an impurity is doped in a quantum confined structure [19-21].

The present paper deals with the synthesis, Structural characterization and thermoluminescence behavior of ZnS and Cu^{2+} doped ZnS phsophor.

II. EXPERIMENTAL

The pure and Cu^{2+} doped ZnS nanoparticles were synthesized by a chemical route method. Aqueous solution of zinc acetate, copper acetate and sodium sulphide were used as a precursor material. Thioglycerol was used as a capping agent. Sodium sulphide solution was slowly added to a boiled mixture of zinc acetate and thioglycerol nano ZnS was formed. For preparation of Cu^{2+} doped ZnS, thioglycerol solution was added slowly in zinc acetate and copper acetate mixture, this mixture was heated upto boiling. The mixture was followed by slow addition of sodium sulphide solution with continuous stirring in an ice bath. The precipitate of ZnS: Cu^{2+} nano particle was formed and separated by centrifugation of the mixture. The separated powders were repeatedly washed by using distilled water then the samples were dried and used for further investigations [6,22].

The X-ray diffraction (XRD) patterns were recorded to characterize the phase and structure of the nanoparticles using a Ringaku Rotating Anode (H-3R) Diffractometer with rotating anode and a Cu Kα radiation source (λ=1.5418 Å). Room temperature Thermoluminescence (TL) was recorded by TLD Reader TL 1009 Nucleonix.

III. RESULT AND DISCUSSION:-

3.1 X-ray diffraction (XRD) results:-XRD patterns of the Zns and ZnS: Cu^{2+} nanoparticles shown in Fig. 1 reveal the cubic zinc blende structure of ZnS (JCPDS No. 05-0566). The three peaks corresponds to the (111), (220), and (311) lattice planes, respectively. From the XRD patterns, the broadening of the diffraction peaks of the nanoparticles is obvious, which is characteristics of nanosized materials. According to the line width analysis of the (111) diffraction peak based on Scherer formula, the average size of the particle for pure and doped ZnS were estimated as 3-8 nm. From XRD analysis, no characteristic peaks of impurity phases were observed in doped samples. That is due to very small amount of impurity, and these ions were doped into ZnS lattice [6, 24].

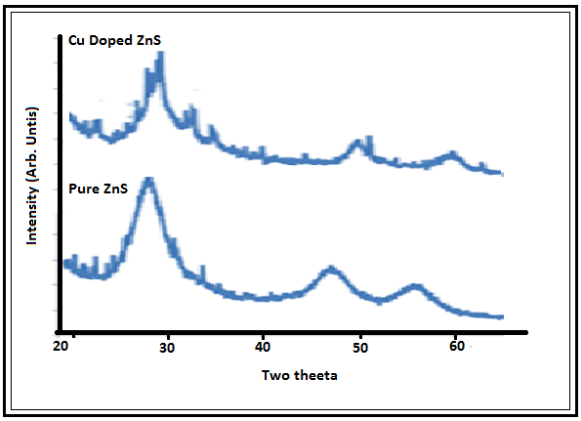

Fig. 1. XRD pattern of the pure ZnS and Cu doped ZnS [22.24].

3.2 Scanning electron Microscope (SEM) result:-

The SEM images of pure ZnS and Cu doped ZnS are shown in Fig. 2(a- b), in which the samples are composed of nano structure with uniform size.

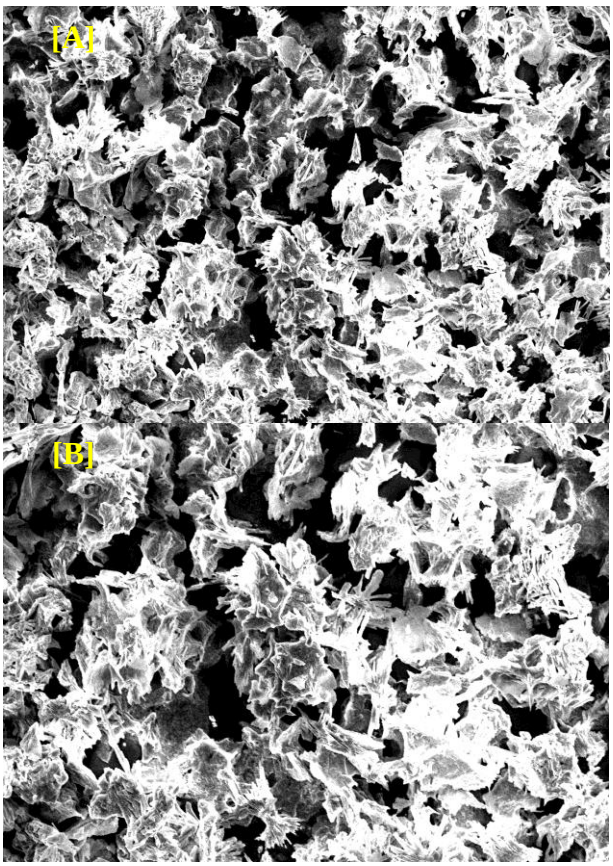

Figure 2 SEM images of (a) Pure ZnS and (b) Cu doped ZnS

3.3 Thermoluminescence Glow Curves: -

Figure 3 shows the thermoluminescence glow curves of pure and Cu doped ZnS nanoparticles. As seen from this figure, the ZnS:Cu nanophosphor shows higher intensity with 1mM Cu concentration as compared to pure ZnS. The heating rate (β) was fixed at 6.7°c/sec. All the samples were irradiated by UV radiation for 10 minutes.

The analysis of any TL glow curve i.e. the analysis of trap parameters by various methods and to see what kind and nature of traps are there, is an important tool to know about the nature of the material. The analysis of the same can be done from the various methods. The activation energy, the frequency factor, and the shape alone i.e. the order of kinetics can give so much of information to the nature and the type of the glow processes taking place in the specimen[22-24].Table 1 shows the values of TL parameter calculated by using Chen and others [25-30].

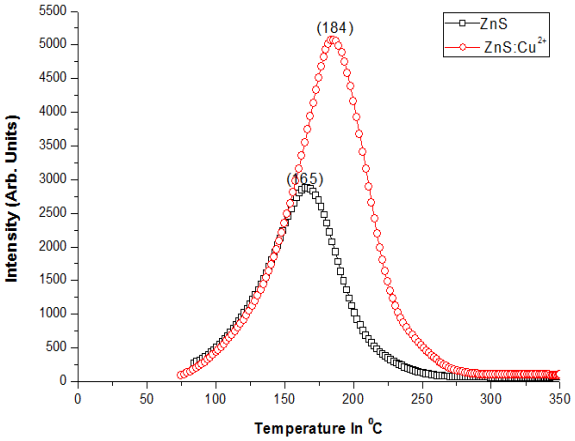

Fig.3. TL glow curve of pure and ZnS:Cu^{2+} nanoparticle.

Table 1. Thermoluminescence glow curve of ZnS and ZnS:Cu^{2+} phosphor with different TL parameters

Samples		Pure ZnS	Copper doped ZnS
Temperature (^{0}C)		165.1	184.3
τ		31.88	32.05
δ		28.02	31.4
ω		59.9	63.45
Frequency factor(s)		1.01×10^{10}	2.56×10^{10}
Activation energy (eV)	Half-width method	.77	.84
	Initial-rise method	.79	.92
Order of kinetics		1	1

IV CONCLUSIONS

The pure ZnS and ZnS:Cu^{2+} nanoparticles were successfully synthesized by the chemical rout technique, with thioglycerol as a capping agent. XRD pattern shows that the nanoparticles are in zinc blend phase. The thermoluminescence (TL) behavior of pure and copper doped ZnS has been studied for fixed 10 min UV exposure time. TL glow curve shows a single peak at 165.1°C and 184.3°C temperature respectively. It was

also found that TL intensity increases as the particle size is decreased. For first order of kinetics the activation energy for all samples was calculated and they were found in the range 0.77eV-0.92eV.The activation energy decreases with the decrease in particle size. The frequency factor was also calculated and it was found in the range 1.01×10^{10}-2.56×10^{10}. The frequency factor also decreases with the decrease in the particle size.

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