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SYNTHESIS AND STRUCTURAL INVESTIGATION OF ZINC SELENIDE (ZNSE) NANOPARTICLES BY MICROWAVE ASSISTED METHOD

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ABSTRACT

Synthesis of Zinc Selenide (ZnSe) Nanoparticles has been carried out by Microwave Assisted Method. Poly vinyl alcohol (PVA) is used as a capping agent to stabilize the ZnSe nanoparticles. The Synthesized nanoparticles are characterized by powder X-Ray diffraction (XRD) and Scanning Electron Microscope (SEM). The XRD explains the interrelationship of particle size and specific surface area. X-rays diffraction measurement confirms the incorporation of ZnSe with a cubic structure and nanometer size. Scanning electron microscopy (SEM) demonstrates the morphological study of the ZnSe nanoparticles.

Keywords: Microwave, XRD, SEM.

Introduction

Zinc selenide (ZnSe) is a light yellow solid compound comprising zinc (Zn) and selenium (Se). It can be made in both cubic (zincblende) and hexagonal (wurtzite) crystal structures. Currently nanotechnology and nanomaterials have attracted several researchers from different fields due to their unique properties and potential applications in diverse areas such as photocatalysis, solar cells, display panels [1–4] and as well as their scientific interest. In recent years, II–VI semiconducting nanomaterials have been vigorously investigated as efficient luminescence materials, which have been proved to be promising in a number of application areas including biological markers [5–7], light-emitting diodes [8–10], solar cells [11,12] and color converted solid state lighting devices [13–15]. Among II–VI semiconductor materials, ZnSe is chemically more stable and technologically better than other semiconductor materials (such as ZnS), it is considered to be a promising host material. The synthesis strategy of ZnSe nanomaterials tends to environment and user friendly solvents, low energy consumption and low waste [16–18]. ZnSe is also widely used in photoluminescence and electroluminescent devices, solar cells, laser technology, infrared detectors and thermal imaging technology [25]. Hence, the preparation of ZnSe has been ahotresearchtopic in the field of semiconductor [26–30]. It is realized from the literature, that the morphology of the nanoparticles is sensitive to the method of preparation [27].

In addition, most of these methods require the use of expensive materials and sophisticated equipment. In addition, most of these methods require the use of expensive materials and sophisticated equipment. In this work, ZnSe is prepared by simple and inexpensive Microwave-assisted method.

Materials

Zinc Chloride (ZnCl), Selenium Di Oxide (SeO_2), PVA, NH_3, Sodium hydroxide (NaOH) and Deionized water were used to prepare the nanoparticles of this study.

Synthesis

All chemicals were analytical grade (AR) and used without further purification. In a synthesis of ZnSe nanoparticles the amount of PVA required to dissolved in deionized water (sol-A) and $ZnCl_2$ required to dissolved in deionized water was calculated to be 0.2M (sol-B). Then the NaOH dissolved in deionized water was calculated to be 1M (sol-C) and selenium dioxide dissolved in acetone (sol-D). Solution A, B and 20ml of NH_3 was mixed in drop wise manner the prepared solution was taken in a vessel and it was kept magnetic stirrer and add the solution D to the stirrer. The prepared solution kept out from the magnetic stirrer and kept in microwave oven for 3mins with 40˚ C then the solution taken out from the oven and cooling at room temperature for 3mins the process was repeated for 2 or 3 times and the solution was filtered. It was dried at room temperature for two days to obtain as-prepared colorless powder.

Instrumentation

The prepared nano ZnSe were characterized by powder XRD using an X-ray diffractometer (Model Bruker D-8). SEM spectra of nano ZnSe were recorded using Model VEGA3 TESCAN, PMU Thanjavur, Tamilnadu, India.

Result and discussion

Structural Characterization

XRD Analysis

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The prepared ZnSe nanoparticles were characterized study by different characterization techniques. The structure of the powders was examined by powder X-ray diffraction (XRD) technique using an X-ray diffractometer (Model Brucker D-8).

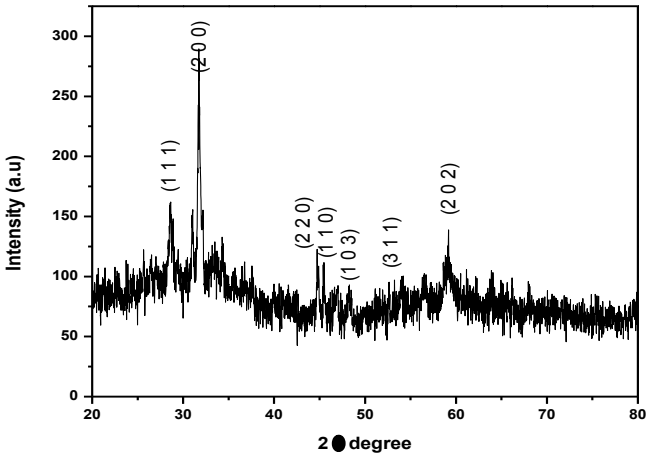

Fig 1.XRD Pattern of ZnSe nanoparticles

Table: 1 XRD data of the ZnSe nanoparticles

2θ	Cos θ	FWHM(°)	FWHM β (Radian)	β cosθ	Size (nm)	D Spacing (A°)
13.4401	0.9931	0.2342	0.004087	0.00405	34.17	6.58817
14.6312	0.9918	0.2676	0.004670	0.00463	29.94	6.05444
28.6361	0.9689	0.4015	0.007007	0.00678	20.43	3.11737
31.7502	0.9618	0.2007	0.003502	0.00336	41.17	2.81835
44.8063	0.9245	0.2007	0.003502	0.00323	42.83	2.02281

The powder XRD pattern for the as-prepared ZnSe nanoparticles is presented in the fig 1.It is observed that the XRD reflection peaks for ZnSe sample are in a perfect match with the diffraction pattern of ZnSe published in the (JCPDS File No. 89-2940) and the observed values are a=3.996Å, b=3.996Å and c=6.626Å. The diffraction peaks of the as prepared ZnSe samples at 2θ =13.44,14.63, 16.49, 28.63, ,31.75, and 44.80 corresponds to the Miller indices or lattice planes of (111), (200), (220), (103) ,(202), (212) and (311) respectively. It has been given in accordance with the data reported in the literature [25-30]. Therefore, it can be indexed to the hexagonal structure of ZnSe. The powder XRD pattern of ZnSe nanoparticles shows broad peaks, which confirmed the formation of small-sized nanoparticles.

Particle Size Calculation

From this study, considering the peak at degrees, average particle size has been estimated by using Debye-Scherer formula. Inter-planar spacing between atoms (d-spacing) is calculated using Bragg's law and enumerated in Table.1.

$$D = 0.9\lambda/\beta \cos\theta \quad \text{(1)}$$

$$2d \sin\theta = n\lambda \quad \text{(2)}$$

Where, λ is wavelength of X-Ray (0.1540nm), β is FWHM (full width at half maximum), θ is diffraction angle, d is d-spacing and D is particle diameter size and n is the order of diffraction.

Specific surface area (SSA)

The surface states will play an important role in the nanoparticles, due to their large surface to volume ratio with decrease in particle size. SSA is a material property. It is a derived scientific value that can be used to determine the type and properties of a material. It has a particular importance in case of adsorption, heterogeneous catalysis and reactions on surfaces. SSA is the Surface Area (SA) per mass. The average specific surface area of ZnSe nanoparticles was calculated using equation (3).

$$SSA = 6000/D * \rho \quad \text{(3)}$$

Where D is the particle size in meter, SSA is the mean specific surface area of ZnSe nanoparticles, ρ is the density of ZnSe in kg/m^3. Table.2. shows calculation of specific surface

area of the ZnSe nanoparticles. The crystalline boundary sizes were increased to increasing in specific surface area of the ZnSe nanoparticles. Figure.2. shows that specific surface area of ZnSe nanoparticles.

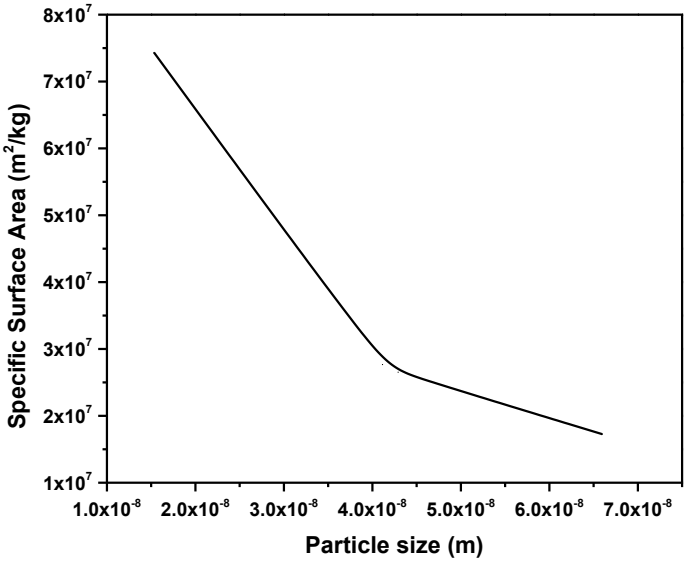

Fig 2. Specific surface area of ZnSe nanoparticles

Table.2. Specific surface area of ZnSe nanoparticles

Cosθ	FWHM β (Radian)	β cosθ (deg)	Size(nm)	Density (kg/m^3)	SSA×10^8
0.9931	0.004087	0.00405	34.17	5.65×10^3	1.6118
0.9918	0.004670	0.00463	29.94	5.65×10^3	1.7540
0.9689	0.007007	0.00678	20.43	5.65×10^3	3.4069
0.9618	0.003502	0.00336	41.17	5.65×10^3	3.7679
0.9245	0.003502	0.00323	42.83	5.65×10^3	5.2498
Average Specific surface area					4.1936

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Scanning Electron Microscope (SEM) of as-prepared samples

The morphologies of the as-prepared samples were investigated through Scanning Electron Microscopic (SEM) images. The SEM images were taken for the nano powdered samples prepared by the present method using Model JSM-6390 device. Fig 3. Shows the SEM image of ZnSe nanoparticles.

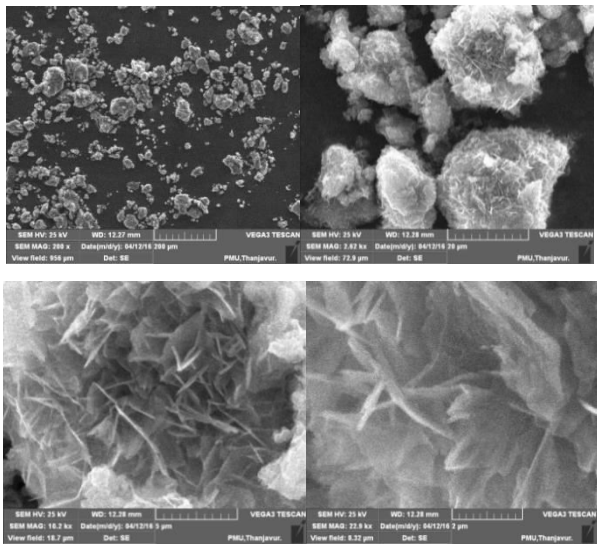

Fig 3. SEM images of the ZnSe Nanoparticles

CONCLUSION

ZnSe nano powders were successfully synthesized by microwave assisted method. The Miller Indices and the crystalline size as-prepared ZnSe nanoparticles were determined by powder XRD technique. Strong diffraction peaks at 31° and 59° indicating the ZnSe. The XRD studies were used to find specific surface area and d-spacing of ZnSe nanoparticles. The morphological studies revealed that the particles were spherical in structure and slightly agglomerated.

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