

Structural Properties of Tin Selenide Nanoparticles Prepared by Aqueous Solution Method

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Abstract

In present investigations the structural properties of nanoparticles of Tin Selenide (SnSe) of group IV-VI semiconductors is reported. It is one of the promising materials from its applications. SnSe powder has been prepared using chemical precipitation method in deionized water. The nanocrystalline SnSe prepared by a complete reaction between alkaline solution and tin complex, likewise the SnSe crystallizes very fine at room temperature in the aqueous solution. The structural properties of SnSe crystallized powder were studied by EDAX which confirms the perfect stoichiometry and XRD shows the formation of crystal is orthorhombic as well as the average particle size of the prepared SnSe nanoparticles is 9.88 nm.

Keywords: SnSe nanoparticles, aqueous solution method, EDAX, Powder X-ray diffraction, optical properties.

INTRODUCTION

In the last few years many investigators have been involved in the study of nanocrystals because of their special properties like electric, optoelectric and magnetic. In recent years; the synthesis of one-dimensional semiconductor materials such as nanowires, nanoparticles or fibers has been the focus of research work [1, 2]. Tin Selenide (SnSe) is one of the group IV-VI semiconductors. SnSe thin film has

been used as light emitting diodes or laser diodes, memory switching devices and infrared production and detention [3, 4]. SnSe nanoparticles were synthesized by numerous

Methods like solid – state reaction, state metathesis, Bridgman method, self – propagating high temperature synthesis, brush plating technique [5-9]. These methods have some limitations like the requirement of a special device and high temperature. Recently, solution routes, such as hydrothermal [10], solvothermal [11], and organometallic precursor methods [12] have been developed for the Synthesis of SnSe. So we have used chemical precipitation method, it's very easy technique and it does not require any special sophisticated equipment and high temperature.

It is a time-consuming process, which facilitates a better orientation of the crystallites with an improved grain structure, depending on the deposition situation. Present paper reports the preparation and morphological study of the tin selenide powder obtained by simple chemical route.

EXPERIMENTAL DETAILS:

For the growth of SnSe nanoparticles all the chemicals were of AR grade with 99.99% purity from LobalChemie. Tin chloride and selenium oxide used as precursors of Sn^{+2} and Se^{-2} ions in the reaction system. The SnCl_2 and SeO_2 solutions were mixed for 30 minutes using a magnetic stirrer by drop wise and as a result precipitations of SnSe were obtained in a solution. This precipitation is separated by filtering method. Finally separated SnSe nanoparticles were washed by water and ethanol several times and kept at 100°c for one hour for obtaining dry powder of SnSe nanoparticles. The compositional studies were carried out by EDAX. The structural characterization of nanoparticles under investigation was carried out using an X-ray diffractometer (XRD).

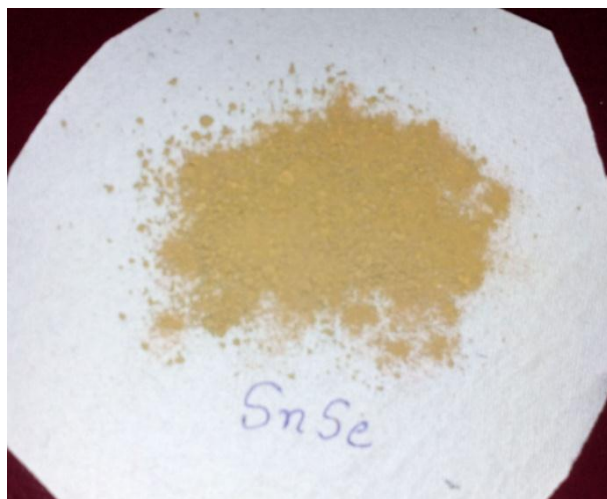


Fig.1 Photograph of synthesized SnSe nanoparticles.

RESULTS AND DISCUSSION

EDAX:

The EDAX Spectrum of SnSe nanoparticle is shown in Fig.2 The basic stoichiometric study of SnSe nanoparticles obtained from EDAX and theoretical calculated values are nearly similar as given in table-1. The EDAX spectrum also showed that the synthesized SnSe nanoparticles are free of any other impurities and contaminants.

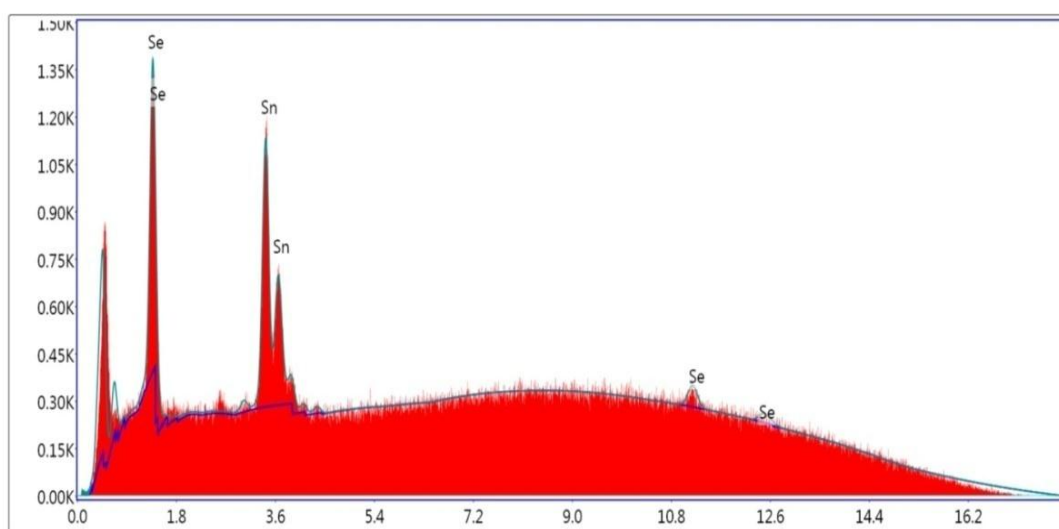


Fig. 2 EDAX spectrum of prepared SnSe nanoparticles.

Table 1 Elemental quantity of Sn and Se in SnSe nanoparticles as determined by EDAX

Elements	Wt (%) obtain from EDAX	Wt (%) calculated by theoretical
Sn	62.73	60.05
Se	37.27	39.95

XRD:

Figure 3 shows the X-Ray diffraction pattern of SnSe nanoparticles ready by chemical precipitation method. The X-Ray diffraction pattern shows 5 to 79.975 2θ value and it gives total 29 experimental peaks. Total 24 matching lines are found. The X-Ray diffraction pattern exhibit peaks at 26.86°, 37.33° and 50.76° corresponding to the (210), (401) and (221) planes. All these peaks correspond to the orthorhombic phase. The lattice parameter value a, b and c have been calculated and are found to be a = 11.50Å, b = 4.15Å and c = 4.44Å which are in good agreement with the JCPDS data (card no. 321382). The broaden peaks representative average crystallite size is small.

The average size of particles has been obtained from the X-ray diffraction pattern using the Scherrer's formula⁽¹³⁾.

$$D = \frac{K \lambda}{\beta \cos \theta}$$

Where: D is the grain size, K is a constant taken to be 0.94, wavelength of X-ray (1.5406), β is the full width half maximum (FWHM), θ is the diffraction angle. The obtained average particles size of the prepared SnSe nanoparticles is 9.88 nm.

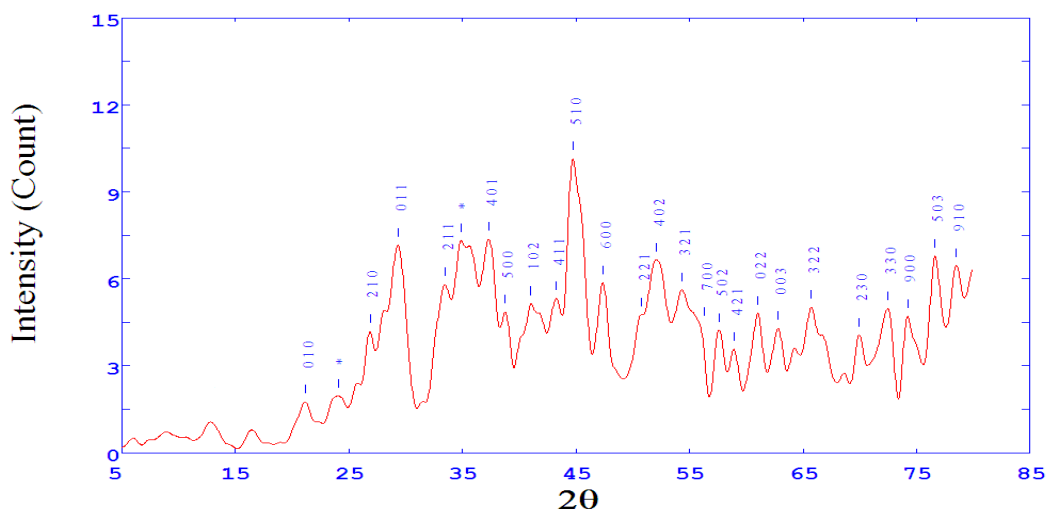


Fig.3 XRD pattern of prepared SnSe nanoparticles

CONCLUSION

In this study, a simple chemical route for Tin selenide has been described. The technique is simple, cost-effective and requires less monitoring. The nanostructures of the prepared SnSe nanoparticles have been confirmed using XRD. And all peaks correspond to the orthorhombic phase. The EDAX spectrum shows that the elemental stoichiometric analyses of SnSe nanoparticles almost match with the theoretical calculated values.

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