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Preparation Ag_2S nanorods and nanoparticles via a simple chemical method

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Abstract. Ag_2S nanorods and nonoparticles have been successfully prepared using chemical method. Silver nitrate with molar concentration of 0.1 M and thiourea with different molar concentration were used as a source of Ag^{++} and S^{++} ions, respectively. The pH of solution was in range of 10-11. Scanning electron microscopy (SEM) image showed that the nanorods length and diameter were 2.5-3 μm and 300-400 nm, respectively. X-ray diffraction results showed a monoclinic α-Ag_2S phase was obtained. The atomic ratio of silver and sulphur were found using energy dispersive spectroscopy (EDS) and it was 62.39% and 37.61%, respectively.

Introduction

Semiconductor nanostructures especially 1D such as nanorods and nanowires structures have been intensive interest over the past few years due to the unique physical properties which lead to potential applications in nanoscale devices fabrication [1].

There is a vivid interest to apply silver sulphide (Ag_2S) as a functional media in the variety of electronic and optoelectronic devices like ion selective membranes [2], IR detectors [3], solar cells absorber [4,5], photo switching device [6], etc.

Ag_2S is a mixed ionic electronic conductor, which exhibits highly nonlinear conductive properties. The ratio of the ionic with respect to the electronic contribution to the total conductivity depends strongly on the composition and temperature of the material [7,8]. At room temperature, Ag_2S crystallizes in a monoclinic structure called acanthite (α-phase). At higher temperatures, $T >$ 453 K, it forms a cubic structure (β-phase)[9].

In this work a simple method has been used in preparation Ag2S nanorods. X-Ray diffraction, EDS, and scanning electron microscope used in investigation the nano particles.

Experimental

A simple chemical method was used in preparation Ag_2S nanoparticles. The chemicals used were analytical grade without further purification. To optimise the compound stiochometry, 0.1 M of $AgNO_3$ dissolved with different molar concentration (0.2,0.4,0.6, and 0.8M) of thiourea in 50 ml distilled water in separated beakers, then all fixed in water path at 60°C. The pH of solution was raised up to 10-11 by adding drops of NH_3OH. After one hour the beakers were taken out from the water path. The obtained powder washed by for a several times by ethanol and DI water to remove any undesirable and non reacted materials. The resultants separated by centrifuged of 4000 rpm for five minutes. Finally, the prepared powder left to dry at 60°C for 6 hrs.

$(NH_2)_2CS+OH=HS^- +CN_2H_2+H_2O$

$2Ag^+ + HS^- + OH^- = Ag_2S + H_2O$

The structural properties were obtained by X-ray diffraction XRD (PANalytical X'Pert PRO MPD) system.Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) were used to determine the morphology and elements ratio of the Ag_2S nanostructured powder.

Results and Discussions

Figure 1 shows the XRD patterns of Ag_2S nanostructured powders of different molar concentration of thiourea. The patterns prove that the resultant material was single phase α-Ag_2S monoclinic.

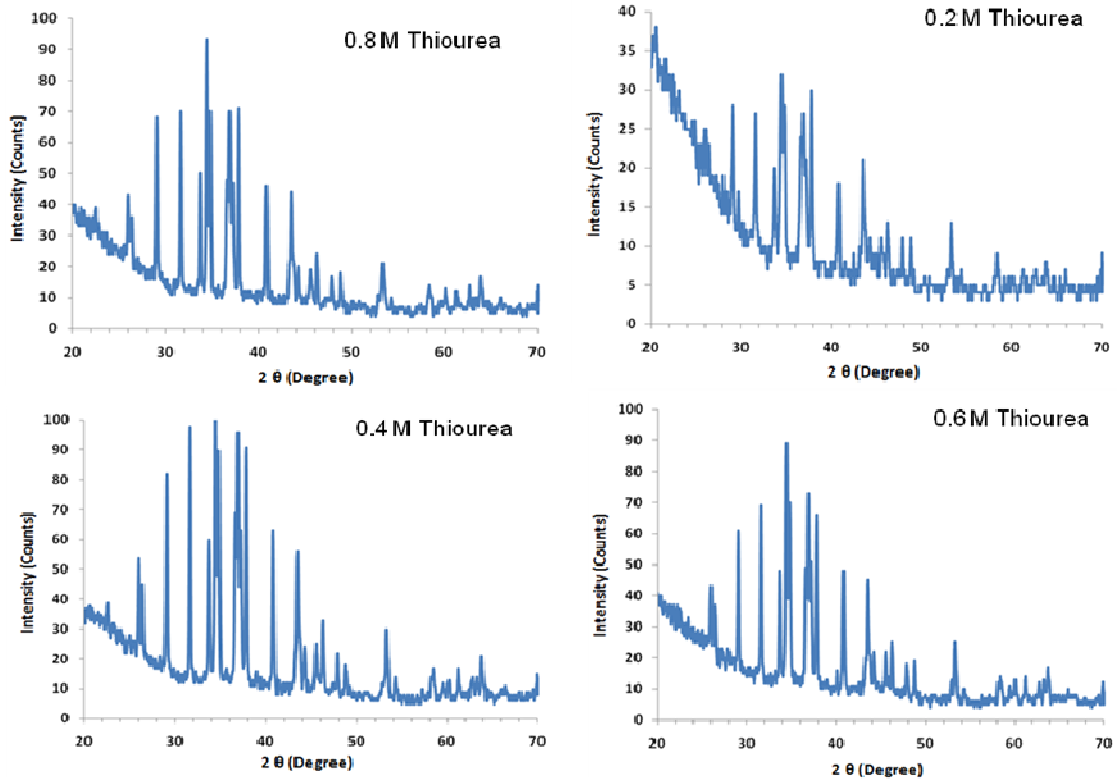

Fig.1: The X-Ray Diffraction patterns of Ag_2S powder with different thiourea molar concentrations

The pattern peaks compared with (ICDD Card 14-0072) and show good coincidence. But we have seen the molar ratio of 0.6 is the most coincidences with the card. So we have concentrated our study on this ratio.

Table 1. A comparison of XRD peaks of relative thiourea molarity prepared Ag_2S powder with (ICDD 14-0072) card

0.2 M	0.4 M	0.6 M	0.8 M	ICDD	Hkl
25.1801	25.9501	25.9139	25.9269	25.902	111
28.9776	26.3350	26.3225	26.3376	26.322	012
29.6758	29.0037	28.9822	28.9949	28.966	111
31.5202	31.5438	31.5234	31.5260	31.520	112
33.6279	33.6533	33.6342	33.6233	33.613	120
34.3972	34.4112	34.3966	34.4031	34.385	121
34.7134	34.7348	34.7223	34.7188	34.700	022
36.5820	36.5896	36.5515	36.5748	36.557	112
36.8025	36.8467	36.8195	36.8225	36.805	121
	37.1169	37.0855	37.1132	37.104	013
37.7413	37.7562	37.7373	37.7542	37.718	103
40.7350	40.7674	40.7439	40.7586	40.739	031
43.4076	43.4300	43.4200	43.4119	43.406	122
44.9486	44.2449	44.1804	44.2238	44.209	103
45.4516	45.4786	45.4810	45.5102	45.425	131
46.1808	46.2152	46.2107	46.1820	46.208	123
47.7615	47.8025	47.8052	47.7938	47.754	212

Fig.2 shows the EDS results of 0.6 M thiourea molar concentration. It shows the molar ratios of the Ag and S elements in the compound which are 62.39% and 37.61% respectively.

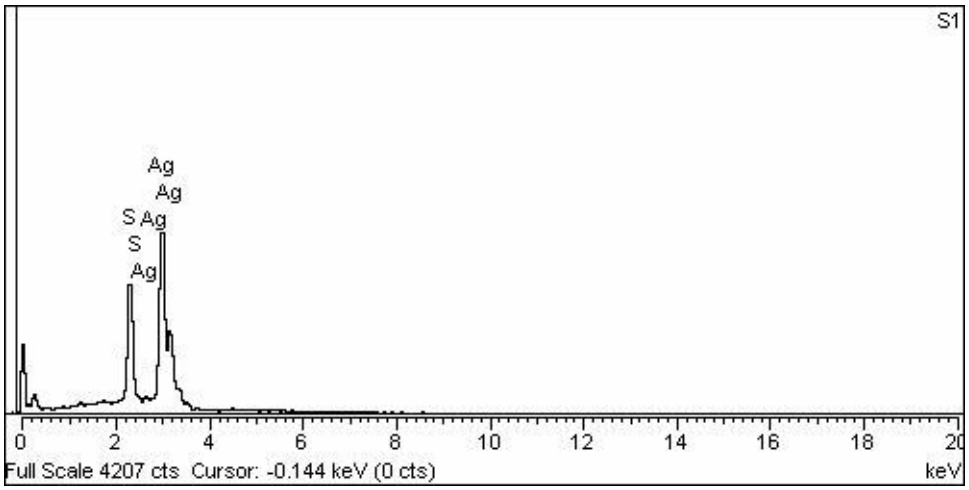

Fig 2: The EDS results which shows the elements ratio in the compound

Fig.3 shows the SEM image of nanostructured Ag_2S which reveals the nanorods structure with diameter of 300-400 nm and length of 2-3 μm.

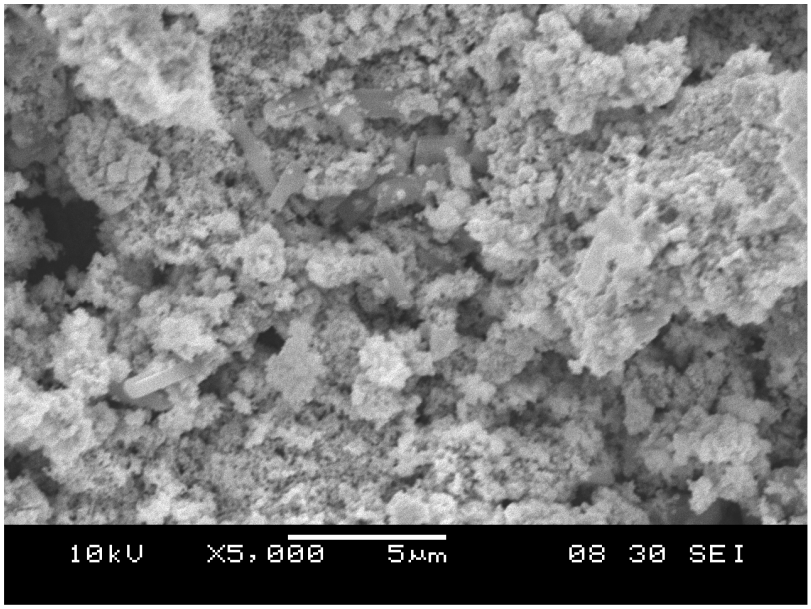

Fig. 3 The SEM image of Ag_2S nanoparticles.

Conclusion

The Ag_2S nanostructures prepared using simple chemical methods. Concentration of thiourea relative to $AgNO_3$ affects the compound structure. The proper molar concentration is 0.6 M to achieve excellent coincidence with ICDD Card. It's clear from the image the growth of nano rods besides the nano particles.

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