International Journal of All Research Education and Scientific Methods (IJARESM), ISSN: 2455-6211
Volume 11, Issue 3, March-2023, Impact Factor: 7.429, Available online at: www.ijaresm.com

Effect of Tin Oxide (SNO) Nanoparticles Prepared By Hydrothermal Method

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ABSTRACT

The calculated average crystallite sizes of SnO in 24 nm. Furthermore, tin oxide nanoparticles have the crystallite size in the range ~18-29 nm, as confirmed by TEM. The tin oxide (SnO) nanoparticles have been successfully prepared by hydrothermal method. The crystallite size and morphology of tin oxide have been investigated by X-Ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive spectrum (EDS), and transmission electron microscopy (TEM) techniques. Results obtained indicate that the co-precipitation method is a promising low temperature, cheap, and fast method for the production of tin oxide nanostructures.

Keywords: XRD; Hydrothermal method; SEM; EDS; TEM:

INTRODUCTION

General, SnO crystallizes in two main form, hexagonal wurtzite and cubic SnO blende but the (B4 type) wurtzite structure is obtained only at optimum pressure and temperature [1-3]. SnO crystallizes in the typical wurtzite hexagonal structure where oxygen and SnO atoms are spatially arranged in a way that O atoms are arranged in a closed hexagonal structure, while the Bi atoms occupy the centre of the distorted tetrahedron structure [4]. The variety of structures of Nano metric SnO means that SnO can be classified among new materials with potential applications in many fields of nano technology. SnO can occur in one - (ID), two - (2D), and three-dimensional (3D) structures. One dimensional structure make up the largest group, including nano rod -needles, -helixes, - springs and -rings, - ribbons, - tubes - belts - wires and -combs. SnO can be obtained in 2D structures, such as Nano plate/Nano sheet and Nano pellets. Examples of 3D structures of zinc oxide include flower, dandelion, snowflakes, coniferous urchin-like, BiO provides one of the greatest assortments of varied particle structures among all known materials [5-6]. The large specific surface area high pore volume, nano structured properties, low cost and low toxicity of nano SnO [7] make it a promising candidate, particularly in catalysts [8], photo catalysis, electrostatic dissipative coating, transparent UV protection films, and chemical sensors [9-13], gas sensor, solar cells. Moreover, SnO nanoparticles have a tremendous potential in biological applications like biological sensing, biological labeling, gene delivery, drug delivery and nano-medicine [14].

In the present study was report the synthesis of SnO nanoparticles using co-precipitation method and the characterization of SnO nanoparticles using X-ray diffraction (XRD), transmission electron microscopy (TEM), selected area electron diffraction (SAED), scanning electron microscopy (SEM), fourier transform infrared spectroscopy (FTIR) energy dispersive spectrum (EDS) are discussed. Here we present a simple hydrothermal method to synthesize uniform, spherically shaped and SnO is the topic of interest in these days due to its presence much unique and important morphology likes nanorods, nanoflowers, nanowires, nano dendrites and nanoparticles SnO is a white solid inorganic powder.

It is non flammable, stable and insoluble in water, II-VI semiconductor with wide band gap energy that is 3.3ev and high excitation energy that is 60 eV. Bismuth oxide is the topic of interest in these days due to its presence much unique and important morphology likes nanorods, nanoflowers, nanowires, nano dendrites and nanoparticles SnO is a white solid inorganic powder. In recent years, noble metal oxide nanoparticles have been the subject of focused research due to their unique electronic optical, mechanical, magnetic and chemical properties. This semiconductor has several favorable properties including good transparency, high electron mobility, strong room temperature, low toxicity, luminescence and photo chemical stability and higher breakdown field strength.

One of the most important environmental applications of nanotechnology is in the water sector. heterogeneous photocatalysts, one of the advanced oxidation process(AOPS),is a cost-effective treatment methods for the removal of toxic pollutants from industrial waste water sowing to its ability to convert these into safer and products such as CO_2 , H_2O and mineral acids [15]. Several conventional methods have been used for synthesis of SnO nanoparticles like chemical vapour synthesis [16], laser ablation [17], solvothermal [18], thermal decomposition [19], and sol-gel method [20].

EXPERIMENTAL PROCEDURE

MATERIALS

Tin nitrate (Bi $(NO_3)_2.6H_2O$) and ammonia solution of analytical grade (SD fine chemicals, 98.5%) were used as such without further purification for synthesis process. Double distilled water was used throught the experiments.

SYNTHESIS OF TIN NITRATE NANOPOWDER

Pure SnO sample have been prepared by using a starting solution of Sn nitrate with 0.1 M concentration diluted in deionized water salt used as dopant source is added with a small amount in the starting solution. Then, NH_3 was added, under constant stirring conditions, up to at the pH level of 8. The stirred mixture was irradiated by the microwave radiation of frequency 2.45GHZ, for 5 minutes continuously. The precipitates were collected and, washed with distilled water for several times until the extracts turns into a white product. The final product was annealed at 400 °C for 3 hours.

CHARACTERIZATION

The resulting powders were analyzed by X-ray diffraction (XRD) using a Bruker AXS D8 Advance instrument diffractometer with monochromatic CuKα1 wavelength of 1.5406 Å. The samples morphology was observed by scanning electron microscopy (SEM), using a JEOL 5600LV microscope at an accelerating voltage of 10 kV. The microstructure was studied by transmission electron microscopy (TEM) and selected-area electron diffraction (SAED) in a Tecnai G20-stwin operated at 200 kV. The Fourier transform infrared spectra (FT-IR) of the samples were recorded by using a Nicolet 5DX FTIR spectrometer.

RESULTS AND DISCUSSION

X-Ray Diffraction (XRD)

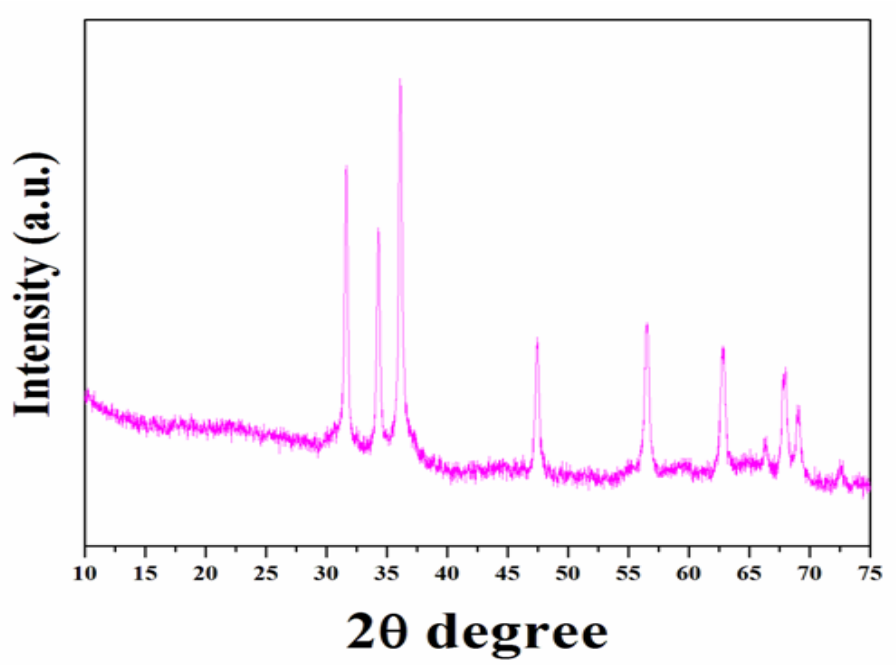


Fig.1 X-ray diffraction patterns of SnO were annealed temperature at 400°C.

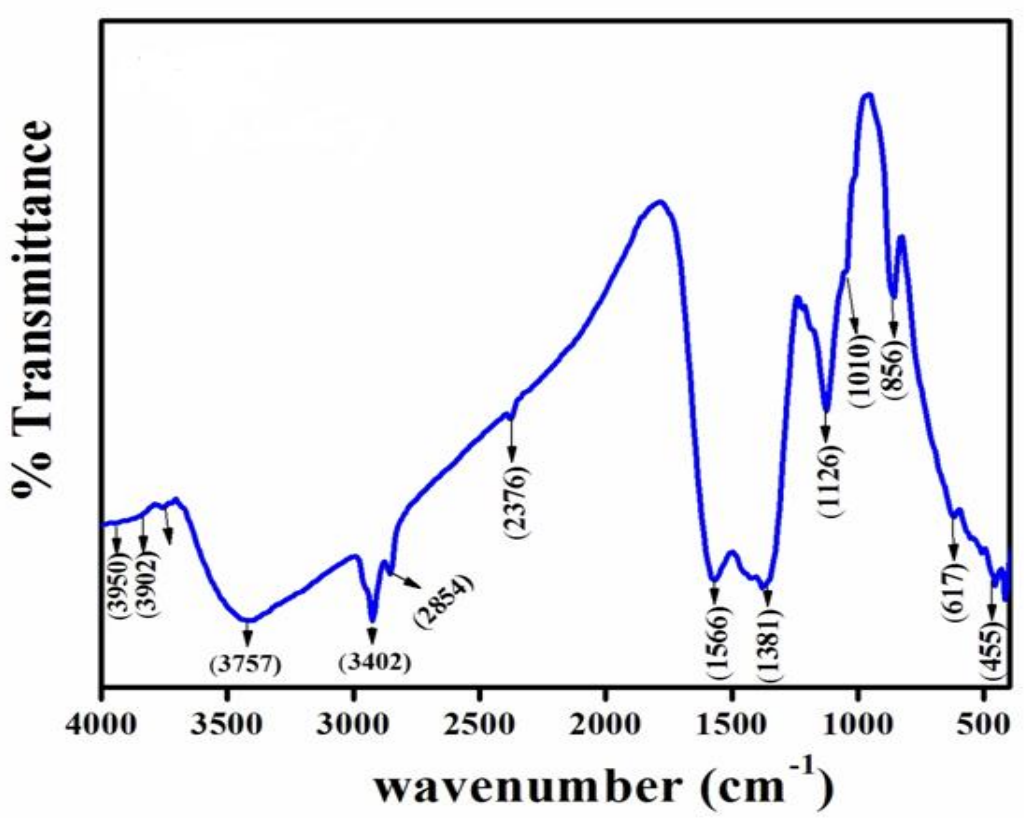
The XRD patterns of SnO nanoparticles synthesized by hydrothermal method. The diffraction peaks namely, (101), (022), (112), (103) and (220) planes are shown in Fig.1. All the diffraction peaks for the products match the tetragonal phase confirms with the JCPDS (77-0450) card. The average crystalline size of the crystallites was evaluated using the scherrer's formula,

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

Where D is the crystalline size (nm), K is a grain shape dependent constant (0.9), λ is the wavelength (0.15406 nm) of the incident beam, θ is a Bragg reflection angle and β is the full width at half maximum (FWHM) of the main diffraction peak. The average crystallite size of SnO_2 nanoparticles are found to be 22 nm for annealing temperature at 400°C. The lattice spacing (d), diffraction angle (2θ), full width at half maximum, FWHM (β) and the (hkl) plane waves. The lattice constants of the SnO_2 nanoparticles are calculated using following equation.

$$\frac{1}{d^2} = \frac{h^2 + k^2}{a^2} + \frac{l^2}{c^2} \quad (2)$$

The calculated unit cell parameters are (a=4.738 and c=3.187) good agreements with JCPDS data.



Fourier transform infra-red spectroscopy (FT-IR)

Fig.2 FTIR spectra of SnO were annealed temperature at 400°C.

Fig.2 shows the FT-IR spectra of SnO samples. The sample shows the typical FT-IR spectrum in broad sharp peak at 3950 cm^{-1}, 3757 cm^{-1} and 3402 cm^{-1} are the characteristic of a non-associating O-H stretching vibration which indicates the presence of free hydroxyls. The absorption peaks at 2854 cm^{-1}, and 2376 cm^{-1} are attributed to C-H stretching vibrations. The absorption peaks at 1566 cm^{-1}, 1381 cm^{-1} and 1086 cm^{-1} correspond to the vibrational mode of O-H stretching of absorbed water. The peak located at 856 cm^{-1}, 617 cm^{-1} and 455 cm^{-1} are due to the stretching vibrations of Sn-O.

Scanning electron microscopy (SEM)

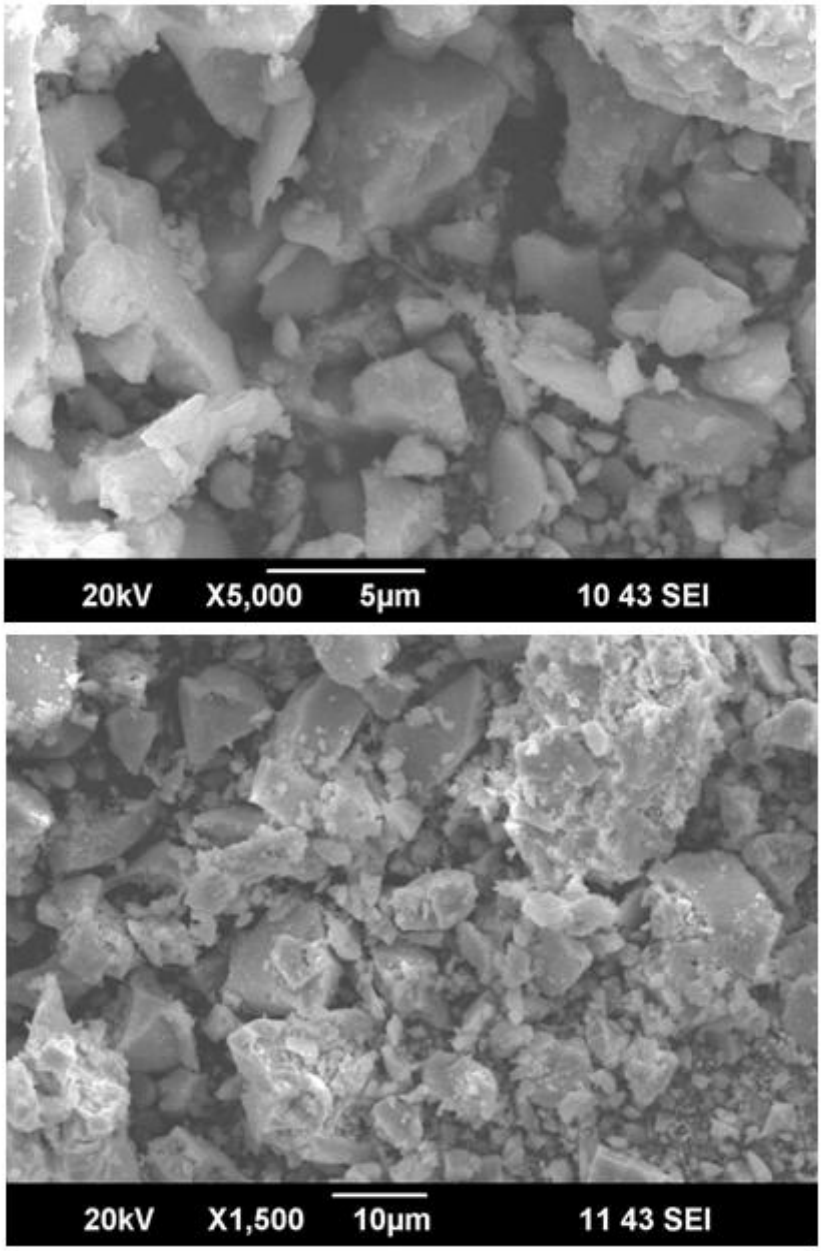


Fig.3. Scanning electron microscope of SnO annealed temperature at 400°C.

The surface morphology of the synthesized SnO nanoparticles was analyzed by scanning electron microscope (SEM). Fig. 3 shows the presence of the SnO nanoparticles are needle shaped with crystalline nature. The SEM images also show that the synthesized samples are composed by the needle shaped like that the slighter crystallites. Therefore the temperature circulation is uniform and is transferred to the materials inside, making an volatile effect followed by energetic growth of the gases to form SnO with good polycrystalline nature.

Energy dispersive spectrum (EDS)

Fig.4 shows a typical energy dispersive spectrum of SnO_2 nanoparticles synthesized by combustion method. This spectrum is performed to investigate the elemental composition of SnO_2 nanostructures. EDS analysis confirms that the presence of Sn, O nanostructures.

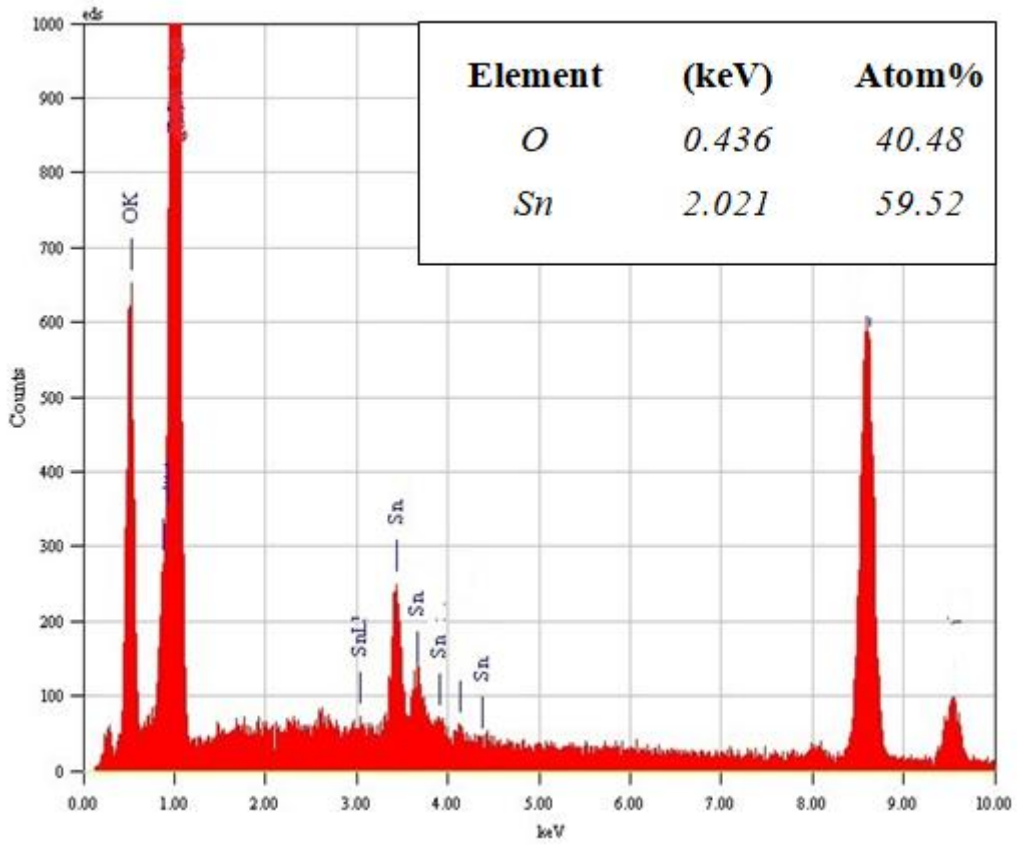
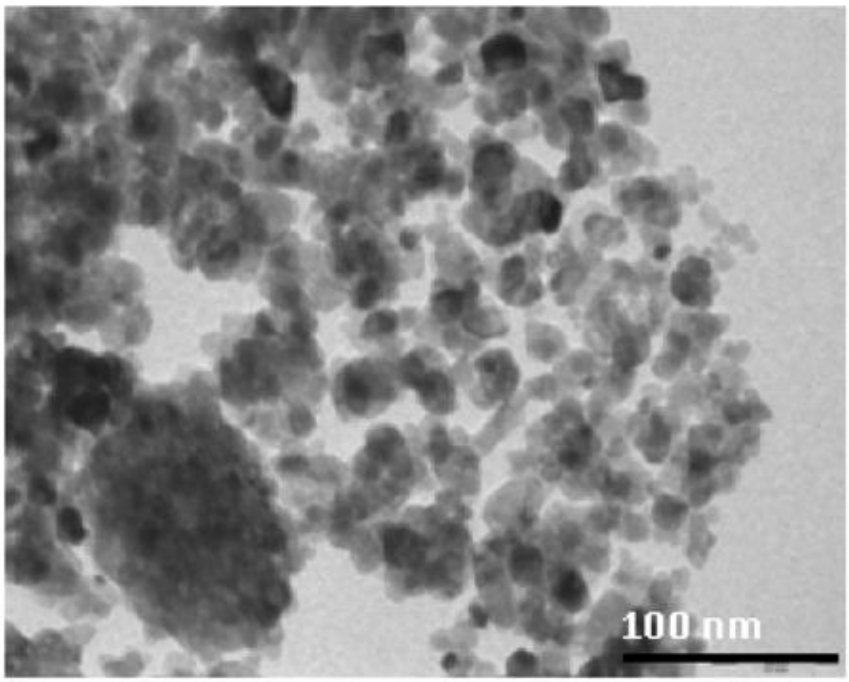


Fig.4. Energy dispersive spectrum of SnO annealed temperature at 400°C.



Transmission electron microscopy (TEM)

Fig.5. Transmission electron microscope of SnO annealed temperature at 400°C.

Fig. 3 shows the presence of the SnO nanoparticles are needle shaped with crystalline nature. The TEM images also show that the synthesized samples are composed by the needle shaped like that the slighter crystallites. The average particle size is 19 – 27 nm.

CONCLUSION

The SnO nanoparticles were successfully synthesized by hydrothermal method under subsequent annealing temperature at 400°C. XRD pattern confirms that the average crystallite size have been found to be 22 nm with confirms with JCPDS data. The SEM image confirms that the needle shaped like that the smaller crystallites. The EDS analysis confirms that the presence of Sn, O structures. Thus the simple synthesis route is a quiet interesting feature and cost effective approach to produce SnO_2 nanoparticles for optical and photocatalytic applications.

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