International Journal of Science and Engineering(IJSE)

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Synthesis, Structural and Optical studies of SnO_2 nanoparticles by Chemical precipitation method

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Abstract *- Tin Oxide (SnO_2) nanoparticles have been prepared by chemical precipitation method. The prepared sample was characterized by X-ray diffraction, SEM with EDAX, UV-Vis absorption and Photoluminescence. From the X-ray diffraction patterns showed that the formation of pure SnO_2 with their average crystallite size are 17 nm. The crystalline product shows good morphology with meragre agglomeration by SEM images. Elemental compositions of SnO_2 nanoparticles were determined by EDX Spectroscopy. UV – Visible spectrum reveals that the transparency of nanoparticles over entire range. The Photoluminescence spectrum for the prepared samples was also recorded.*

Keywords — *Nanoparticles, SEM, XRD*

Submission: July 30, 2018 Corrected: October 21, 2018 Accepted: April 2, 2019

Doi: 10.12777/ijse.13.1.24-27

*[**How to cite this article**:* Ganeshan, S and Vijayalakshmi, R. *(2019).* Synthesis, Structural and Optical studies of SnO_2 nanoparticles by Chemical precipitation method, *International Journal of Science and Engineering, 13(1),24-27.* **Doi**: 10.12777/ijse.13.1.24-27*]*

I. Introduction

Among the various transparent conducting oxide materials, SnO_2 has been much more promising material because they are highly conducting one. Synthesis of SnO_2 in different methods like hydrothermal, microwave assisted, chemical precipitation, sol-gel, spray pyrolysis, co-precipitation method and chemical vapour deposition [1-7]. Since it is a n-type semiconductor material having a wide band gap between in the range of 3.6 – 3.8 eV due to the presences of oxygen vacancies [8-10]. The synthesis was carried out by chemical precipitation method; it is well suited for the formation of nanostructure materials, because it is relatively low processing cost and ability to yield excellent crystalline qualities. Impurities present in the precipitate were easily removed by filtering and washing process. Tin oxide used in various applications such as transparent conducting electrodes for solar cells [11-12], optoelectronics devices [13] and energy storages [14-16].

II. Material and Method

Tin Oxide (SnO_2) nanopowders were prepared by using dissolving of 2 g stannous chloride dehydrates in 100 ml distilled water. After complete dissolution, ammonia solution was added to the above solution by drop wise under stirring. The resulting gels were filtered and dried at 70°C for 24 hours in order to remove water molecules. Finally, tin oxide nanopowders were formed at 500°C for 2h. The XRD pattern of the SnO_2 powder was recorded by Powder X-ray diffraction using Bruker Eco D8 Advance X-ray diffractometer. The surface morphology of nanoparticles was examined by means of JEOL Model JSM - 6390LV and elemental composition of the particles was examined by means of OXFORD XMX N. The PL emission spectra of samples were recorded at room temperature using spectrofluometer equipped with a 450 W Xenon lamp as the excitation source.

III. RESULT AND DISCUSSION

XRD Analysis

The X-ray diffraction pattern of SnO2 nanoparticles are shown in Figure 1. The XRD results shows that the sharp diffraction peaks formed at 260,330 and 510 can be indexed with to (1 1 0), (1 0 1), and (2 1 1) planes of SnO2 nanoparticles [14-15] which matches well with JCPDS file no: 71-0652. All the peaks were indexed as tetragonal structure for the sample calcined at 5000C. The crystallite size for SnO2 nanoparticles was found to be 17 nm. The lattice parameters of crystal were calculated as a = 0.47380 nm, and c = 0.31865 nm. Moreover, broad peaks were observed in the XRD pattern due to the small crystallite size, along with the sharp peaks which reveals the good crystalline nature of the sample.

Morphological Studies

SEM & EDAX Analysis

The SEM images of SnO_2 nanoparticles are shown agglomeration of powder. SEM image exhibits spherical grain morphological structure was observed. From the morphological studies, the prepared calcined SnO_2 nanoparticles look like plate like grain structured with homogeneous, uniformity among the agglomeration [17]. From the morphological studies, it was observed with the particle size of the range of 17 nm which is good agreement with the XRD spectra. The elemental composition of Tin oxide nanoparticles was shown in the EDAX spectrum. The EDAX spectra reveal that only the component Sn and O elements are present, whereas no other elements present i.e., no other impurities are present.

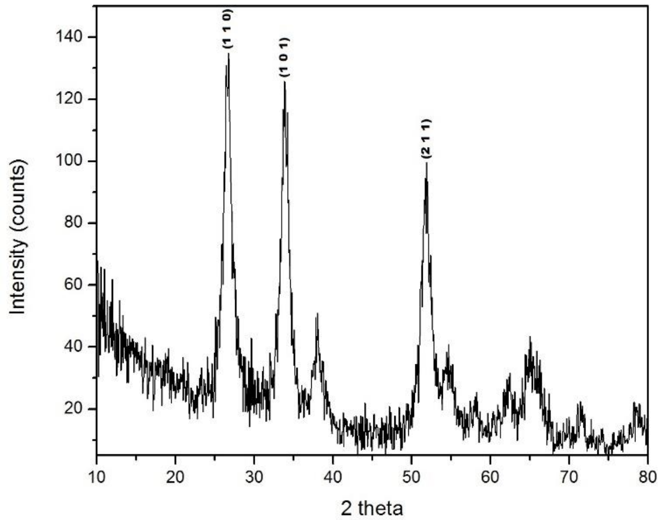

Figure 1. XRD pattern of SnO_2 nanoparticles

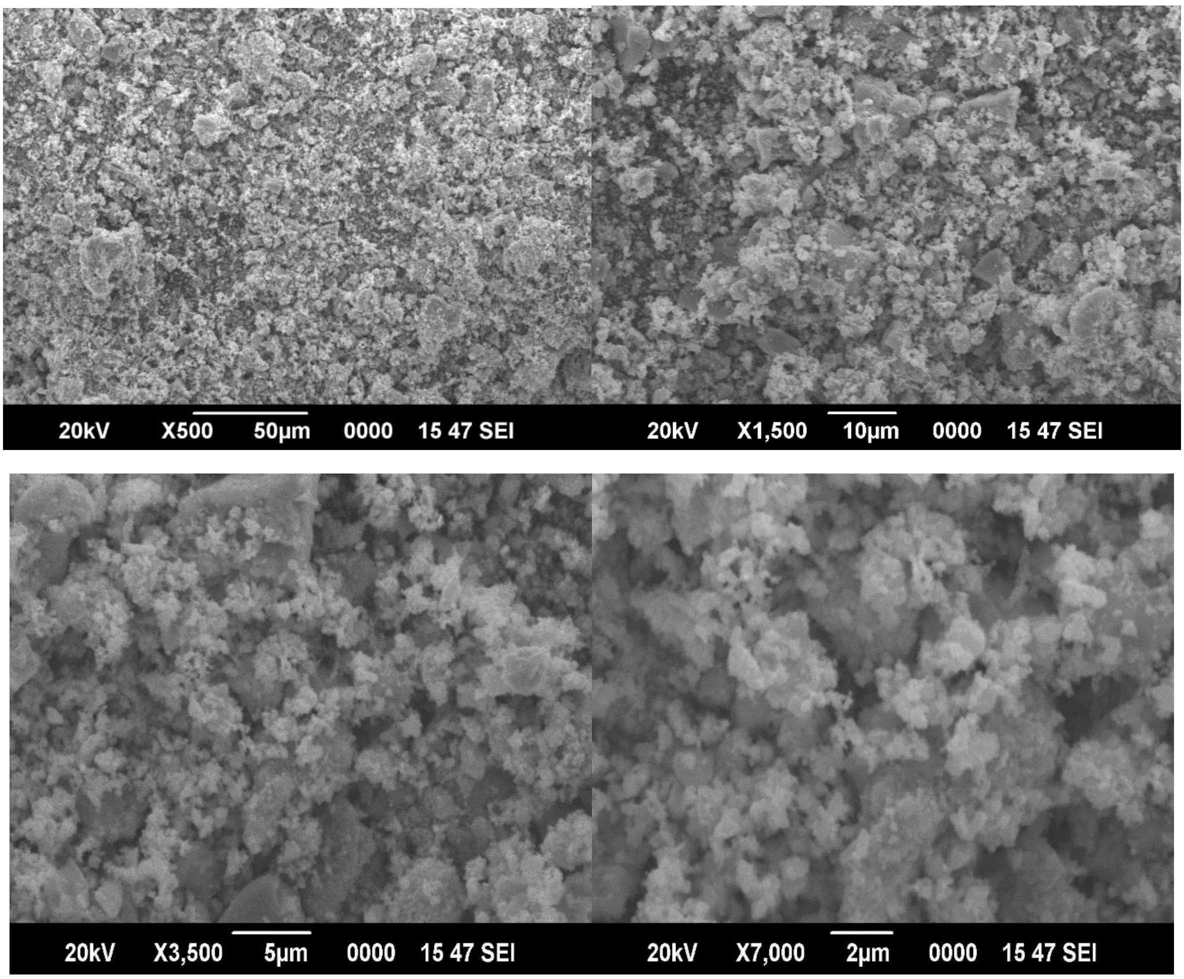

Figure 2. SEM images of SnO_2 nanoparticles

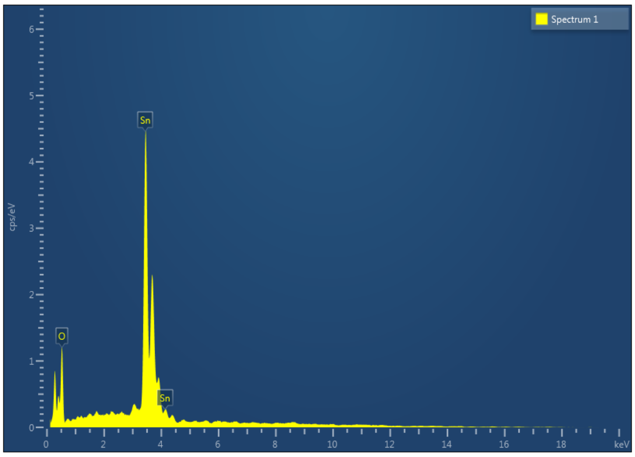

Figure 3. EDAX spectrum of SnO_2 nanoparticles

Optical Studies

UV Vis Spectroscopy

The UV-Vis absorbance spectra of SnO2 nanocrystalites are shown in the figure 3. The absorption edge has been obtained at a shorter wavelength. The broadening of the absorption spectrum could be due to the quantum confinement of the nanoparticles. The calculated band gap energy value 3.3 -3.5 eV.

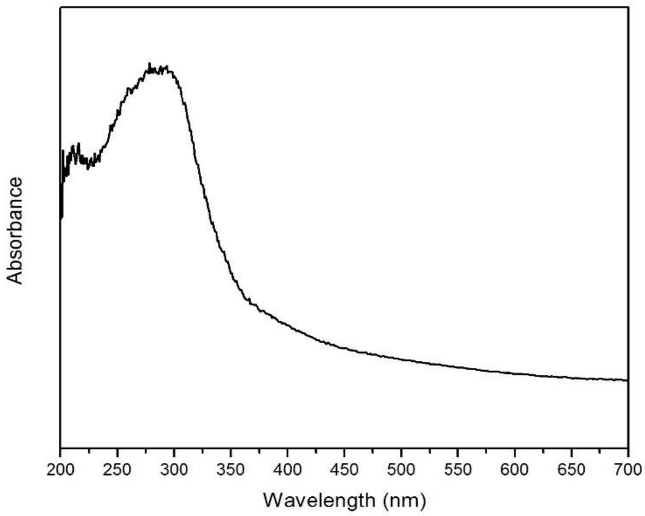

Figure 4. UV-Vis absorption pattern of SnO_2 nanoparticles

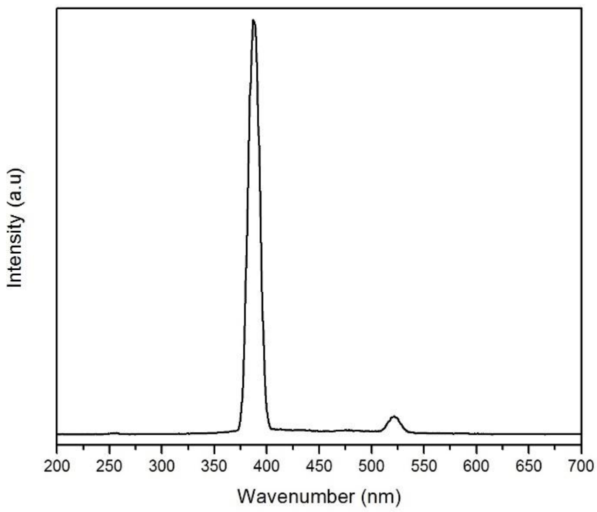

Figure 5. Photoluminescence pattern of SnO_2 nanoparticles

Photoluminescence Studies

The excitation energy of the photoluminescence spectrum is found to be 2.95 eV & 4.2 eV (360 nm and 520 nm). The maximum emission of photoluminescence occurs at 364 nm in a visible emission band. The quantum size effects and the oxygen vacancies could play a dominant role in the luminescence processes.

IV. CONLUSIONS

Tin oxide nanoparticle was synthesized by precipitation method. Nanoparticles are annealed up to 500oC. The XRD studies show that, nanoparticles prepared are in nanocrystalline range. XRD results confirmed the tetragonal crystalline structure of SnO2 nanoparticles. The size and morphology of the Tin oxide nanoparticles were characterized using scanning electron microscopy (SEM).The optical properties were studied by the UV-Vis absorption and photoluminescence spectra.

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