

Synthesis and Characterization of Tin Oxide (SnO) nanoparticles

1. Introduction:

Metal and metal oxide nanoparticles, differing from their bulk analogs in chemical, thermal, optical, magnetic and other properties, are widely used in catalysis, medicine, electronics and other fields. Many different methods of nanoparticle synthesis with the use of supercritical fluids (SCF) have been suggested, in particular, the reverse micelle, rapid expansion and hydrothermal synthesis methods [1-3]. Among these methods hydrothermal process has the best advantages and possibilities for synthesis of metal and metal oxide nanoparticles [4-6]. SnO is an important semiconductor material with excellent chemical and physical performances. As an effective photocatalyst, SnO nanostructures can photo degrade organic pollutants to other nontoxic small molecules. In this work, we report on the synthesis of SnO nanoparticles using a one-pot hydrothermal method.

This chapter presents the synthesis of SnO nanoparticles. The synthesized SnO nanoparticles were characterized with various experimental methods such as X-ray Diffraction, TEM, SEM, FT-IR, EDAX and UV-Vis spectroscopy etc.

2. Synthesis of SnO Nanoparticles:

The synthesis of SnO nano particles was carried out by conventional hydrothermal protocol. $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ and Dilute HCl were used as starting materials for the synthesis. In a typical procedure stock solutions of 0.1 M (2.3 g) $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ solution prepared in 50 ml of 1.0 M HCl under stirring. To this stock solution 250ml of SnCl_2 (0.1 M) solution prepared in appropriate amount of urea was added under continuous stirring in order maintain the pH of reactants as 9. The solution was transferred into Teflon-lined autoclave and maintained a 150°C for 1hr under autogenously pressure. It was then allowed to cool naturally to room temperature. After the reaction was complete, the resulting white solid product was washed with distilled water, filtered and then dried in air in a laboratory oven at 60°C (figure1).

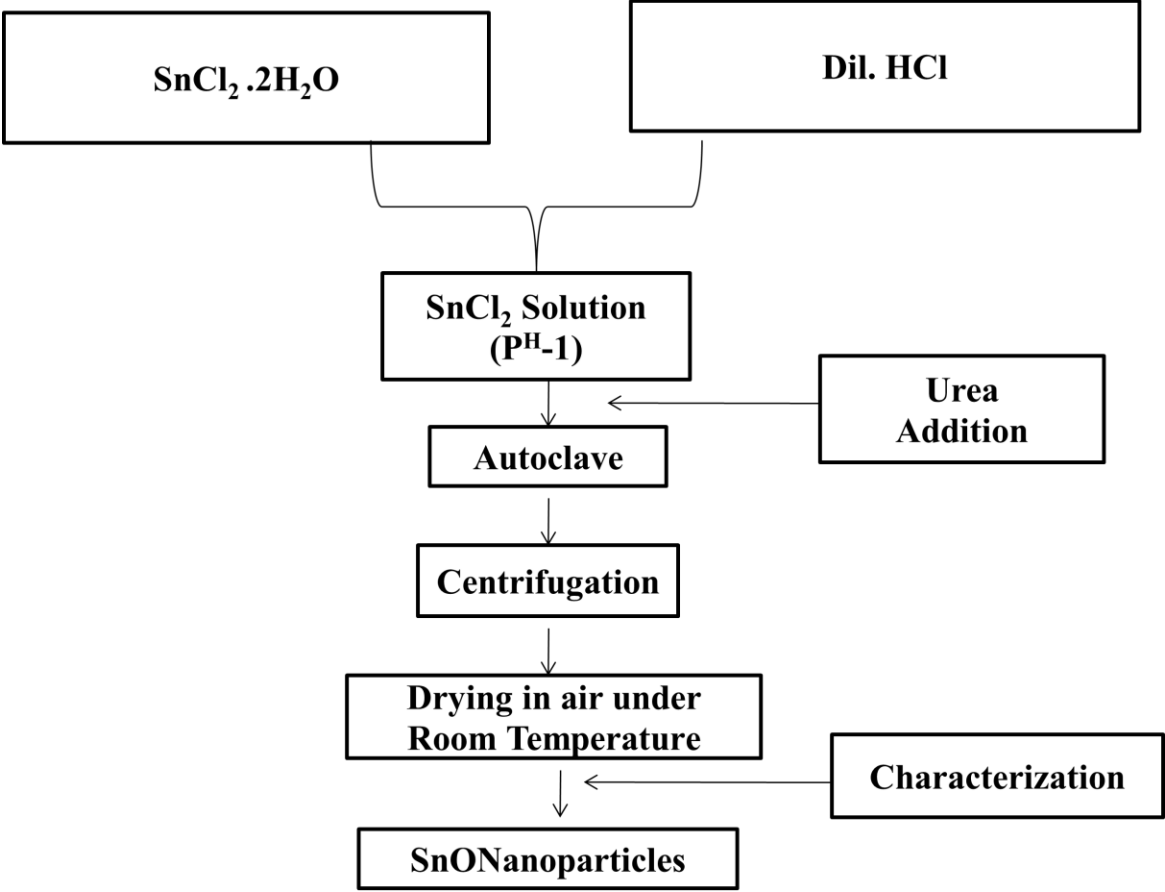


Figure 1: Flowchart for the synthesis of SnO Nanoparticles.

3. Characterization of SnO nanoparticles

3.1 X-ray Diffraction of SnO nanoparticles

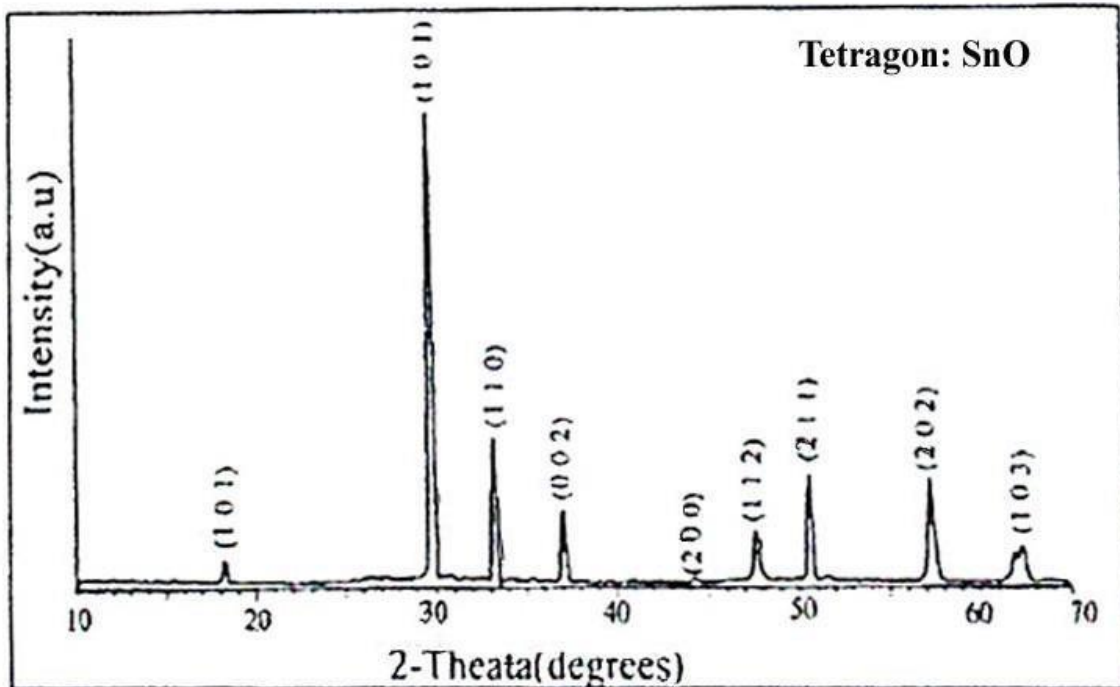


Figure 2: XRD pattern of SnO Nanoparticles

The recorded X-ray diffraction pattern of SnO powder sample synthesized by hydrothermal technique is shown in figure 2. The calculated from the X-Rd data of SnO nano particles are found to be having diameter ~ 50 nm in size [7,8] with crystalline in nature. The XRD pattern reveals the formation of SnO nanoparticles with polycrystalline phase demonstrating rutile structure with crystal planes in (0 0 1), (1 0 1), (1 1 0), (0 0 2), (2 0 0), (1 1 2), (2 1 1), (2 0 2) and (1 0 3) planes at 18.2, 29.8, 33.2, 37.1, 44.3, 47.8, 50.7, 57.3 and 62.5 theta values corresponding to SnO and these values well matches with JCPDD

No.36-1451 data.

3.2 TEM Micrograph of SnO Nanoparticles:

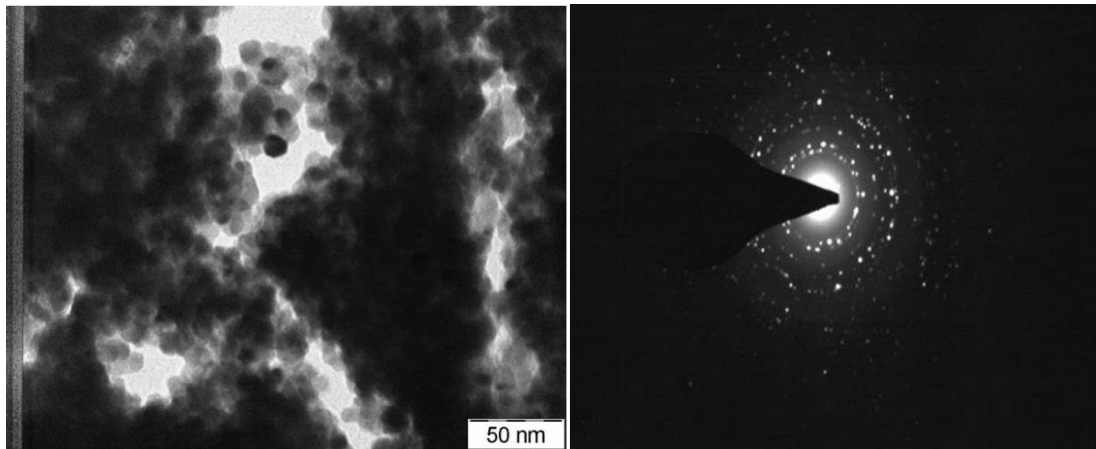


Figure 3: TEM of SnO nano partricles

Fig 3 represents the TEM image of SnO nanoparticles. TEM images of SnO nano particles are clear tetragonal structures having diameter ~ 50 nm, [132,133, 7,8] which clearly indicates that the SnO nano particles are highly crystalline in nature.

3.3 SEM Micrograph of SnO Nanoparticles:

The SEM micrograph of SnO nanoparticles is appeared in figure 6.4. It is seen that the particles are mesoporous in nature with molecule size of ~ 50 nm. [7-10] Filtering Electron Microscopy (SEM) is a fundamental portrayal apparatus for legitimately imaging nano materials to get quantitative proportions of grain size, size

conveyance, and morphology. SEM Micrographs at $1\mu\text{m}$ offer better outstanding about passivation of SnO nano particles growth aspect. Images showed the developed shape of the composite and exhibit uniform particles with diameter of 100 nm. Further the closest view shows the absence of agglomeration to a large extent in the particles synthesized via hydrothermal method.

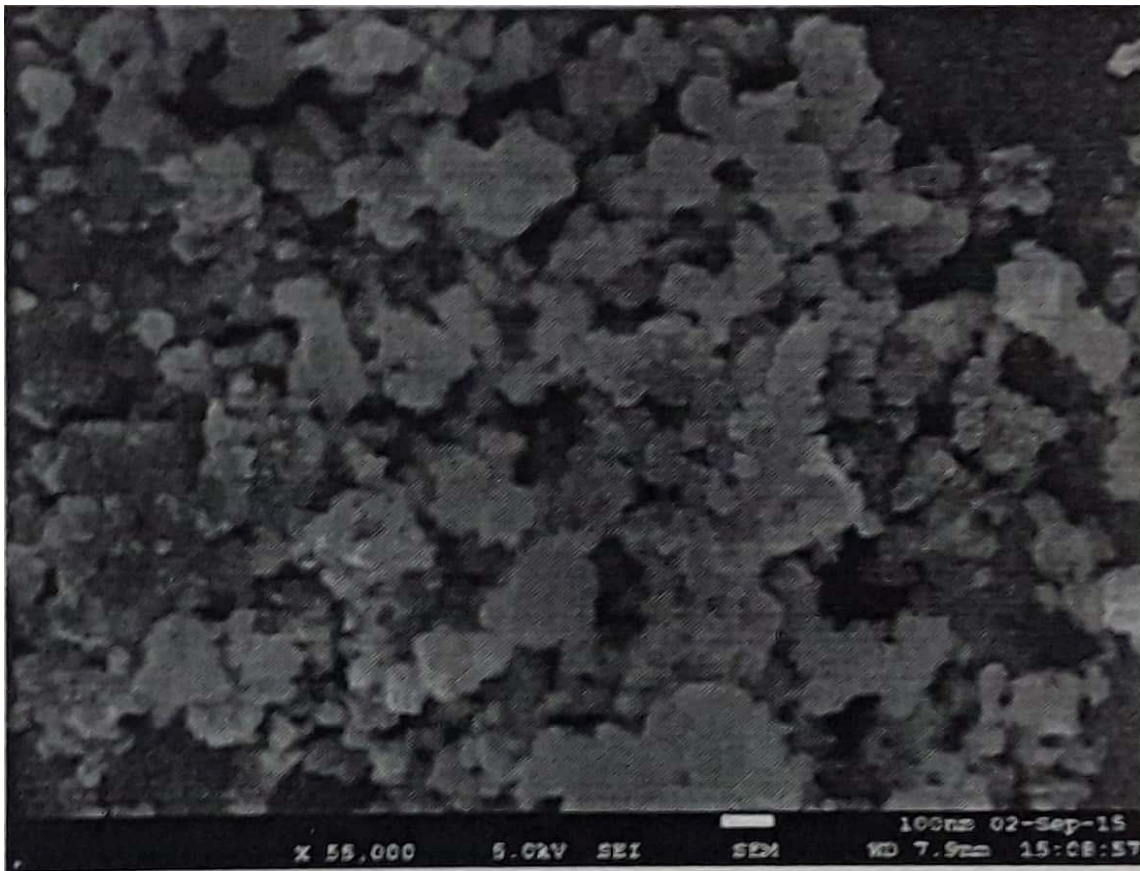


Figure 4: SEM image of SnO nanoparticles.

3.4 FT-IR Spectrum of SnO Nanoparticles:

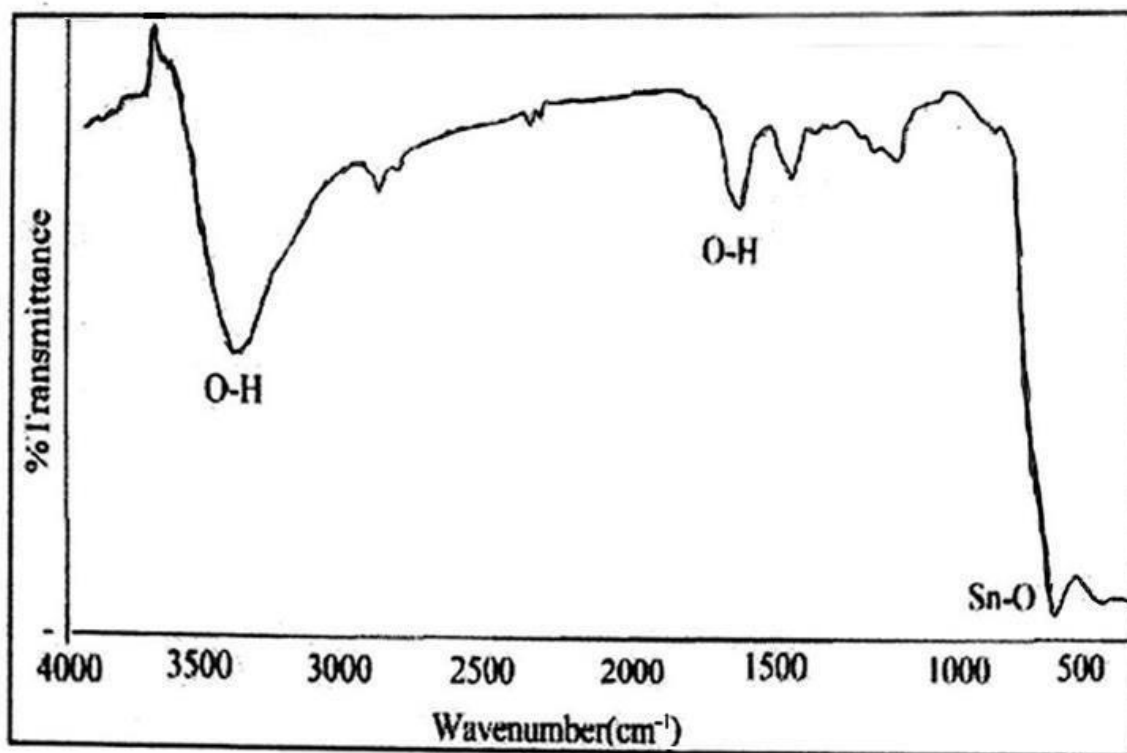


Figure 5: FTIR spectra of SnO nano particles.

The FT-IR range of the SnO nanoparticles, the solid vibrational peaks at 3456 cm^{-1} and 1618 cm^{-1} are credited primarily to the O-H extending vibration of surface hydroxyl gathering or adsorbed water on the SnO nanoparticles. Pinnacle saw at 1409 cm^{-1} is appointed to N - O, this might be from urea utilized in the examination. At lower wave number region exhibits a very strong vibration at 515 cm^{-1} is all Sn-O vibration, [7, 8] which clear evidence of nanoparticle of SnO as shown in fig.5.

3.5 EDAX of SnO Nanoparticles:

Table: 1 EDAX of SnO

Element	Weight %	Atomic %
O K	31.29	45.29
Sn L	68.71	54.71
Total	100.00	100.00

Figure 7: EDAX graph of SnO nanoparticles and also obtained data from EDAX of SnO nanoparticles have shown in Table 1. Energy Dispersive X-ray Spectroscopy analysis was carried out for SnO nano particles. The atomic weight percentage of the oxygen was found to be 45.29% and Tin was found to be 54.71% [8]

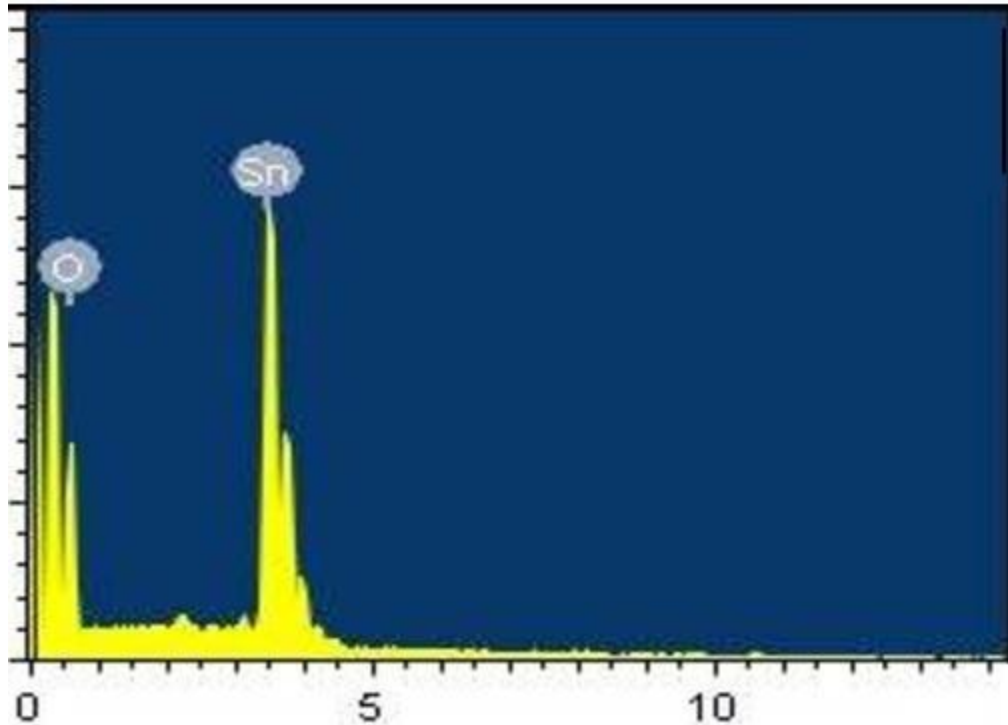


Figure 6: EDAX of SnO nanoparticles.

3.8 UV-visible spectroscopy:

The frequency at pinnacle of the absorbance range was estimated. With the frequency, band hole (in electron Volts) was determined utilizing the principle

$$E = \frac{hc}{\lambda}$$

Where h is plank's constant, $E = 4.136 \times 10^{-15}$ eV

The Speed of light in vacuum, $c = 3 \times 10^8$ m/s

λ is wave1ength in meters up on substitution

$$E = \frac{4.136 \times 10^{-15} \times 3 \times 10^8}{\lambda} = \frac{1.241 \times 10^{-6}}{\lambda} eV$$

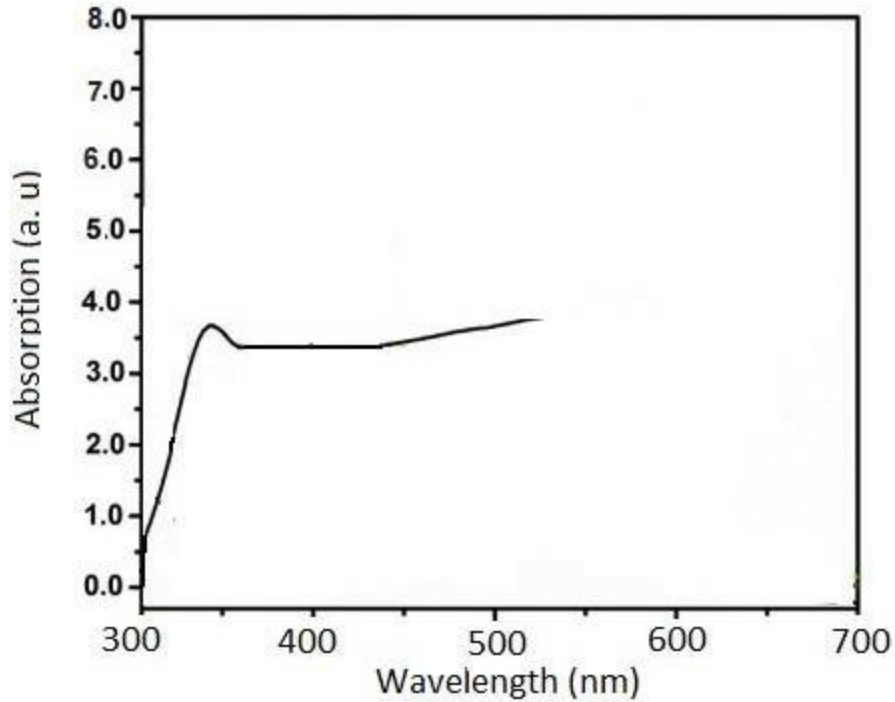


Figure 7: UV-visible spectroscopy of SnO nanoparticles.

Fig. 7 demonstrates the UV – Vis spectra of SnO nanoparticles. The absorbance spectrum was observed Energy band gap is 3.85 eV at 322 nm wavelength [11].

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