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Synthesis and Investigation of Ce doped Tinoxide (SnO_2) nanoparticles

P.M.R. Mani Bharathi[1], T.Amutha[1], M.Rameshbabu[2] and K.Prabha[1*]

[1] Department of Physics, Mother Teresa Women's University, Kodaikanal. Tamil Nadu, India
[2]Department of Physics, Arulmigu Palaniandavar College of Arts and Culture, Palani, Tamil Nadu,India

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Abstract - *In the Present work, pure and Ce doped SnO_2 nanoparticles have been prepared by the Co-precipitation method. The prepared samples have investigated by Powder XRD pattern, FT-IR, SEM and EDAX analysis, UV-Vis measured. From the XRD pattern of all the prepared samples are identified as Orthorhombic with space group pnnm (58) and the grain size in the range of 24.85nm. In FT-IR results indicates the information of the O-Sn-O bonds shows that the stretching of vibration bonds in the particular frequency region. From the UV-Vis absorption spectra, to find the band gap energy of the prepared tin oxide nanoparticles by using Tauc's plot. SEM and EDAX for various concentration were confirms the surface morphology of SnO_2 nanoparticles.*

***Key Words*: Tin Oxide, XRD, SEM & EDAX, FT-IR, UV-Vis studies.**

1. INTRODUCTION

Tin oxide is one of the most important n-type semiconductors. It having the wide band gap energy is 3.6eV(1). SnO_2 having the more number of applications, such as optoelectronics, gas sensors(2), solar cells(3) and lithium batteries(4). Tin oxide having most interested in the properties of photo catalytic. Due to its high photochemical stability, strong oxidizing power, low cost and non- toxic nature. Many synthesis methodology are used to synthesis the SnO_2 nanoparticles like Sol-gel method(5), thermal decomposition method(6), solvothermal method(7), chemical precipitation(8), chemical vapour deposition method(9). Among the various methods, the co-precipitation method is one of the best suitable method for synthesis the nanoparticles, because it having the low cost and there is no need to require the high temperature and pressure. Now-a-days, the research has been focused on the photo luminescent properties in the metal oxide semiconductor nanoparticles. In the present work, pure and Ce doped SnO_2 nanoparticles have been prepared by the Co-precipitation method.

2. EXPERIMENTAL ANALYSIS

2.1 Synthesis

SnO_2 nanoparticles can be prepared by co-precipitation method. The preparation of pure and Ce doped SnO_2 nano particles. The analytical grade of 98M & 96M of $SnCl_2.2H_2O$ and 2M & 4M of $Ce(No_3)_3.6\ H_2O$ were taken and to dissolved the DD water and stirred each for half an hour by using the Magnetic stirrer. Then, ammonium hydroxide (NH_4OH) (2ml) was added into the solution (drop by drop), with stirring, until pH 10 was reached. After reached the pH value. The solution was string for2 hours. After getting the homogeneous solution was to kept at room temperature for 24 hours. The precipitate the Sol-gel was washed several times with ethanol and DD water and it will be calcined at 400 ˚C for 2 h to remove the inorganic groups. After annealing the particles were ground in an agate mortar and pestle to obtain fine powder. Finally to get the annealed powder sample of pure and Ce doped SnO_2.

3. RESULTS AND DISCUSSION

3.1 X-Ray Diffraction Analysis

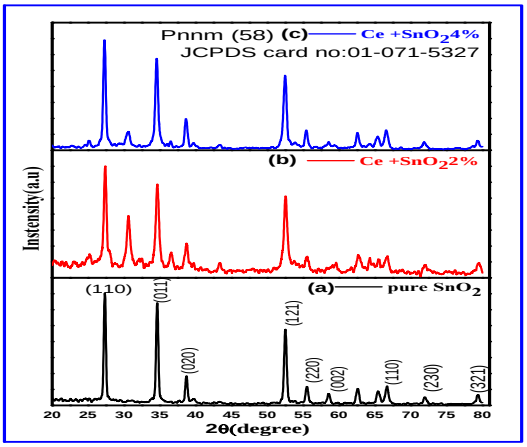

Fig.1: XRD patterns of (a) Pure (b) Ce2% and (c) Ce4% doped SnO_2 nanoparticles.

Table 1: Crystallite size of pure and Ce doped SnO_2 nanoparticles.

S.No	Sample Name	Grain Size(nm)
1	Pure SnO_2	17.92
2	Ce 2%doped SnO_2	27.54
3	Ce 4%doped SnO_2	29.11

Fig.1 shows the X-ray diffraction (XRD) pattern of pure and Ce doped SnO_2 nanoparticles. The XRD study reveals that, all the prepared samples were identified as orthorhombic structure (JCPDS card no: 01-071-5327) with space group pnnm(58). The Grain crystalline size D can be calculated by using the Scherer's equation (i.e.,)D= kλ/(β cosθ), where 'k' is the shape factor, 'λ' is the wavelength of x-rays used, β is the full width at half maximum of the prominent Bragg peak and θ is the Bragg angle. From the small crystalline size indicated the presence of broad peaks. When the increasing the dopant level of Ce, it in indicates that the intensity level CeO_2 peaks also increased, it's shows that, the peak shifted towards the higher angle. The crystallite size of the pure and Ce doped SnO_2 samples were calculated. When the concentration of doped increases the grain sizes also increased. Crystallite size of pure and Ce doped SnO_2 nanoparticles are shown in the Table 1.

3.2 FT-IR Analysis

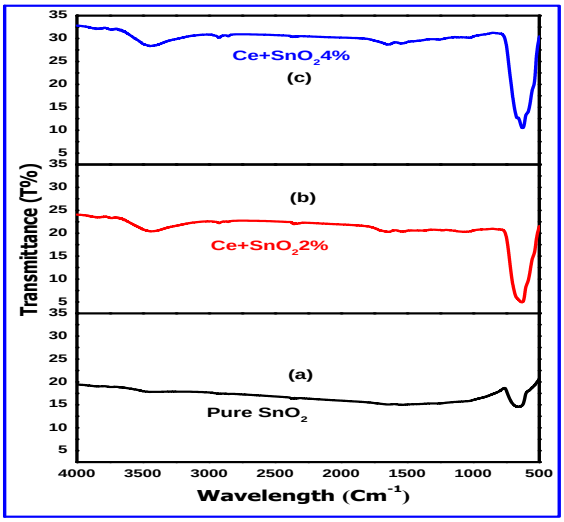

Fig -2: FT-IR spectra of (a) Pure (b) ce2% and (c) ce4% doped SnO_2 nanoparticles.

Fig. 2 shows that, the FT-IR absorption spectrum of pure and Ce doped SnO_2 nanoparticles. The peak at 3447.14 cm-1 it indicates the Stretching vibration of O-H groups. The absorption bands at 1634 cm-1 indicates the deformation mode of OH groups. The Peak at 646 cm-1 refers as the pure tin oxide and also denoted to the stretching vibrations of O-Sn-O bonds. The transmission band at the stretching vibrations of O-Sn-O bonds formed by oxalating reaction(5). From the FT-IR studies the prepared samples were confirmed the presence of $Sn0_2$ nanoparticles.

3.3 UV-Vis. Analysis

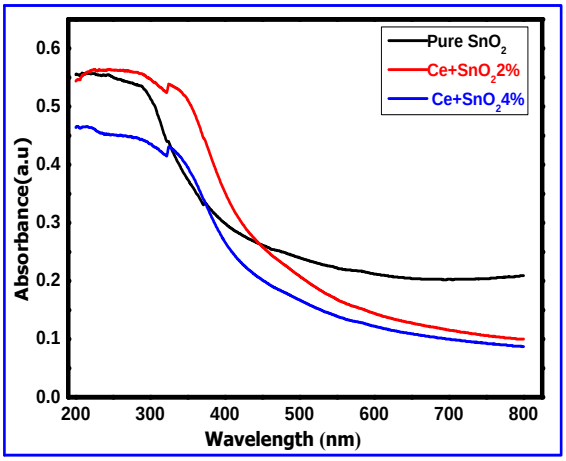

Fig.3: UV-Absorption of (a) Pure (b) Ce2% and (c) Ce4% doped SnO_2 nanoparticles.

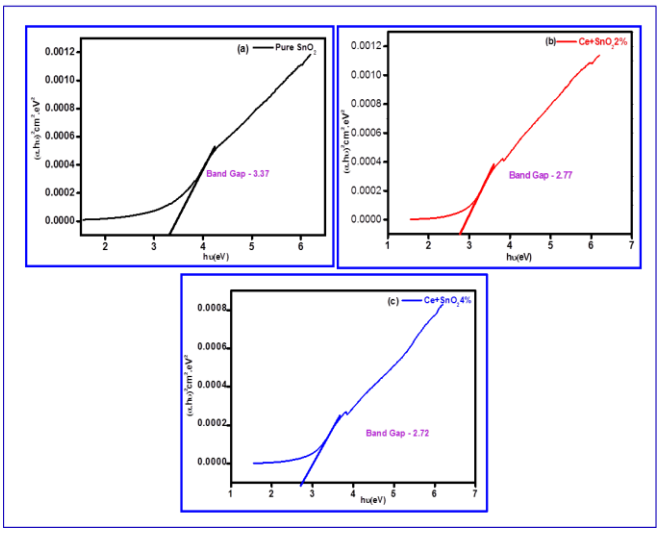

Fig.(3a-3c):Tauc's plot of of (a) Pure (b) Ce2% and (c) Ce4% doped SnO_2 nanoparticles.

Table 2: Band gap energy of pure and Ce2% and Ce4% doped SnO_2 nanoparticles.

S.No	Sample Name	Band gap energy(eV)
1	Pure SnO_2	3.37
2	Ce 2%doped SnO_2	2.77
3	Ce 4%doped SnO_2	2.72

Fig.3 shows that, UV-Absorption of Pure, Ce2% and Ce4% doped SnO_2 nanoparticles. From the UV-Vis spectra, the absorption edge shifts towards to the red shift ranges, due to increasing the dopant concentration. Fig.3a-3c shows that, the Tauc's plot of of Pure, Ce2% and Ce4% doped SnO_2 nanoparticles. The band gap energy can be calculated by using Tauc's plot. From the table 2 shows that, when the dopant of the concentration increases, the band gap energy decreases it may be due to some substitution of Ce ions in to the tin oxide nanoparticles.

3.4 SEM and EADX Analysis

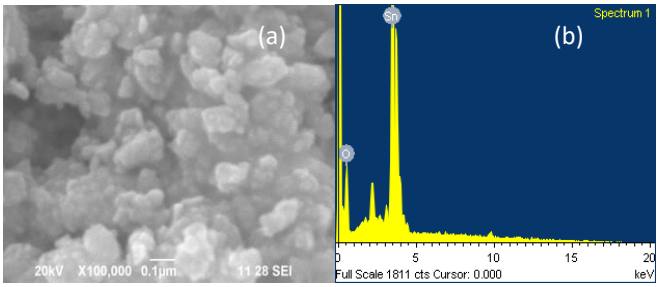

Fig.4a-b: (a) SEM image of pure SnO_2 and (b) EDX spectrum of pure SnO_2 nanoparticles.

Table 3: Atomic Weight % of pure SnO_2 nanoparticles.

S.No	Element	App Conc	Intensity Corrn.	Weight %	Weight % Sigma	Atomic%
1	O K	17.28	0.3399	32.52	1.20	78.14
2	Sn L	96.09	0.9111	67.48	1.20	21.86
Total : 100.00						

S.No	Element	App Conc	Intensity Corrn.	Weight %	Weight % Sigma	Atomic%
1	O K	29.91	0.3754	39.80	1.05	83.09
2	Sn L	106.38	0.8939	59.44	1.05	16.73
3	Ce L	1.17	0.7744	0.6	0.31	0.18
Total : 100.00						

Table 4: Atomic Weight % of Ce 2 % doped SnO_2 nanoparticles.

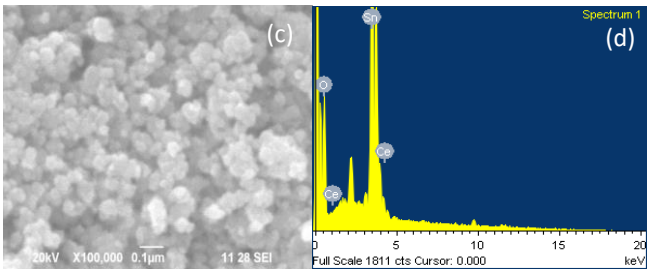

Fig.4c-d: (c) SEM image of Ce2% doped SnO_2 and (d) EADX spectrum of Ce2%doped SnO_2 nanoparticles.

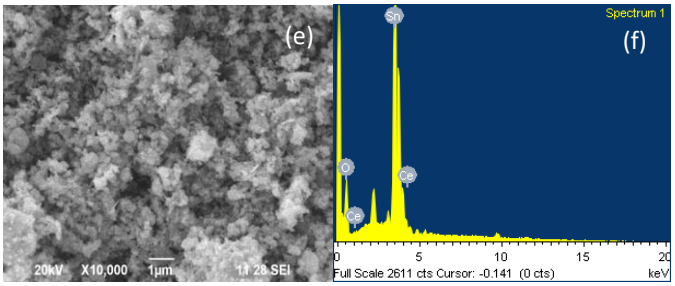

Fig.4e-f: (e) SEM image of Ce2% doped SnO_2 and (f) EADX spectrum of Ce2%doped SnO_2 nanoparticles.

S. No	Element	App Conc	Intensity Corrn.	Weight%	Weight% Sigma	Atomic %
1	O K	19.64	0.3469	31.41	1.11	77.36
2	Sn L	108.67	0.9115	66.14	1.10	21.95
3	Ce L	3.44	0.7793	2.45	0.35	0.69
Total : 100.00						

Table 5: Atomic Weight % of Ce 4 % doped SnO_2 nanoparticles.

Figure 4a-f, shows that the surface morphology and Table 3-5 shows the element composition of pure and Ce2% & Ce4% doped SnO_2 nano particles. SEM morphology shows the surface morphology of the Ce doped (SnO_2) nano particles. When the concentration of dopant increases with grain size also increases, which is also conform from XRD grain size, it may be due to some low calcinations and agglomeration are present in the particles. EDAX confirms the presence of prepared tin oxide nanoparticles.

4. CONCLUSIONS

Pure and Ce doped SnO_2 nanoparticles were prepared by the co-precipitation method. From, the XRD pattern studies identified as orthorhombic structure (JCPDS card no: 01-071-5327) with space group pnnm(58). The stretching vibration of the O-Sn-O bond, OH vibrational mode and deformation mode of OH groups identified by FT-IR. The results of band gap energy decreases, due the concentration of dopent increases. From the SEM and EDAX study confirms the presence of pure and Ce dopent SnO_2 nanoparticles.

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