Mixture and Description of SnO2 Nanoparticles complete by Sol Gel System.

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Abstract:

Thin films prepared from SnO2 sol have also been deposited on glass substrate by spin coating at 500 rpm for 15 seconds and then at 3000 rpm for 20 seconds.

Crystallite size was calculated to be ~30 nm from XRD results. Scanning electron microscopy (SEM) results show the formation of Nano diamonds (~ 40 nm) and Nano rods (~30 nm) after annealing at 300oC for 60 minutes.

Index Terms: Nanoparticles; SnO2, SEM, XRD, FT-IR.

INTRODUCTION

Enormous efforts are being taken towards the development of nanometer sized materials in studies related on one hand to their fundamental mechanism such as the size effect and the quantum effect, on the other hand towards application of these materials.

Metal oxide semiconductors are low cost and effective gas sensing material. Among the various metal oxide semiconductors, Tin Oxide SnO2 have been attracting much attention since they are highly conducting, transparent and sensitive to gases. SnO2 as a n-type semiconductor because of wide energy-gap has attracted many considerations, therefore this product was used in many fields such as transparent conducting films, catalytic materials, environmental monitoring, biochemical sensor, lithium rechargeable batteries, dye-sensitized solar cells and ultrasensitive gas sensors [1-4].

Many processes have been developed to the synthesis of SnO2 nanostructures, e.g., spray pyrolysis [5], hydrothermal methods [6-8], evaporating tin grains in air [9], chemical vapor deposition [10], thermal evaporation Davar et al. [14] reported the synthesis of SnO2 nanoparticles by thermal decomposition using [bis(2- hydroxyacetophenato) tin(II)], [Sn(HAP)2], as precursor. Salavati-Niasari et al.[15] synthesized zinc blend ZnS nanoparticles by a thioglycolic acid (HSCH2COOH)-assisted hydrothermal technique via the reaction between a new inorganic precursor [bis(2-hydroxyacetophenato) zinc(II)], [Zn(HAP)2] and thioacetamide (CH3CSNH2). Gnanam and Rajendran [16] synthesized Nano crystalline tin oxide powders of about 15 to 20 nm in size using different surfactants. such sodium dodecyl sulphate and polyethylene glycol via hydrothermal reaction at 150°C for 12 hours and studied their structural and photoluminescence properties. Metal oxide semiconductor materials such as SnO2, ZnO, TiO2, WO3, Fe2O3, ZrO2, Cr2O3, BaTiO3, Ga2O3 etc. have been well reported as gas sensors in the form of thick film [18]. The SnO2 is used because of their long term stability, small size, light weight, low cost, good mechanical strength and high reliability. It has a strong physical and chemical interaction with adsorbed species and thermal stability in air up to 500 0C [19]. The changes in the properties of SnO2 due to gas adsorption are related to the nonstoichiometry, average co-ordination number per grain and the neck size effect in the functional material. As such there is no specific report relating to its structure and sensing properties. Catalysts like Pt, Pd, Ag, Ru and CuO often added to the base material to improve the gas sensitivity and selectivity [20,21].

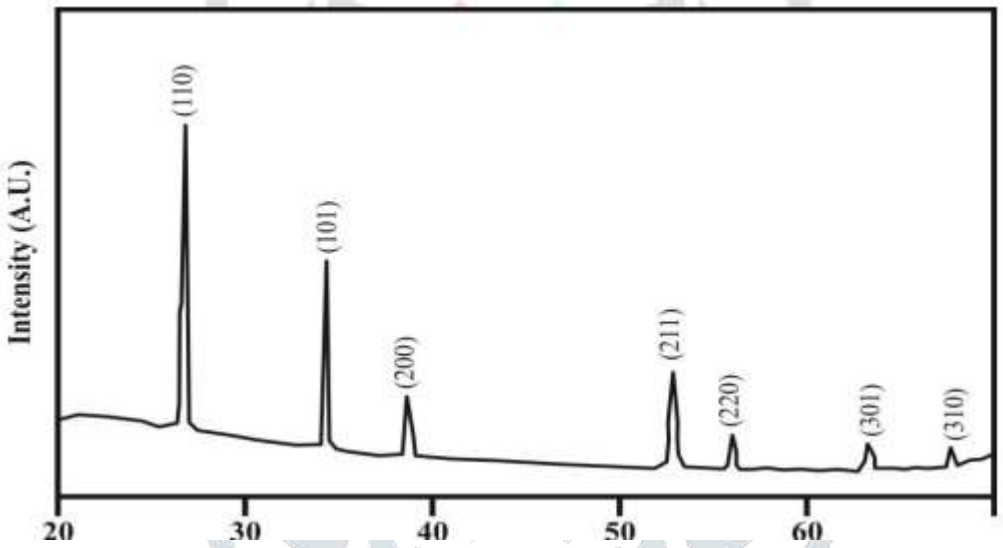
EXPERIMENTAL DETAILS:

SnO2 nanoparticles were synthesized by using Sol-Gel method. All the chemicals used for the preparation were of analytical grade. It includes tin chloride hydrate SnCl2.2H2O was used as starting material. A solution

of 0.1 mole % SnCl2 in ethylene glycol was prepared by dissolving appropriate amounts of SnCl2 under vigorous stirring at 60°C until colorless and transparent sol was obtained. 1% poly vinyl alcohol. The mixture is sticky, dry the mixture with a natural process. The solution was allowed to centrifuge in presence of water and acetone to remove impurities, for the solution and allowed to dry at room temperature. Dried powder of SnO2 was kept in stainless steel autoclave for 24 hours at 1500C and calcinaised at 4000C for 2 hours in a muffle furnace. The dried powder of SnO2 is used for the characterization by XRD, SEM, FTIR. etc. Samples were dried at room temperature for 24 hours and then annealed at 300°C for 1 hour.

RESULTS AND DISCUSSION

Crystallographic structure along with the phase variation and crystallite size of SnO2 samples was studied by Rigaku D-MAX/IIA X-ray Diffractometer (XRD). CuKα (Ni filtered) radiations (λ =1.5405 A.U.) were used to obtain the XRD pattern. The X-ray diffraction study was undertaken. X-Ray diffraction analysis of SnO2 samples were carried out in the range 20-800 range using CuKα radiation. Figure. shows an XRD pattern of SnO2 sample plotted in the range 20-800 (2θ) verses intensity having several peaks of SnO2 indicating random orientation for the tetragonal rutile nature and measured interplaner distance agreed with the value reported for SnO2 in literature, which gives a highest peak at 26.78 degree on calculating the crystal size by Debye Scherer formula, it is found that the size is about 33.4 nm.

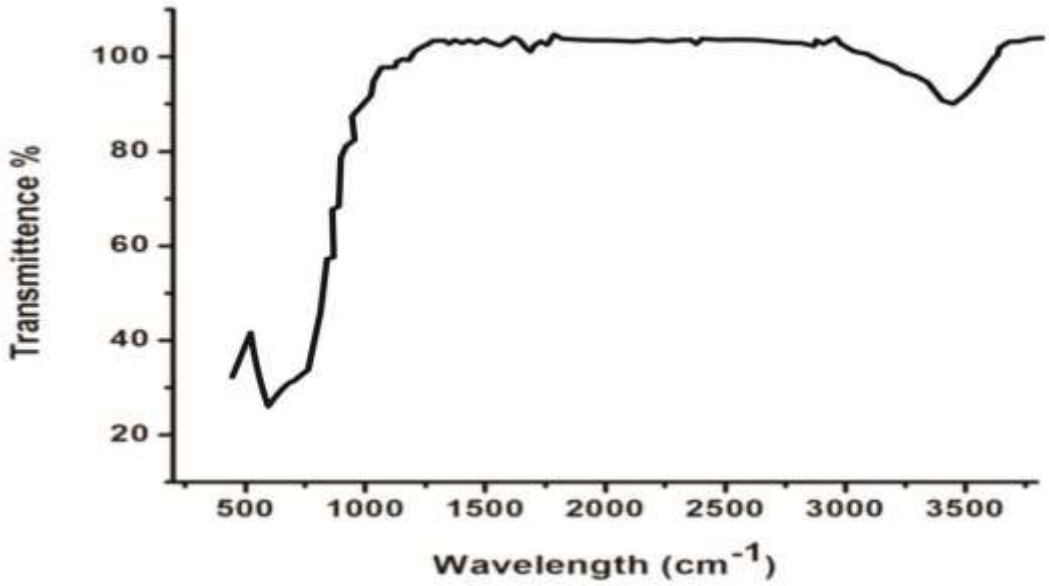


Surface Morphology:

The model JEOL, JSM-6360 was used for the determination of morphology of nanoparticle. Fig. depicts the Scanning electron micrograph (SEM) of the prepared SnO2 nano powder annealed at 4000C for 2 hours. Larger particles in this figure may be aggregates of the smaller particles. The surface of SnO2 nanostructure exhibits a highly corrugated surface, where voids between the crystalline increase the specific surface area, which is a key feature for high sensitivity of gas sensors.

FTIR Spectra :

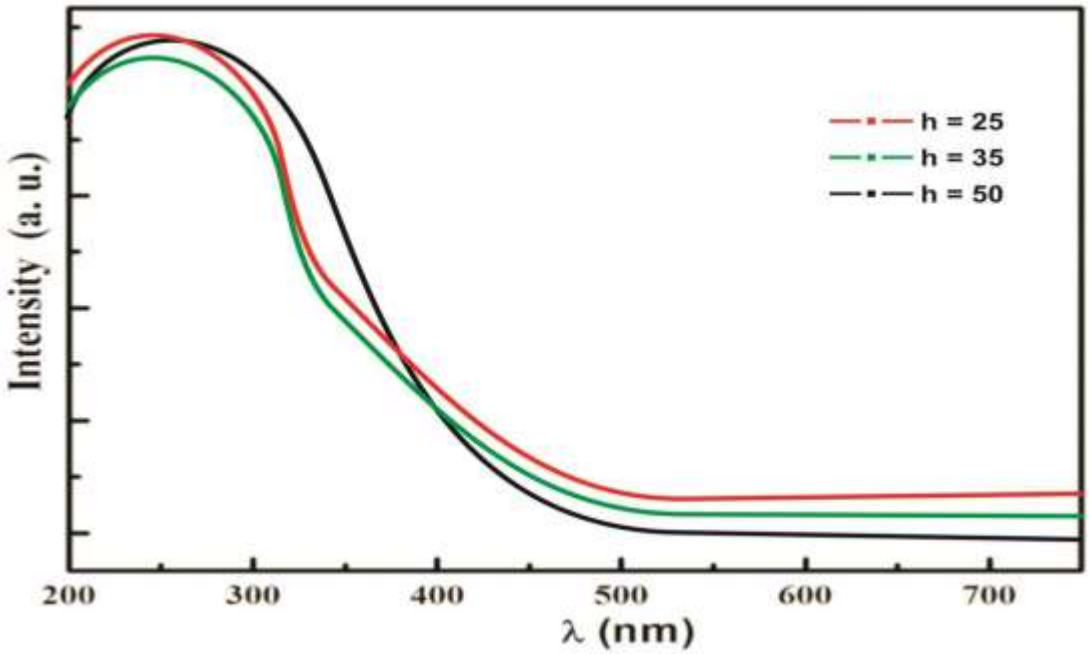
The FTIR spectra are analyzed between absorption and wavelength, these vibrational spectra gives peaks due to resonance of vibration, stretching of atoms and bond between them in According to quantum mechanics, these frequencies correspond to the ground state at lowest frequency and several excited states at higher frequencies. For any given transition between two states the light energy must exactly equal the difference in the energy between the two states usually ground state (E0) and the first excited state (E1). Difference in the energy state = Energy absorbed E1 - E0 = h c /λ Where, h is the Plank's constant, c is the velocity of the light, λ is the wavelength of the light.



shows the FTIR pattern of SnO2

For crystalline SnO2, optical transition has been shown to be direct. The variation in the absorption coefficient as a function of photon energy for allowed direct is given by $\alpha(h\nu) = A(h\nu - Eg)1/2$ where, α is the absorption coefficient, A is a constant, h is Planck's constant, ν is the frequency, and Eg is the band gap energy.

UV-vis-IR absorption spectrum:



UV-vis-IR absorption spectrum of SnO2 nanoparticles with different hydrolysis rate.

CONCLUSIONS:

The present study illustrates that Sol-Gel Spin Coating method which produce single phase material at lower temperature and shorten the synthesis time. X-Ray diffraction (XRD) result shows that the obtained SnO2 nanoparticles were composed of tetragonal lattice nature with high crystallinity. Scanning electron microscopy (SEM) result showed that grains are uniformly distributed and the particles are spherical in nature. The FTIR spectra gives peaks due to resonance of vibration, stretching of atoms and bond between them. In UV–vis–IR absorption spectrum of SnO2 nanoparticles all absorption curves exhibit an intense absorption, owing to the relatively large exciton binding energy.

REFERENCES:

[1] H. Liu, Sh. Gong, Y. Hu, J. Zhao, J. Liu, Zh. Zheng, D. Zhou, 2009. Synthesis and Characterization of SnO2 nanoparticles by a facile Precipitation Method, Ceram. International. 35: 961-966. [2] X. Chu, Y. Han, S. Zhou, H. Shui, 2010. Trimethylamine Sensing Properties of Nano-SiO2 prepared using Microwave Heating Method. Ceram. International. 36: 2175-2180. [3] Y. Tan, Ch. Li, Y. Wang, J. Tang, X. Ouyang, 2008. Fast-response and high sensitivity gas sensors based on SnO2 hollow spheres. Thin Solid Films, 516: 7840-7843. [4] Y. Wang, Ch. Ma, X. Sun, H. Li,2002. Synthesis and Characterization of SnO2 nanoparticles by CoPrecipitation Method , Inorg. Chem. Commun. 5: 751-755. [5] Paraguay-Delgado, F.,Antúnez-Flores, W., Miki-Yoshida, M., Aguilar-Elguezabal, A, Santiago, (2005).Structural analysis and growing mechanisms for long SnO2.Thin Solid Films, 16: 688-696. [6] Cheng, B., Russell, J.M., Shi, W., Zhang, L., Samulski, E.T. , 2004. Large-scale, Solution phase growth of single-crystalline SnO2 nanorods. Journal Am. Chem. Soc. 126: 5972-5982. [7] Du, F., Guo, Z., Li, G. 2005.Hydrothermal synthesis of SnO2, hollow microspheres. Mater. Lett. 59, 2563-2572. [8] Fujihara, S., Maeda, T., Ohgi, H., Hosono, E., Imai, H., Kim, S. 2004. Hydrothermal routes to prepare Nano crystalline mesoporous SnO2 having high thermal stability. Langmuir 20: 6476- 6488. [9] Duan, J., Yang, S., Liu, H., Gong, J., Huang, H., Zhao, X., Zhang, R., Du, Y. 2005.Single crystal SnO2 , zigzag nanobelts. Journal of American Chem. Soc. 127: 6180-6191. [10] Liu, Y., Koep, E., Liu, M. 2005. A highly sensitive and fast-responding SnO2 sensor fabricated by combustion chemical vapor deposition. Chemical Mater 17: 3997-4010. [11] Dai, Z.R., Gole, J.L., Stout, J.D., Wang, Z.L. 2002.Tin oxide nanowires, nanoribbons, and nanotubes. J. Phys. Chem. B 106:1274. [12] Hu, J.Q., Ma, X.L., Shang, N.G., Xie, Z.Y., Wong, N.B., Lee, C.S., Lee, S.T. 2002.Large scale rapid oxidation synthesis of SnO2 Nano ribbons. J. Phys. Chem. B 106: 3823.