Eco-friendly Synthesis and Characterization of Nanostructure SnO_2 Thin Films Using *Citrus aurantifolia* Peel Extract by Spin Coating Method

Abstract

The present study of reveals green synthesis of nanostructured SnO_2 is becoming increasing importance as eco-friendly alternative to traditional production process because of its growing industrial applications. Thin film is produced using $SnCl_2.2H_2O$ solution which prepared in *citrus aurantifolia* peel extract and H_2O. The solution which prepared in *citrus aurantifolia* peel extract by spin-Coating System fabricated. Thin films are annealed at 100 °C and 200 °C for one hour. The structural properties were studied using characterization such as XRD, FTIR, and UV-Visible, FE-SEM, EDX analyzed for synthesized SnO_2 thin films.

Keywords: SnO_2 nanoparticles; Green synthesis; Spin coating; *citrus aurantifolia* peel leaf extract

Research Article

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Introduction

Nanotechnology is anticipated to open novel opportunities to prevent and fight against diseases using atomic scale tailoring of materials [1-3]. In the field of nanotechnology, the synthesis of nanoparticles of different sizes, shape, chemical compositions and controlled morphology with high dispersityis essential because they exhibit unique properties, which are not observed in bulk materials [3-5]. Nanoparticles play crucial roles in, Solar cell, photovoltaic, Photo catalytic, drug delivery, diagnostics, imaging, sensing, gene delivery, artificial implants and tissue engineering [6] and which has considerable attention because of their various applications. The green synthesis of SnO_2 is evolving an important branch of nanotechnology. Recently, researchers have focused on biologically synthesized SnO_2 because of its extensive applications in the development of new technology in the field of electronics, Solar cell, material science and medicine at the nanoscale [7]. *Gendarussa vulgaris* an important medicinal plant belongs to family *apocynaceae* and it is a perennial herb grown commercially for its alkaloids [8,9]. There are more than 70 alkaloids (mostly of indole type) that have been reported from different parts of *Celeome Gynandra* [10] and the major alkaloids are Vincristine and Vinblastine, which has anticancer property and used as a drug in the treatment of different cancers [11]. In India as well as other countries, tea made from the fresh leaf juice of *G. vulgaris* has been used by ayurvedic physicians for the treatment of certain skin problems such as dermatitis, eczema and acne [12-15]. The main aim of this study is to synthesize green SnO_2 NP by using the reducing tin oxide the fresh aqueous leaf extract of the herbal plant *citrus aurantifolia* peel leaf extract. SnO_2 NP synthesized by leaf extract results were compared to SnO_2 NP synthesized using spin coating method of synthesis were are investigated and reported. The synthesized SnO_2 films Different post sintered 100 °C and 200 °C for 25 minutes to investigate the phase transition and crystalline nature of materials. The synthesized materials were evaluated for the Solar cell applications [16].

Materials and Methods

Chemical and plant collection

The fresh, fully matured leaves of *Citrus aurantifolia* (lemon) were collected from the Nehru Memorial College campus Puthanamapatti, Tiruchirappalli, Tamil Nadu, India and were authenticated by a plant taxonomist from the Department of Plant Science, Periyar University, Salem. All chemicals used in this study were of high purity were obtained from Sigma (Bangalore, India) and Merck (Mumbai, India). The leaf is made into small piece and 40 gram extract directly taken into the beaker and extracted with 90 mL water for h 85°C**.** Before the film coating, the substrates were cleaned with detergent using toothbrush and rinsed under tap water, ultrasonicated in ethanol and H_2O, respectively.

Synthesis of SnO2 NPs and coating thin films

Lemon was grated and the peels were taken 10 g of the dried peels was mixed in 100 mL dH_2O for one hours at 85°C. The extract was cooled to the dried peels was mixed in 25°C and filtered with filtered paper to remove large particles. The color of the extract was light yellow. The extract was saved in refrigerator at 5°C for subsequent experiments. SnO_2 was used as a Tin source.10 g $Sncl_2$ was mixed with 100 mL of the peel extract under continuous stirring 95 °C. The cleaned substrate was fixed on the disk of spin

-Coater. 1 mL of the coating solution was injected on the substrate at 3000 rpm for 45 seconds. After the deposition, the film was different dried at 100 °C, and 150 °C for 25minutes in an oven in order to remove any residuals and obtained a well-Crystallized SnO_2 films.

Results and Discussion

X-ray diffraction pattern (XRD)

Figure 1 shows X-ray diffraction patterns obtained for the SnO_2 nanoparticles synthesized using leaf extract confirmed the formation of Tetragonal structure SnO_2 nanoparticles. The crystal structure of biosynthesized SnO_2 Nps different temperature 100 °C, and 200 °C at 2 hours, which shown well defined diffraction peaks at 26.75°,37,343°,37.88°,51.95°,54.50°,57.93°, 62.09°,64.95°,66.8°,71.70°,and 79.13° can be indexed to (1 1 0),(1 0 1),(2 0 0) ,(2 1 1),(2 2 0), (0 0 2), (3 1 0),(1 1 2), (3 0 1),(3 2 0) and (3 2 1) crystal planes of tetragonal SnO2 compared JCPDS card no(41-1445). The formation of the biosynthesis of high purity SnO_2 Nps. The diffracted pattern using Debye's Scherrer's formula D= (0.9λ)/βcosө. Sample M1 Crystalline size D=26 nm, and lattice parameters a=4.764, c=3.203nm, and lattice strain=0.492 ε x10^{-3}. The M2 crystalline average size 32 nm, calculated lattice parameters a=4.720, c=3.179 and lattice strain 4.1 nm obtained.

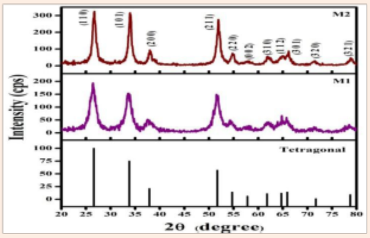

Figure 1: XRD patterns of (100 °C, (M1). (15o °C) (M2) of biosynthesized SnO_2 thin films.

Optical study

Thin films of Sno_2 nanostructure were prepared by spin coating to observe the optical properties. The absorbance SnO_2 films with different annealing conditions are shown Figure 2. The average absorbance of thin films at 296 nm is decreasing of band gap is increasing of crystallite size films.

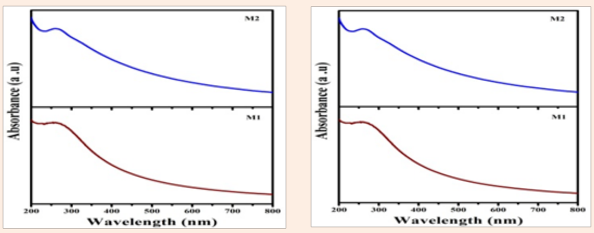

Figure 2: Uv-Visible absorbance spectra of biosynthesized SnO2 100 °C , (M1). (200 °C (M2).

FT-IR Study

Figure 3 shows the FTIR spectrum of biosynthesized SnO2 NPs. The band between 600 to 700 cm^{-1} can be assigned to O-Sn-O Asymmetric stretching. The peak located at 3437, 1646, 1335, 565, 551 and 2360 cm^{-1} can be assigned to aromatic CH2 out of plane bending , aromatic ring stretching of cyclic compound, N3 symmetric stretching and stretching vibration of olefinic compounds [38], respectively. The weak absorption at 1335 cm^{-1} denotes N-H stretching vibration of the secondary amine. Therefore, the biomolecules capping on the SnO_2 NPs probably are volatile essential oil and flavonoid.

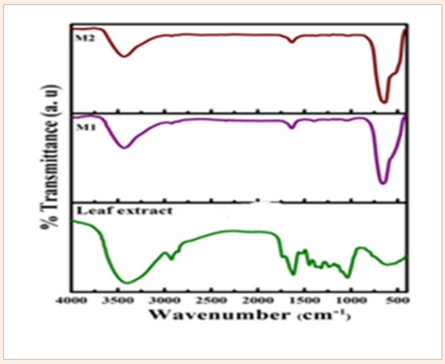

Figure 3: The FTIR spectrum of biosynthesized SnO2 NPs.

Conclusion

A simple, rapid green route for the synthesis of SnO_2 thin films prepared has been explored using from lemon feel extract using to spin coating system. SnO_2 thin film is different annealed up to 100 °C, 220 °C. XRD results confirmed the tetragonal crystalline structure. The most important thing is that these uniformly distributed nanostructures are formed without the use of any surfactant. Thin films are deposited on glass substrate in order to study the optical properties. Band gap values are in the range of 3.62eV-3.65 eV. For SnO_2 films FT-IR spectrum confirmed the strong presence of SnO_2 films.

Acknowledgment

None.

Conflicts of Interest

None.

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