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$_2$O solution which prepared in *citrus aurantifolia* peel extract and H$_2$O. 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

**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 dispersity is essential because they exhibit unique properties, which are not observed in bulk materials [3-5]. Nanoparticles play crucial roles in, Solar cell, photo voltaic, Photo catalytic, drug 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 pieces 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$_2$O$_2$, 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$_2$O 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 25 minutes in an oven in order to remove any residuals and obtained a well-Crystallized SnO₂ films.

Results and Discussion

X-ray diffraction pattern (XRD)

Figure 1 shows X-ray diffraction patterns obtained for the SnO₂ nanoparticles synthesized using leaf extract confirmed the formation of Tetragonal structure SnO₂ nanoparticles. The crystal structure of biosynthesized SnO₂ 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), (1 1 0), (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 SnO₂ Nps. The diffracted pattern using Debye’s Scherrer’s formula D = (0.9λ) / βcosθ. Sample M1 Crystalline size D=26 nm, and lattice parameters a=4.764, c=3.203 nm, and lattice strain=0.492 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.

Optical study

Thin films of SnO₂ nanostructure were prepared by spin coating to observe the optical properties. The absorbance SnO₂ 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.

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 SnO₂ NPs probably are volatile essential oil and flavonoid.

Conclusion

A simple, rapid green route for the synthesis of SnO₂ thin films prepared has been explored using from lemon peel extract using to spin coating system. SnO₂ 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 SnO₂ films FT-IR spectrum confirmed the strong presence of SnO₂ films.

Acknowledgment

None.

Conflicts of Interest

None.

References


