

# Synthesis and Characteristics of Microstructure Titanium Dioxide TiO<sub>2</sub> using sol-gel method

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**ABSTRACT:** Titanium Oxide thin films were synthesized by using spin-coating method. Thin films samples were characterized by their structural and optical properties. The prepared films were process by annealed at 400°C. Structural properties of TiO<sub>2</sub> thin films were studied using their HXRD pattern. Scherrer's formula was used to calculate crystallite size. The surface structural of TiO<sub>2</sub> films was studied by using FESEM field emission scanning electronic microscope which shows uniform surface. The band gap energy was calculated with the help of UV-vis Spectroscopy.

**KEYWORDS:** TiO<sub>2</sub> thin films, spin-coating, properties.

## I. INTRODUCTION

Recently, organic-inorganic hybrid materials have been extensively investigated. Its main reason is to expect to be obtained new type of composite materials with synergetic or complementary behaviours and be used in nanoelectronics devices [1-4]. Titanium Oxide is one of the typical of n-type semiconductor materials. Sol-gel processing is a low temperature chemical technique used for the synthesis of inorganic oxides material such as TiO<sub>2</sub>. Such as process is used to yield single and multi-component oxides in crystalline or amorphous form. The method of sol-gel helps the oxides to be deposited on a substrate at a much lower temperature than traditional ceramics [5]. Many preparation processes with low cost and lower processes temperatures such as solid-state route is used to synthesize titanium oxide powders [6]. Titanium Oxide belongs to an important material class because of its various applications e.g. in solar cells [7], and its physical properties which make it suitable for various thin film applications i.e. in photo catalysis [8]. In this paper, we present the structural and optical properties of Titanium Oxide thin film prepared by sol gel processes.

## II. RELATED WORK

The simplest and developed method as sol-gel Byun et al [9] among the different methods, in which various material parameters such as the powder natural, surface, average crystallite size and mode of structure are controlled in determining photocatalytic activity of TiO<sub>2</sub>. TiO<sub>2</sub> has energy value of band gap 3.3 eV. It is active in ultra-visible light spectroscopy, in which electrons are in to conduction band leaving holes in valence band. The sol-gel route is considered as very promising one for the synthesis of fine metallic oxide Li et al [10] and has been widely applied for preparing of TiO<sub>2</sub> Nano particles Haguuet et al [11]. For synthesis by sol-gel route several different precursors can be applied. In the work study, we have prepared Nano particles sized TiO<sub>2</sub> and characterized the prepared sample.

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## III. SYNTHESIS AND PROPERTIES OF TiO<sub>2</sub>

For sol preparation used 0.3M solution of Titanium Tetraisopropoxide, is dissolved in methanol. The solution was cleared by adding 1 drop of HCl and 1 drop of distilled water with a 0.45ml micro pipette and stirred at room temperature. After that the whole solution was put in a safe place to overnight. The solution is made ready for the preparation of TiO<sub>2</sub> thin films by using spin coating at 3000 rpm, 30 secs. The resultant films were dried at 80°C for 30 min and subsequently annealed for 3hr. Multilayer films were annealed at 400°C for 1hr. The structural properties of films were studied by using HXRD diffraction measurements. FESEM was used to study the surface morphology. UV Spectrophotometer was used to record the absorption spectra of the films in a wavelength range of 200-800 nm.

## IV. EXPERIMENTAL RESULTS

The x-ray diffraction pattern is shown in Figure. 1 was recorded using an HXRD diffraction meter (Model: PANalytical X-Pert Pro MRD PW3040) (using CuK $\alpha$  Radiation of  $\lambda=0.15418$  nm) in a scale of angle diffraction of 20 to 80. The diffraction pattern of film indicates amorphous state of deposited thin films.

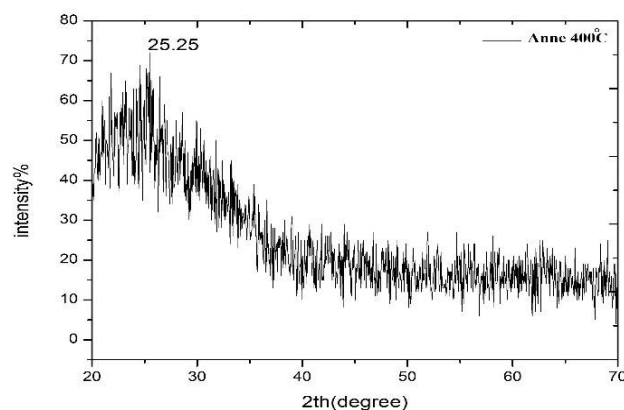


Fig. 1 X-ray pattern of TiO<sub>2</sub> film deposited on glass.

Figure. 1 demonstrate the HXRD pattern of TiO<sub>2</sub> shows a broad peak at  $2\theta=25.25^\circ$  at annealing 400 °C [12]. The XRD patterns show sharp peak, indicated to the crystalline of the prepared materials. The observed  $2\theta$  values are consistent with the standard values, which specify the tetragonal structure of TiO<sub>2</sub> [13-16]. The intensity of diffraction peaks for TiO<sub>2</sub>, is high value thus strengthen diffraction peaks of TiO<sub>2</sub>. The surface structure study of Titanium Oxide thin films was studied using a Field Emission Scanning Electron Microscope FESEM, Techniques. Figure.2 shows FESEM images (at 400°C) that reveals smooth, uniform, surface.

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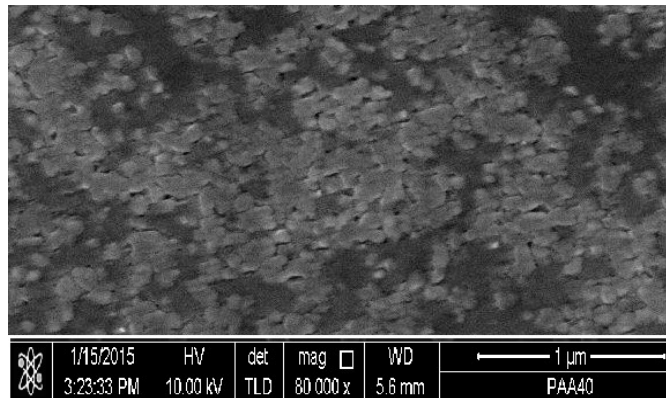


Fig.2 FESEM mode of TiO<sub>2</sub> films deposited on glass at 400°C.

Optical absorption spectra of the annealed samples were recorded using a UV-vis spectrometer. Figure.4 shows it found that the absorption peaks for the sample were observed at around 200 nm to 350 nm. The energy gap of TiO<sub>2</sub> thin film is 3.3eV for 400°C.

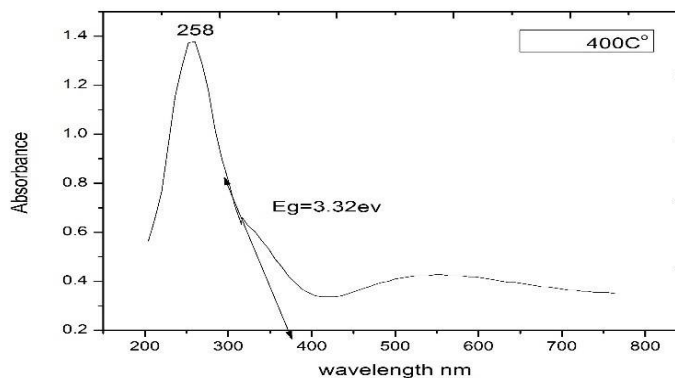


Fig. 4 UV-vis pattern of TiO<sub>2</sub> annealed at 400°C.

## V. CONCLUSIONS

Thin films of TiO<sub>2</sub> were prepared by the sol-gel method, then annealed film were characterized by using HXRD, FESEM, and UV-vis. X-ray investigation shows the diffraction peaks for TiO<sub>2</sub> is lower value. The XRD pattern of TiO<sub>2</sub> films shows that as the temperature increases the particle crystalline size increases. The FESEM study of TiO<sub>2</sub> film revealed uniform distribution of TiO<sub>2</sub> particles on the surface. UV Shows that energy gap decreases with temperature. FESEM images revealed that the distribution of particles is uniform shape of the particles is spherical in nature.

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