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Optical, Structural and Morphological Study of TiO_2 Thin film using Sol-gel Spin Coating Techniques

Supekar A.K.[1], Bhise R.B.[2], Thorat S.S.[3]
Department of Physics, B.J.College, Ale, Tal-Junnar, Dist- Pune, MS. (India)-412411.

Abstract:- Titanium Dioxide films were synthesized on glass substrate by using sol-gel spin coating method. The thin film samples were characterized for its structural and optical properties. The synthesis was carried out by optimizing preparative conditions, such as Temperature (T), pH, Concentration, Time to get uniform, adherent and pinhole free films. The prepared films were pre-annealed at 300°C and post-annealed at 500°C. Structural properties of Titanium Oxide thin films were studied by XRD pattern. Scherrer's formula was used to calculate crystallite size. Surface morphological of Titanium Oxide films studied using SEM which shows granular surface. The band gap energy was calculated with the help of UV-VIS Spectroscopy.

Keywords: *Titanium Oxide thin films spin coating, sol-gel method, XRD, SEM, UV-Visible Spectroscopy.*

I. INTRODUCTION:

The Sol-gel processing has low temperature chemical method use for synthesis of inorganic oxide material i.e. Titanium Oxide. Such process is used to yield for of single and multi component oxide as crystalline or amorphous form. The method of sol-gel helps oxide to be deposited on a substrate at much lower temperature than traditional ceramic [1]. The Sol-gel technique has many advantages over other fabrication techniques, such as homogeneity, stoichiometry control, purity, Ease of processing and controlling the composition and ability to coat large and complex area substrate [2]. Many preparation processes with low cost and lower processes temperatures such as malate route, citrate route, and solid state rout are used to synthesize titanium oxide powders [3]. Titanium Oxide belongs to an important material class because of its wide applications e.g. in solar cell as an EHP generator [4], physical properties which makes its suitable for various thin film applications i.e. in photo catalysis[5], solar cell, gas sensor[6]. In this paper, we present the optical and structural properties of Titanium Oxide thin film prepared by spin coating processes.

II. EXPERIMENTAL:

For sol preparation 0.1M solution of Titanium Tetraisopropoxide [$C_{12}H_{28}O_4Ti$] is dissolved in methanol. The turbid solution was cleared by adding 1 drop of HCL and 1 drop of H_2O by a 0.25ml micro pipette and stirs it at normal temperature. After that whole solution put in safe place for ageing, and ageing period is two days. The solution is read for preparation of TiO_2 thin film using spin coating on glass substrate having size 2.5 x 7 cm^2. The spinning rate was kept at 140 Volt. The wet films were dried at 75ºc for 10 min and subsequent annealed for 1 hr. The process was repeated to obtain the workable thickness 10 nm of the film. Multilayer films were pre-annealed at 300ºC and post-annealed at 500ºC for 1hr.

The structural properties of the prepared films were studied by X-ray diffraction measurements. Scanning electron microscope was used to study surface morphology. UV-VIS Spectrophotometer (Systronics Double beam sprectro-photometer model 2202) was used to record the transmission spectrum of the films in the wavelength range from 200 nm to 800 nm.

III. RESULT AND DISCUSSION:

1. Structural Properties:

The X-ray diffraction pattern is shown in fig. 1(a) and (b) was recorded using X-ray diffractometer (Hitachi using CuKα Radiation of λ=0.15418 nm) in this scale of angle 20^0 to 80^0 diffraction of film indicates amorphous state of deposited thin films.

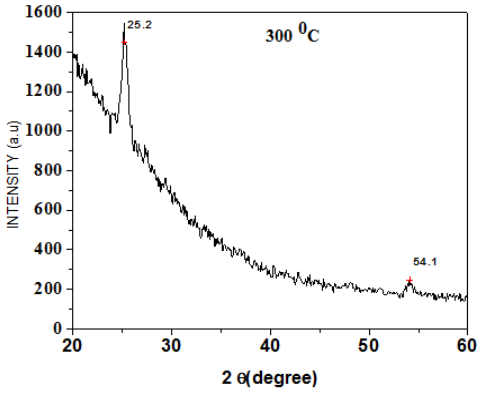

Fig. 1 (a) X-RD pattern of TiO2 thin film deposited on glass at 3000C

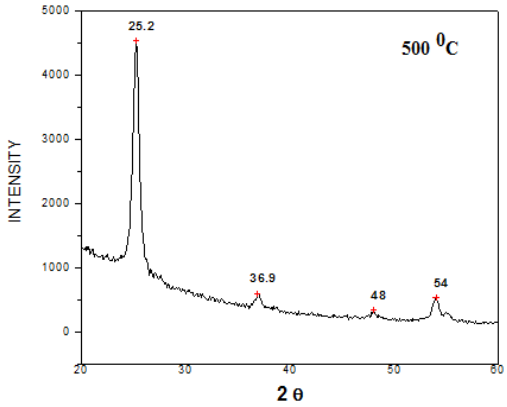

Fig. 1 (b) X-RD pattern of TiO2 thin film deposited on glass at 5000C

Table 1. The Result table of TiO2 Thin film for 300^{0}C and 500^{0}C annealing temperature.

Obs.No.	Annealing Temp. T	Diffraction Angle 2θ	Crystalline Size d(nm)
1)	300 ^{0}C	25.20	3.5353
2)	500 ^{0}C	25.23	3.6146

Above result table shows increase in crystalline size with increase in annealing temperature.

2. Morphology:

The morphological study of Titanium oxide thin film was studied using Scanning Electron Microscope (SEM) Techniques. Fig.2 (a) and (b) shows SEM images reveals with smooth, crack free (uniform), surface and granular surface.

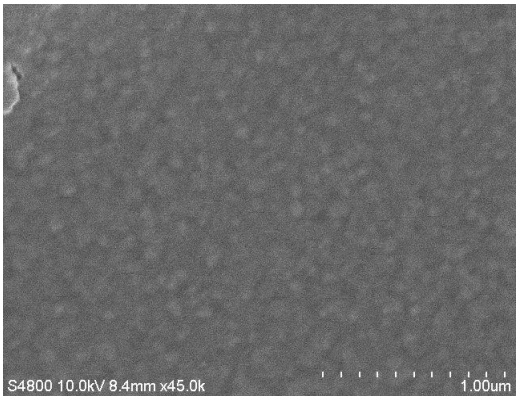

Fig. 2 (a) SEM pattern of TiO_2 thin film deposited on glass at 300^{0}C

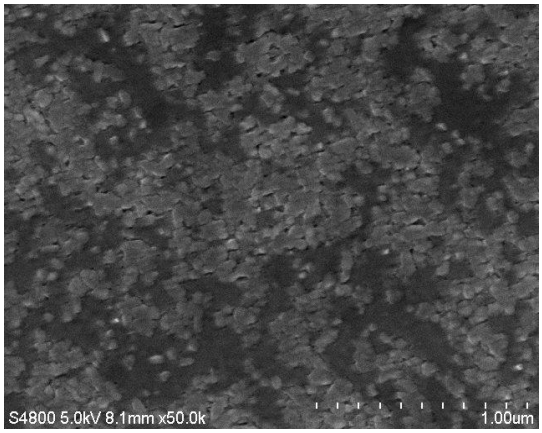

Fig. 2 (b) SEM pattern of TiO_2 thin film deposited on glass at 500^0C

3. Optical Properties:

The prepared TiO_2 thin films were characterized for their optical properties. The optical transmission spectra of annealed samples were recorded using UV-VIS spectrometer (UV-VIS 1700 Pharma). It is found that absorption peaks for sample is observed at around 250nm to 350 nm with reference to black glass substrate. The optical energy band gap of TiO_2 thin film is 3.42eV for 300^0C and 3.34eV for 500^0C.

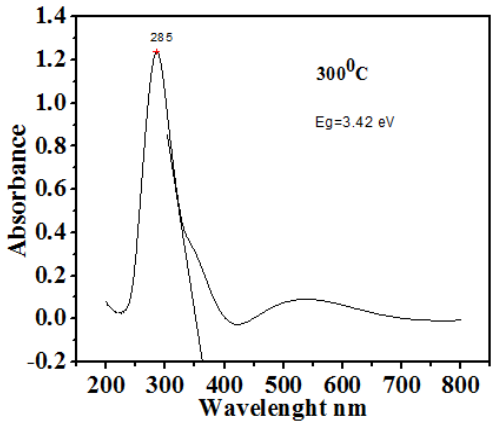

Fig. 3 (a) UV pattern of TiO_2 thin film deposited on glass at 300^0C

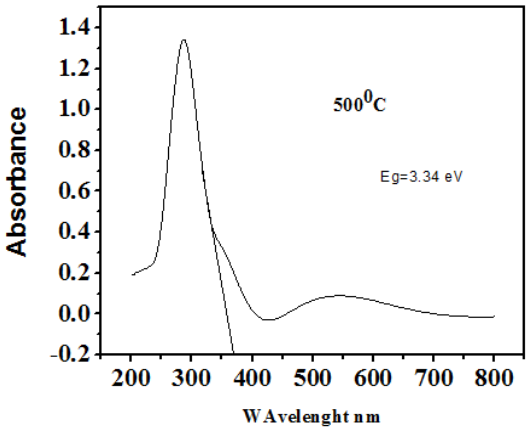

Fig. 3 (b) UV pattern of TiO_2 thin film deposited on glass at 500^0C

IV. CONCLUSION

TiO_2 thin film prepared using spin coating techniques. Annealed films were characterized using XRD, UV and SEM.

UV Shows band gap energy decreases with temperature.

The XRD pattern of TiO_2 films shows that as temperature increases the particle size increases.

SEM images revealed that the distribution of particles is uniform and the shape of the particles is spherical in nature.

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