SYNTHESIS AND ELECTRO-OPTICAL CHARECTERIZATION OF TiO_2: PVA THIN FILM

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Abstract: Thin films of titanium dioxide TiO2: PVA polymer was synthesized using Solution Cast technique. The films were annealed in the temperature range of 333k and 353K in order to investigate the effect of annealing on the optical properties and thickness of the film .The optical properties such as Transmittance, absorptance, refractive index, absorption coefficient and electronic transitions of samples are altered by altering the concentration of TiO2 nanostructures in PVA thin film which is confirmed by UV-visible spectroscopy. The band gap values of the TiO2 nanoparticles were calculated to be 3.54 and 3.43 eV, which get decreased on further doping these nanostructures in the PVA in the range from 2.17eV- 2.68eV. Results showed that there is more crystallization and more orientation of the crystal growth with increase in temperature. The results also revealed that most of the optical properties were significantly affected by the annealing(slow cooling) process. The calculated thickness shows that the films are nanocrystalline and polycrystalline in nature.
Keywords: Titanium dioxide TiO2, Solution Casting, PVA, DMF (dimethyleformamide), thin films and UV-visible spectroscopy.

I. INTRODUCTION

In the last decades, there has been a great deal of interest in the production of inexpensive thin films, due to its high varying characteristics. Such characteristics include high resistivity, heat reflecting windows, catalytic properties, and photo thermal and photovoltaic. Transparent conducting coatings (TCCs) have long been an interesting area of research. This is due to its unique properties and diverse applications in optoelectronics and photovoltaic's applications. This paper includes the synthesis, electro optical characterization and the properties of TiO_2 doped PVA thin film. The thin film was prepared by Solution Casting Method. The experimental results show that the formation of TiO_2 doped PVA matrix formation and their natural thermal conductivity. However perfluoro sulfonic acid membranes are the most widely used membranes, but proton conductivity of these membranes is very small at high temperature and they are very expensive. Therefore studies have been focused on the investigation of alternative membranes. In this study, it is aimed to synthesize an organic-inorganic composite membrane that has better properties than the Nafion membrane. In this study nanosized titanium-dioxide(TiO_2) doped with polyvinyle alcohol (PVA) based membrances were synthesizes. Also these membranes were subjected to the various characterization experiments. Some of these TCCs include titanium di-oxide nanostructures, tin-oxides, cadmium-oxides, ferrous-oxide, cuprous-oxides etc. Titanium dioxide (TiO_2) has been one of the most studied oxides because of its role in various applications, namely photo induced water splitting, dye synthesized solar cells, solar cells environmental purifications, gas sensors, display devices batteries etc [1]. Znic oxide (ZnO) belongs to member of the hexagonal wurtize class, it is semiconducting, piezoelectric and optical waveguide material with a variety of applications. Znic oxide has been extensively studied as a promising material for blue and ultraviolet light emitting devices because of its wide band gap and large binding energy [2]. The development of new materials, blends, composites and advanced materials is a necessity for modification of mechanical, electrical, optical and thermal properties of thin films to fulfil the demand for improved materials in industries. The development runs parallel with the intense series of studies aiming at describing the structure-property relationship of the modified materials. Many studies have been reported on electrical and thermal properties of some core shell thin films [3].The study of semi conducting thin film are being pursued with increasing interest on the account of their proven and potential applications in many semiconductor devices such as solar energy converters, optoelectronics devices etc. Practical applications of thin oxide films are in house hold, electronics, recording heads, memory and microwave devices. Most oxide thin films can also be applied in highly reproducible gas and humidity sensor materials Oxides thin film materials have been one of the most attractive research topics in physics and material science. Materials like Fe3O4, CrO2, manganese pervoskites, double and layered pervoskites, BiFeO3 and more recently transition metal doped semiconductors thin films such as TiO2, ZnO, MnO to mention but a few have been reported and have received new and exciting attentions UV region [4]. It is an important material for a variety of applications including photoconductors, solar cells, and field effect transistors sensors, transducers, optical coatings and light emitting materials.

II. EXPERIMENTAL

The thin film was synthesized by solution cast technique in which the solution of potassium dichromate and concentrated H_2SO_4, TiO_2 and PVA are used as main reagents DI water and DMF (dimethyleformamide) were used as solvents. DMF (dimethyleformamide) is a non polar organic solvent used to dissolve in PVA of 0.5M by which thin film of PVA is synthesized during the film synthesisation 0.01M TiO_2 is added to film where the nanostructures of TiO_2 get introduced in to the PVA film. 0.01g of TiO_2 is dissolved in the solvent and Stir the solution using magnetic stirrer until TiO_2 gets completely dissolve. 15 ml of DMF is taken in a beaker and allow it to get warm. 0.02g of TiO_2 is dissolved in solvent. Stir the above solution using magnetic stirrer until TiO_2 gets completely dissolve. 30 ml DI water is allowed for preheating at 60.C for 10 minutes in which 2g of PVA is added in above solvent. Allow stirring for 30 minutes using magnetic stirrer till homogeneous solution is obtained. The solution is casted over the glass substrate and place it on mercury filled pool for uniform thickness. The sample is dried in the oven for 2 hours. Then obtained film is detached from the glass substrate. In the same way a sample 2 is prepared. To avoid contamination of films they were kept in air tight bag.

During the entire synthesis process change in color was noticed while adding TiO_2 solution to PVA solution. In sample II, dark milky color was observed as compared to that of the sample-1, due to the concentration variation in TiO_2. The films were annealed in the temperature range of 373k and 673K where by the effect of annealing the optical properties and thickness of the film is controlled.

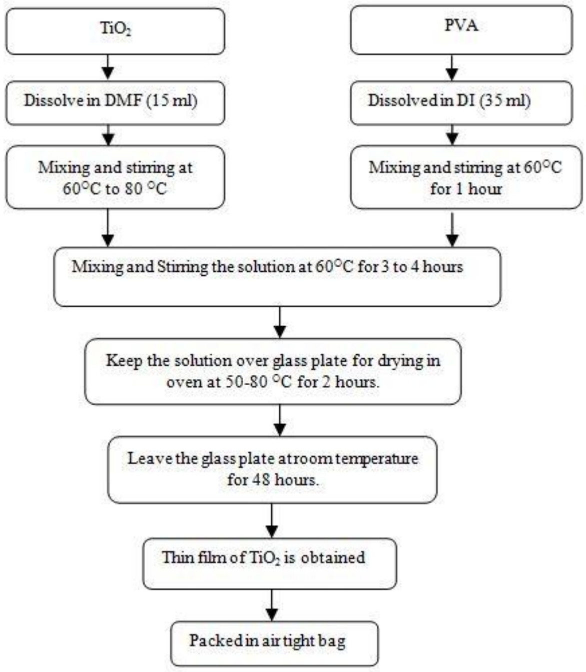

Figure 1 flow chart diagram for synthesis of TiO_2: PVA

Optical characterization:-

UV-visible Spectroscopy:

The absorption edge is observed in the range of 200–300 nm, which is blue shifted compared to bulk TiO_2. As the TiO_2 concentration increases in PVA, the absorption edge shifts to lower wavelength side and intensity also increases with increasing TiO_2 concentration compared to undoped PVA. This blue shift of the absorption edges for different sized nanocrystals is related to the size decrease of particles and is attributed to the quantum confinement limit reaching of nanoparticles. The quantum confinement effect is expected for semiconducting nanoparticles, and the absorption edge will be shifted to a higher energy when the particle size decreases Absorption coefficient (α) of the powders at different wavelengths can be calculated from the absorption spectra.

The absorption spectra of the samples is shown in Figure 2-3

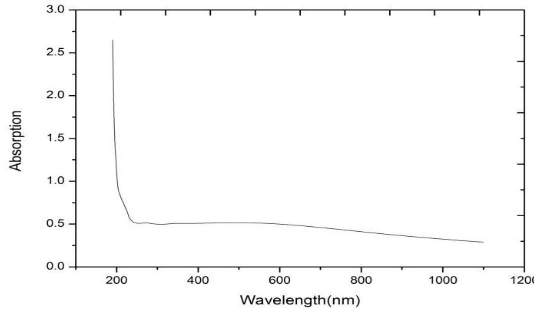

Figure 2 Absorption spectra of sample-1 of TiO_2: PVA.

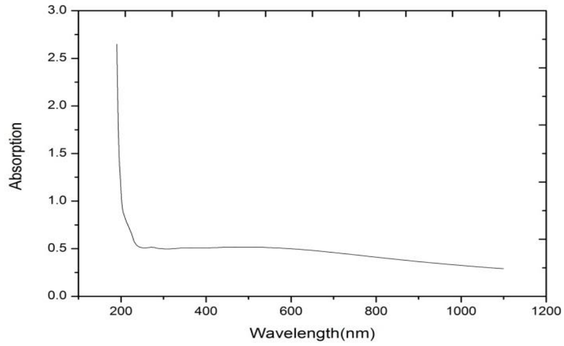

Figure 3 Absorption spectra of sample-2 of TiO_2: PVA.

TiO_2: PVA	***Energy band gap (Eg) eV***
Sample-1	2.17
Sample-2	2.68

Table 1 Showing band gap comparison of sample -1 and sample-2

Comparative result analysis

The comparative analysis of UV-Visible spectroscopy shows that the absorption peaks of sample -1 and sample -2 resembles with the reference graph shown in figure 4 which conclude that our result is correct with respect to already published work. In the published work it could clearly seen that the absorbtion peeks obtained at 200-300 nm, the same range of absorbtion is also obtained in our work, which seems that our work is correct and the film have wide variety of application in sensors technology and inter organic biodegradable light weight display panels.

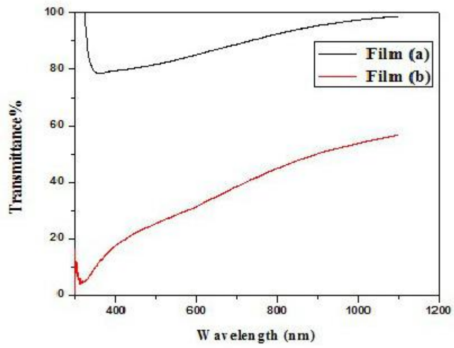

Figure 3 UV-Visible spectrums Absorbance spectrum and Transmittance Spectrum [5].

It is observed that transmittance is inversely proportional to the thickness of the film, for Film (a) transmittance was obtained more than 80%, for Film (b) was 10% as shown in figure 3. shows absorbance is slightly shifting towards the lower wavelength with the increasing of film thickness[6].

III. RESULT AND DISCUSSION

Prepared thin films have high values of absorption coefficient for the wavelength range (300-850 nm), It is increased when add PVA polymer. Absorption and refractive index of TiO_2 thin films increase as film doped with PVA. The direct allowed energy gap of TiO_2 and TiO_2: PVA thin films was (2.17–2.68 eV) respectively, and forbidden energy gap was (2.109–2.383 eV) for TiO2 and TiO2: PVA thin films respectively. This means the PVA decreased the energy gap of TiO2 .From enhancements for structural results, absorption and electronic transitions for optical properties of TiO_2 thin films prepared, can be using it as benefactor of solar cells after adding PVA polymer. The gain material is susceptible to utilization of direct diode or fibre laser pumping of a microchip laser with a level of power density providing formation of positive lens and corresponding cavity stabilization as well as threshold population inversion in the laser material. Multiple applications of the laser material are contemplated in the invention. . It is an important material for a variety of applications including photoconductors, solar cells, and field effect transistors sensors, transducers, optical coatings and light emitting materials.

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