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# STRUCTURAL AND OPTICAL CHARACTERIZATION OF TIO2 NANOPARTICLESBYHYDROTHERMALMETHOD

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**ABSTRACT :**
In the present studies we have synthesized Anatase titanium dioxide (TiO2) nanoparticle on glass substrate using hydrothermal methodwhich have advantage is the materials which have a high vapour pressure near their melting points can also be grown by this method .The structural characterization of deposited samples are done with the help of XRD technique and Optical characterization are done by UV.

**KEYWORD:**Titanium Dioxide (TiO2),Hydrothermal Method, XRD, UV,Band gap.

## INTRODUCTION:

They have Band gap in the range 3.33 & 3.24eV, Tio2 shows in the form of black Hexagonal crystals it exist in 3 phases. (i) Rutile ( Tetragonal Density 4.259gm/cm3)(ii)Anatase(Tetragonal Density 3.894gm/cm3) (iii)Brookite(Orthorhombic Density 4.259gm/cm3) It is having good photon catalytic properties .relative to other materialsTiO2 can be easilyprepare , low cost .the important electrical properties of TiO2 depend on the various factors which includes method of preparations, heating treatment, type and amount of dopant.


## EXPERIMENTAL WORK

The 7.5 ml TIP was mixed wi

150 ml of water and stirred it for 1-2 hours then this solution filter by Whitman filter paper then the slurry get form. This slurry was transferred into the 150 ml of Teflon-lined and laboratory oven at 180 $^0$C for 24 hours. After the reaction, white precipitate was collected by centrifugation process and through washings with distilled water. The powder was dried at 80 $^0$C for 6 hours. The $TiO_2$ nanoparticles can be characterized by XRD Techniques, UV Spectroscopy, etc.

**The synthesis reactions of $TiO_2$ can be done in two steps:**

1. Oxidation of Ti with an aqueous solution of $H_2O_2$ and ammonia to form gel ($TiO_2.H_2O$)
2. Hydrothermal treatment of gel under various conditions.

This Reaction is given as follows-

$Ti + 3H_2O_2 + 2OH^- \xrightarrow{\text{Oxidation}} TiO_4^{2-} + 4H_2O$

$2TiO_4^{2-} + 2(X+1)\,H_2O \xrightarrow{\text{Heating}} 2TiO_2.XH_2O + O_2 + 4OH^-$

$TiO_2.XH_2O \xrightarrow{\text{Hydrothermal Treatment}} TiO_2 + X$

### Preparation of coating $TiO_2$ paste:

In order to prepare a coating paste, 0.5g of the as-obtainedwhite titania ($TiO_2$) powder is taken into a molten. The $TiO_2$ powder in addition to distilled water about 500 µml,2-3 drop of Polyethylene glycol 300(PVA),Triton x is about 50 µml, followed by continuous grinding for 2-3 hours. In this way, cream like white coating $TiO_2$ paste is obtained.

### Preparation of $TiO_2$ film:

Titanium dioxide layers are deposited on fluorine doped tin oxide (FTO) coated glass substrates. Before deposition of the layers, the substrates are cleaned by meansof a three-step procedure: a treatment in an ultrasonic bath forsuccessively 30 and 10 min in a beaker filled with detergent and acetone, respectively, followed by a final cleaning step of 10 min in boiling iso-propane. Layers are deposited by tape casting the highly viscous white coating paste at room temperature. The blade or glass plate moves forward at a fixed speed of 80 mm/s and the distance between the blade and substrate is varied between 60 and 120 µm. After deposition each layer is subjected to a drying step of 10 min at 60 ◦C in an oven under flowing air. For multiple layer deposition the dried layer is cooled down to room temperature before depositing the next layer. Finally, to burn out the organic substances the samples are placed in oven and heated in dry air from room temperature up to 450 ◦C, followed by a 30-60 min soak at this temperature. In this way a macroscopically homogeneous $TiO_2$film is obtained.

## RESULT AND DISCUSSION:

### Structural characterization:(XRD)

The X-ray diffraction (XRD) studies of the sample was performed by using Cu Kα (λ=1.54Å) radiation. The sample was scanned in 2θ range from $10^o$ to 80°.X-ray diffraction (XRD) study indicate that all the diffraction peaks could be indexed to spherical $TiO_2$ nanoparticles and it is match with reported JCPDS. data Fig. 1 depicts the XRD pattern of $TiO_2$ nanoparticles while the sharp peaks at 2θ values $25.27^0$, $30.14^0$, $37.40^0$, $47.54^0$, $54.80^0$, $62.96^0$, $69.12^0$ and $75.29^0$, with corresponding crystal plane (101), B(211), (004), (200), (211), (204), (220), (215). Table 1 shows particle size and inter planer distance of the hydrothermally synthesized $TiO_2$ nanoparticles.

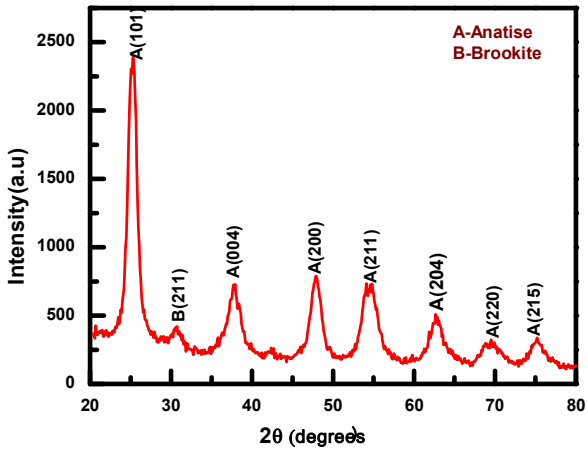



**Fig 1 X-ray diffraction pattern of $TiO_2$ nanoparticles**

| Plane(hkl) | O($^0$C) | Cos(O) | Sin(O) | β(radian) | D(nm) | d(Å) |
|---|---|---|---|---|---|---|
| (101) | 12.67 | 0.9756 | 0.2193 | 0.01552 | 9.1 | 3.51 |
| (004) | 18.9 | 0.9460 | 0.3239 | 0.02128 | 6.88 | 2.37 |
| (200) | 23.95 | 0.9139 | 0.4059 | 0.01692 | 8.96 | 1.89 |
| (204) | 31.23 | 0.8550 | 0.5184 | 0.02991 | 5.42 | 1.48 |
| | | | Mean value = | | 7.00 | 2.31 |

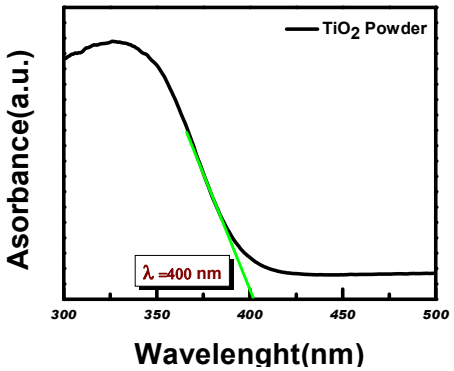
Table 1 Particle size and inter planer distance of $TiO_2$nanoparticle

Avarageparticle size of $TiO_2$ nanoparticle(D)=7 nm.

Avarage Inter planer distance of $TiO_2$ nanoparticle(d)=2.31Å.

## OPTICAL CHARACTERISATION (UV)

UV-visible absorption spectrophotometer is standard technique to obtain the absorption wavelength and band gap which is one of the characteristic properties of the material. It gives the rough idea about the particle size by red or blue shift in the absorption spectra. It also gives the rough idea about the phase formation. UV-Vis spectra of nanocrystalline $TiO_2$ powder synthesized by hydrothermal method are shown in Fig.2.(a-b)The absorption of $TiO_2$ powder and film showed absorption edge cut off at 400 nm and 390 nm (band gap: 3.33 eV& 3.24 eV). The band gap obtained is higher than the reported value i.e. 3.23eV, owing to Nano crystalline nature of the $TiO_2$ powders.



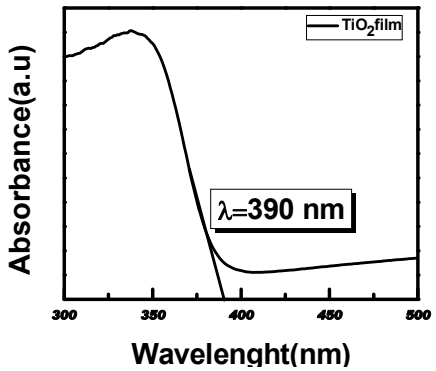




**Fig 2(a): Absorbance wavelength NP[S]Fig 2(b):Absorbance wavelength $TiO_2$ film.**

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## CONCLUSION

In this study it is shown that a hydrothermally synthesized Anatase titanium dioxide ($TiO_2$) nanoparticles.

From UV conclude that the band gap obtained is higher than the reported value i.e. 3.33 eV, and 3.24 eVowing toNano crystalline nature of the $TiO_2$nanoparticles and $TiO_2$ film.

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