Comparison of Performance of TiO_2 Thin Film with PLD Technique & XRD Technique

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Abstract- *The size effect is relevant when the size of the crystals is small enough to create a quantum size effect. In short, the activity of photo catalysis in a pure titanium dioxide thin film depends upon the character of rutile and anatase in the structure. The optical properties also vary, depending on the size of the crystal grains and their orientation even within the same crystal structure. Furthermore, a properly balanced mixture of rutile and anatase may provide good optical properties by drawing upon the advantages of each structure. Pulsed laser deposition (PLD Technique) is suitable as a way to prepare titanium dioxide thin films.*

We grow the High quality Titanium-di-oxide (TiO_2) material and study their optical and electrical properties. The Structure is characterized by the Bruker D-8 Advance X-ray diffractometer (XRD Technique). The X-Ray Pattern suggested that it is crystalline in nature. We have measured the band gap by the UV/Vis Spectroscopy Technique of Titanium-di-oxide (TiO_2) thin film deposited on the quartz crystal.

Semitransparent and nano structured highly conducting TiO_2 (Titanium-di-oxide) thin films were prepared using Pulse laser deposition (PLD) technique. .The Tio_2 Thin films growth is the Polycrystalline.

Keywords- TiO_2 (Titanium dioxide) Material, XRD Technique, PLD Technique, UV/Vis Spectroscopy (Ultraviolet–visible spectroscopy) Rutile Phase, Anatase Phase, Brookite Phase.

I. INTRODUCTION

Titanium dioxide occurs naturally within the soils of the Earth. It has a whitish and opaque appearance. The Paint and cosmetics industry benefit greatly from this naturally occurring mineral. In the field of cosmetics, titanium dioxide serves as a white pigment, a sunscreen, and an opacifier. Nevertheless, issues regarding the use of titanium dioxide have risen because it is a potential photo catalyst and carcinogen which can be very harmful to the human body. Rutile titanium dioxide is the most common form. It is preferably used in interference applications because of its high refractive index. It is also hard and has chemical resistant properties. The natural rutile is composed of ten percent of iron and traces of niobium and tantalum. "Rutile" comes from the Latin word "rutilus" which means red." When viewed by transmitted light, Titanium dioxide has two forms: rutile and anatase Rutile has a high absorbance property than anatase. Rutile and anatase are both used in the white pigmentation of paints, paper, and ceramics. Sunscreens contain rutile because of its absorbance of ultraviolet-rays.

II. PROBLEM

Non clusters of metals and semiconductors are more and more considered as building blocks of future technology. This is due to the size of these particles. Nano crystalline TiO_2 has attracted continuous attention due to its versatile applications in optical devices, sensors, catalysis and photo catalysis etc. (Rufen and Huating 2011). In particular, nanosized TiO_2 has many advantages in the dye-sensitized solar cells. With regards to Nanocrystalline $TiO_{2,}$ the optical properties have been tentatively studied in recent years and some interesting results obtained. The use of large surface area semiconductor for materials in dye sensitized solar cells (DSSC) is necessary to provide sufficient light absorption and charge separations which are the two critical stages in the solar–electric energy conversion. The mesoporous nano TiO_2 /SiO_2 composite is a promising area due to optimum porous size. Nanosized TiO_2 has been fabricated using sol–gel, sputtering, combustion flame, and thermal plasma (Zhang and Xu 2004; San Vicente et al.2001). Although the sol–gel method is considered as a suitable method to synthesize ultra-fine particles, this method needs a large quantity of solution, longer processing time and heat treatment for crystallization since amorphous TiO_2 has a very little photo catalytic activity

III. PROPOSED SCHEME

Thin film materials are the key elements of continued technological advances made in the fields of optoelectronic, photonic, and magnetic devices. The processing of materials into thin films allows easy integration into various types of devices. The properties of material significantly differ when analyzed in the form of thin films. Most of the functional materials are rather applied in thin film form due to their specific electrical, magnetic, optical properties or wear resistance. Thin film technologies make use of the fact that the properties can particularly be controlled by the thickness parameter. Thin films are formed mostly by deposition, either physical or chemical methods. As well as generating ideas for new devices, fundamental research has led to a dramatic improvement in understanding of thin films and surfaces. This in turn has resulted in a greater ability to fabricate devices with predictable, controllable and reproducible properties. The cleanliness and nature of the substrate, the deposition conditions, post deposition heat treatment and passivation are vital process variables in thin film fabrication. TiO_2 is a wide band gap semiconductor, known to occur in three crystalline structures: rutile, anatase and brookite. Rutile is thermodynamically stable phase, i.e. retains its structure at the high temperature and high Pressure conditions and is most widely studied as well .Anatase is quite unstable while brookite is the most complicated and the least study phase. The three phases of TiO_2 have different physiochemical properties, such as density, refractive index, dielectric constant and photochemical reactivity and electrical and magnetic properties. Generally, in bulk form, TiO_2 is present in mixed phases, but one can achieve a single phase of TiO_2 in the thin film from using the proper growth condition. Titanium dioxide is by far the most widely used white pigment. Titania is very white and has a very high refractive index – surpassed only by diamond.

A. Introduction to Pulsed Laser Deposition (PLD)

The main advantage of PLD over conventional techniques to prepare thin film is that the material is stoichiometrically transferred from the target to the substrate. Stoichiometry transfer between target and substrate is difficult to obtain with any other thin film deposition technique such as with evaporation and sputtering; because in general the partial vapor pressures are sputtering yields of the components are different from each other which give rise to different concentration of the thin film growing on the Substrate. In the case of PLD, with most material a stoichiometry transfer between target and substrate is obtained, due to the fast and strong heating of the target surface by the intense laser beam, which ensures that all target components irrespective of their partial binding energies evaporate at the same time. Though solid- state laser and Excimer laser sources are known to produce laser beam in this wavelength region, Excimer laser sources have higher efficiency. Excimer laser is a type of Gas laser where the lasing action takes place between the repulsive ground state and a bound (associative) excited state. The term Excimer is short for ‘excited dimer’. Noble gases such as xenon and krypton are highly inert and do not usually form chemical compounds. The main disadvantage of PLD is it can be used only small area deposition.

IV. SIMULLATION RESULT

A. XRD Pattern of TiO_2 Thin films under oxygen pressure

All these films were indexed and Matched with TiO_2 Phase as in JCPDS Card (No. 89-4920), JCPDS Card (No. 89-4921), JCPDS Card (No. 76-1937) , JCPDS Card (No. 85-1060).The fig XRD Pattern indicates that these films have Polyphase contribution with a weak peak indicating the (R) rutile phase formation, (A) Anatase phase formation, (B) Brookite Phase Formation and Another Phase (An) Anorithic Phase Formation also Present.

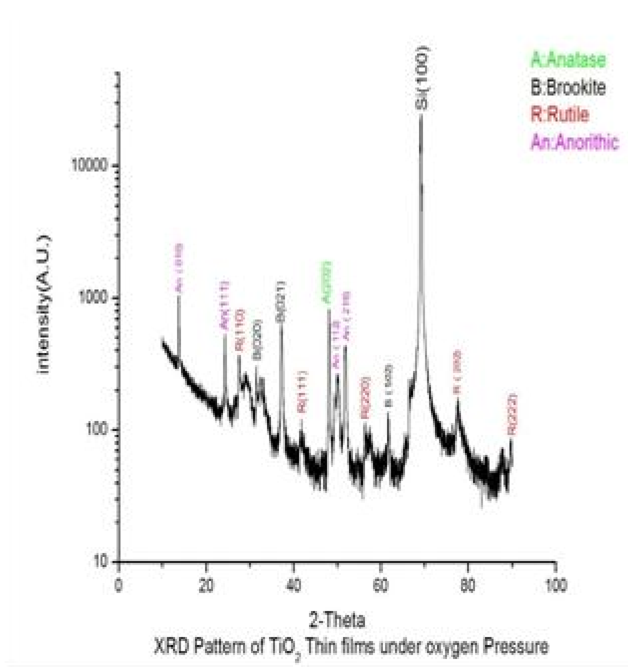

Figure: XRD Pattern of TiO_2 Thin films under oxygen pressure

B. XRD Pattern of TiO_2 Thin films without oxygen pressure

All these films were indexed and Matched with TiO_2 Phase as in JCPDS Card (No. 89-4920) ,JCPDS Card (No. 89-4921), JCPDS Card (No. 76-1937) , JCPDS Card (No. 85-1060).The fig XRD Pattern indicates that these films have Polyphase contribution with a weak peak indicating the (R) rutile phase formation, (A) Anatase phase formation, (B) Brookite Phase Formation and Another Phase (An) Anorithic Phase Formation also Present.

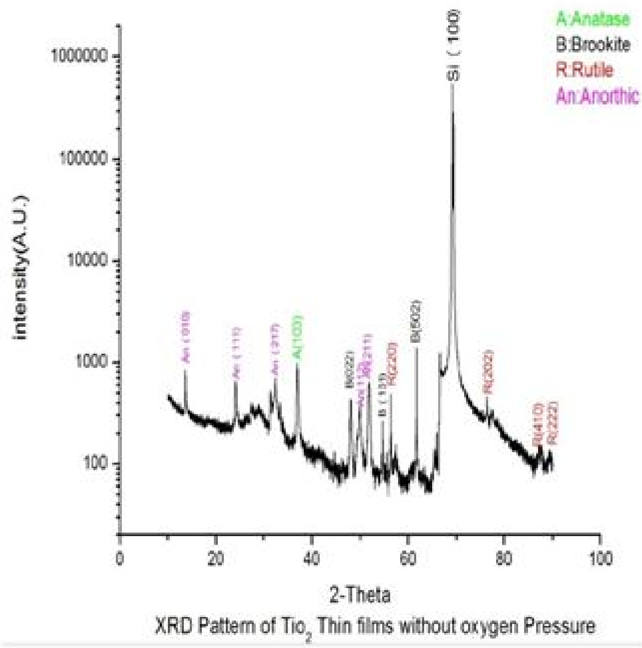

Figure: XRD Pattern of TiO_2 Thin films without oxygen pressure

V. CONCLUSION

The Structure is characterized by the Bruker D-8 Advance X-ray diffractometer. The X-ray Pattern suggested that it is crystalline in nature. The Film growth is found Polycrystalline in nature is A (Anatase), B (Brookite), R (Rutile) Phases are well matched by Standard data base files in the vacuum condition. The Phase Anorthic has are going to increasing the oxygen Pressure. The TiO2 Thin films phases Anatase and Anorthic has been dominant. This is clearly visible in X-Ray Diffractometer Pattern. The Tio2 Thin films growth is the Polycrystalline.

The Thin film has been deposited by Pulse laser deposition (PLD) technique under different oxygen fluence. The Variation of oxygen pressure indicates the different phases or different growth of TiO_2 thin films.

All the specific properties of nano-sized particles have led to the exploitation of nano-TiO_2 for a wide variety of applications in which nano-TiO_2 is essentially preferred over conventional TiO_2 particles. Such applications include self-cleaning surfaces and textiles, UV-resistant coatings and paints, disinfectant sprays, sunscreens, water treatment Agents; anticancer treatments. TiO_2 is indeed one of the most widely used nano-scale materials.

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