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# STRUCTURAL AND MORPHOLOGICAL PROPERTIES OF CHEMICALLY SPRAY DEPOSITED TITANIUM DIOXIDE THIN FILMS

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## ABSTRACT

Nanostructured titanium dioxide ($TiO_2$) thin films have been deposited by chemical spray pyrolysis technique onto the glass substrate at 523K.The conditions have been optimized to obtain quality thin films. Films so obtained have been characterized for their structural and morphological properties using X-ray diffraction (XRD) and scanning electron microscopy (SEM) respectively. The structural study revealed that $TiO_2$ thin films are polycrystalline in nature with tetragonal lattice having preferred orientation along (110) plane, whereas the morphological studies shows well defined porous structure of the as deposited $TiO_2$ thin film which can be further utilize for solar cell applications.

***Keywords:*** *Thin films; Nanostructures;Structuralproperties;Porous.*

## I. INTRODUCTION

Thin film research has been widely expanded due to the increasing demands for microelectronics and microstructural components in different branches of science and technology. Transparent and conductive oxides are extensively used for variety of applications. Among many oxides, Titanium dioxide has unique characteristics which have been investigated extensively in recent years owing to their potential applications such as electrodes for solar cells [1], gas sensor devices [2], photo catalyst [3] etc. Nanostructured $TiO_2$ thin films have been deposited by various techniques such as sputtering [4], pulsed laser deposition [5], chemical vapour deposition [6], sol-gel [7] and spray pyrolysis [8].In the present paper, we have studied the structural and morphological properties of titanium dioxide thin films deposited onto glass substrates at 523Kby chemical spray pyrolysis deposition method.

## II. EXPERIMENTAL DETAILS

The experimental setup for spray deposition is similar to the systems described in other papers [9]. The vertical distance between nozzle and substrate was about 28 cm. The precursor solution was prepared by using titanium isopropoxide, ethanol and hydrochloric acid and was atomized by aninflatedspray system using compressed air as a carrier gas. Glass substrates were previously cleaned with ethanol and acetone in an ultrasonic bath.Several trails were taken to optimize different parameter for the film deposition. Film surface morphology was determined by using Scanning Electron Microscopy (JSM 6100). The structural characterization was made with a Cu-Kα (λ = 1.5406 Å) byPhilips PW 1710 diffractometer.

## III. RESULTS AND DISCUSSION

### 3.1. Structural analysis

The structural studies were carried out using Philips PW 1710 diffractometer with Cu-Kα radiation of wavelength 1.5405 Å. X-ray diffraction patterns of chemically deposited titanium dioxide thin films at 523 K were recorded by varying diffraction angle (2θ) from 10 to 70degree. Figure 1 shows the XRD pattern of titanium dioxide thin

film.The films are polycrystalline and fit well with tetragonal crystal structure. The diffraction peaks from the XRD patternis in agreement with the JCPDS card no 89-4920. The films are observed to have a preferential crystallographic orientation along [110] plane direction corresponding to the Bragg angle 2θ = 27.49.Comparison of observed and standard XRD data of $TiO_2$thin films is shown in table 1.

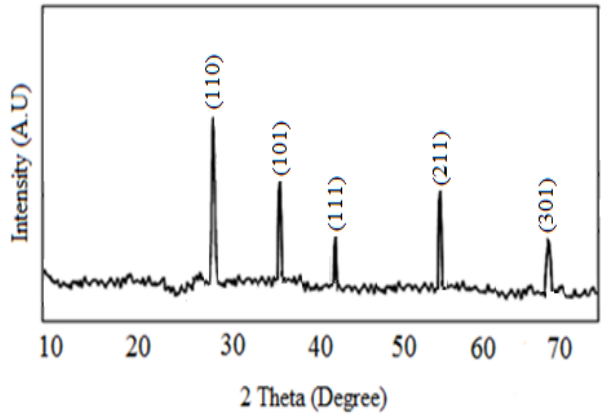


***Figure1. XRD pattern of titanium dioxide thin film***

***Table 1: Comparison of observed and standard XRD data of Titanium dioxide thin films (JCPDS card 89-4920)***

| Film | Observed data | | Standard data | | hkl |
|---|---|---|---|---|---|
| | 2θ (degree) | d ($A^0$) | 2θ (degree) | d ($A^0$) | |
| $TiO_2$ | 27.571 | 3.220 | 27.495 | 3.241 | 1 1 0 |
| | 36.282 | 2.447 | 36.154 | 2.482 | 1 0 1 |
| | 41.281 | 2.193 | 41.326 | 2.182 | 1 1 1 |
| | 54.396 | 1.702 | 54.442 | 1.684 | 2 1 1 |
| | 69.147 | 1.364 | 69.168 | 1.357 | 3 0 1 |

### 3.2. MORPHOLOGY

The surface morphological studies were carried out using scanning electron microscope (JSM 6100)**.** Figure 2 shows, SEM image of $TiO_2$thin film. The SEM micrograph shows that $TiO_2$ thin films have well defined porous structure which covers the entire glass substrate surface.

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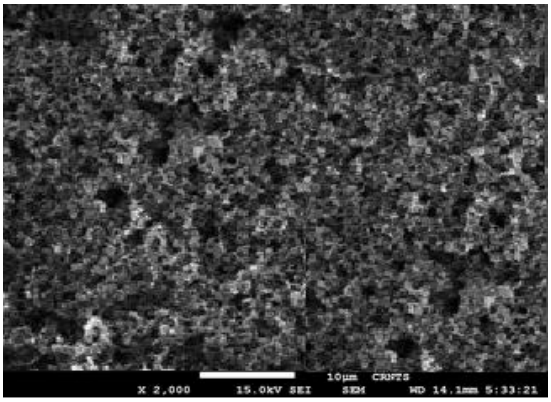


***Figure 2. SEM image of titanium dioxide thin film***

## IV. CONCLUSION

In the present paper, structural and morphological properties of chemically spray deposited titanium dioxide thin films at 523K has been reported. The structural study of deposited titanium dioxide thin films revealed the tetragonal structure with preferential orientation along (110) plane. The morphological study evidenced porosity of the deposited film which can be used for optoelectronic applications.

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