11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Effect of titanium tetra-isopropoxide flow rate on SiO_2-TiO_2 composite films by FHD

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Abstract – SiO_2-TiO_2 composite films were synthesized by indigenously developed Flame Hydrolysis Deposition system. In the present study we have replaced the commercially used $TiCl_4$ a source of titanium by titanium tetra-isopropoxide (TTIP). The $SiCl_4$ is replaced by tetraethylorthosilicate (TEOS) as the source of silica. The refractive index and thickness measurements have been carried out by ellipsometer. Surface morphology has been carried out using Scanning Electron Microscope (SEM) and the films found to be crystalline in nature. The composition is confirmed by the EDAX analysis. The XRD spectrum shows two strong peaks appear at 2θ = 38.3° and 2θ = 44.6°due to the (004) anatase phase and (210) rutile phase of TiO_2 respectively. The broad peak between 2θ = 20°-30° corresponds to SiO_2.

P-type silicon (100) wafers used as substrate. The FHD system was powered ON and the Mass Flow Controllers were allowed to heat up for better performance. After some time the MFC of hydrogen and oxygen were set at 1.6 SLPM and 0.7 SLPM respectively. The flow rate of TEOS (carrier gas nitrogen) was kept constant at 0.7 SLPM. Substrate temperature was kept constant at 700°C throughout the process. All the processes were carried out for 1.5 minutes duration. The flame was ignited at the nozzle end and allowed to get stable. Then MFC of precursor TTIP (carrier gas nitrogen) was set to desired flow and injected at the center of the flame. In the present study the flow of carrier gas for TTIP was varied from 0.04 to 0.1 SLPM with a step of 0.02 SLPM. The effects of flow rate of TTIP (carrier gas nitrogen) on refractive index, thickness and structural properties of the SiO_2-TiO_2 films have been studied.

It is observed that refractive index of the deposited films increases from 1.4607 to 2.067 with the corresponding increase in TTIP flow rate. As the flow rate of the TTIP is increased the reactant species Ti increases. Which increase the percentage of Ti from 0.3 to 0.49% in deposited films tuning the refractive index towards refractive index of the bulk TiO_2. The increase in the percentage of Ti is evident from the EDAX study. Figure 1 illustrates the SEM microphotograph of the deposited film. It is clearly observed from the photographs that the deposited film is crystalline in nature as compared to the SiO_2 films deposited by the same system [1]. From the SEM image it is observed that TiO_2 particles in nanometer size are embedded in SiO_2 film.

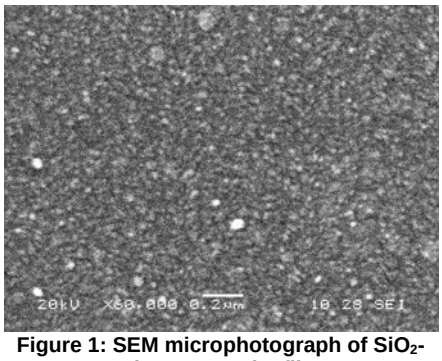

Figure 1: SEM microphotograph of SiO_2-TiO_2 composite film

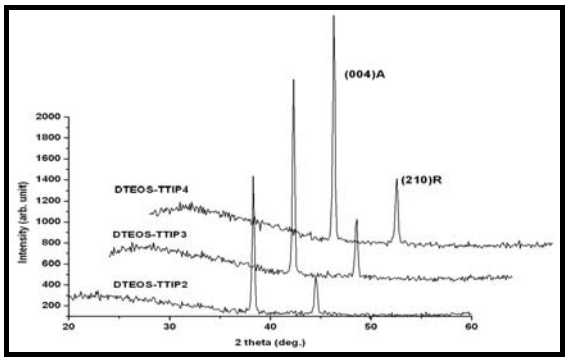

Figure 2: XRD patterns of the SiO_2-TiO_2 composite films.

The XRD patterns of the SiO_2-TiO_2 composite films are as sown in Figure 2. It is depicted from the figure that two strong peaks appear at 2θ = 38.3° and 2θ = 44.6° is due to the (004) anatase phase and (210) rutile phase of TiO_2. The broad peak between 2θ = 20°-30° corresponds to SiO_2 [2-4]. The application of these films is not limited to the optical waveguide structures but can be used in dye synthesize solar cells.

References

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