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Preparation and Characterization of SnO_2-F/TiO_2 photoconductive film by Spray Pyrolysis

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Abstract – In this work a titanium metallic powder was dissolved in H_2O_2 and used as precursor to prepare dense and porous anatase TiO_2 on glass substrate coated with conductor SnO_2-F thin film using spray pyrolysis technique. The film presented fine TiO_2 particles, approximately 30–50 nm in size as observed using SEM. Measurements of X-ray diffraction has shown the presence of anatase crystalline phase (figure 02). The spray pyrolysis process allows us to prepare a photovoltaic thin film on glass substrate. The SnO_2-F films obtained by spray pyrolysis deposition showed a uniform surface as observed with SEM (Fig 01) and good transparency about 70%. and electrical resistance about 9 Ω/□. The SEM micrograph of the SnO2-F/TiO_2 film with yellow, red and green artificial organic dye (figure 04) shown the TiO_2 porous conformation. The dye green were better incorporated in the TiO_2 porous film. The SnO/TiO2 film + artificial organic dye show photoconductive properties when submitted to the sunlight therefore, this film can be used in the manufacture of solar cells. The absorption spectrum for the red, green and yellow artificial organic dye is easily identified for 530-350 nm, 620 e 420 nm and 450 nm, i.e, or in the visible range, respectively, as expected (Figure 03).

An appropriated amount of tin chloride $SnCl_2$ and ammonium fluorine NH_3F was dissolved in HCl solution using magnetic steer at 90 ^{0}C and then was added it ethanol 95% (C_2H_6OH) [1]. By spray pyrolyse technique thin film of SnO_2-F was deposited on glass substrates (Corning) and was kept around 450 ^{0}C - 500 ^{o}C and we used a spray flux of 0,36ml/min.

Titanium powder was dissolved in hydrogen peroxide, H_2O_2 30% and to get a completed dissolution was added ammonium hydroxide[2] at PH=8.0. A fine layer of TiO_2 was deposited by spin coating on the SnO_2-F transparent film conductor. The samples to follow were submitted a heat treatment in electrical furnace around 400ºC during 30 minutes. This procedure produces a dense thin layer on SnO_2-F conductor film. After this procedure other deposition took place using spray pyrolysis. At this time the samples were maintained at 250ºC during spray deposition process. Finally, SnO_2:F/TiO_2 films were sintered at 450^{o}C during 2 hours. The films thus obtained were dived into a solution of artificial organic dye (three different types: red, green and yellow) during 24 hours at room temperature. The films were dried slowly at 60ºC.

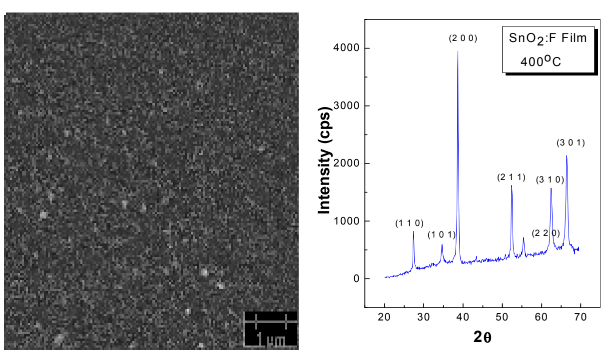

Figure 1: Superficial SEM micrograph of the SnO_2 :F film showing small particles and X-ray diffraction pattern of the film doped with 15 wt% fluorine and some indexed peaks after heat treatment in 400ºC.

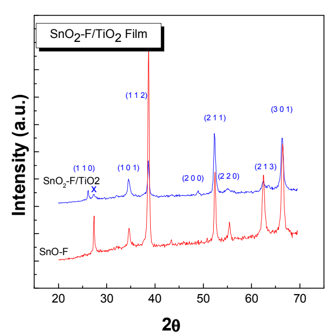

Figure 02: X ray diffraction of SnO2-F/TiO2 film

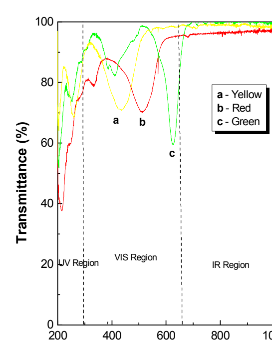

Figure 03: UV-Vis absoption of yellow, red and green artificial organic dye.

The samples were submitted at different characterization techniques. Figure 01, the SEM show morphological uniform surface the SnO_2-F thin film and XRD measurement a good crystalline phase. In Figure 02 shows XRD measurement the SnO2-F thin film and other SnO_2-F/TiO_2 film. We observed anatase phase of TiO_2. Figure 03 shows the Uv-Vis transmittance measurements of the red, green and yellow artificial pigments. Before to take place the measures, the artificial organic dye were dissolved in distilled water using 0.008mg/10 ml proportion rate. The absorption spectrum for the red, green and yellow artificial organic dye is easily identified for 530-350 nm, 620 e 420 nm and 450 nm, i.e, or in the visible range, respectively, as expected. These artificial organic dyes presents some bands in visible region that is a important because this is just the region where photovoltaic devices application. It is possible observe on near infrared region that there are no absorption bands and otherwise exist small one in the UV region.

In the Figure 04 we can see a surface micrograph of the film recovered with red pigment that presents irregular grains and a lot of porous. However, if we compare it with last film it is possible to observe that the amount of porous increased and the estimated size was around 553 nm. Analyzing the micrograph in the figure 03, it is possible identify some smooth areas between the grains or there are some isolated group of grains as island and the grain size is irregular, but they were estimated size between 369 - 553 nm smaller than other films. This result may imply that the green pigment was more incorporated in the TiO_2 film, probably for this reason the film have shown better photovoltaic signal than others.

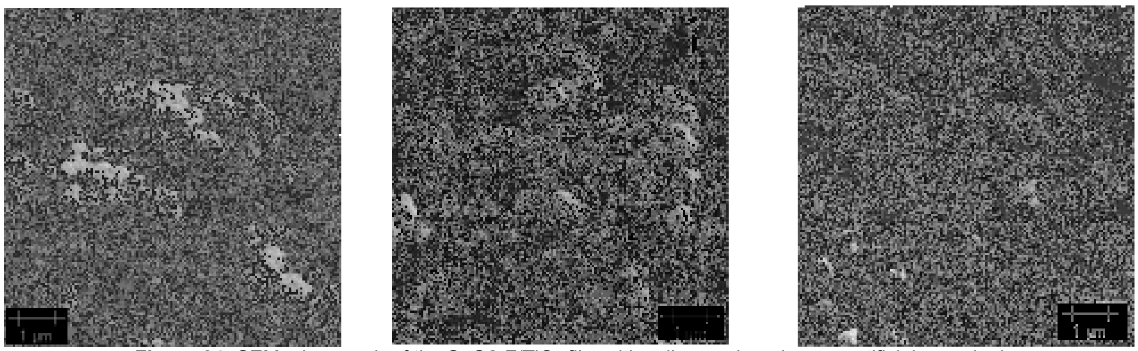

Figure 04: SEM micrograph of the SnO2-F/TiO_2 film with yellow, red and green artificial organic dye

[1]. Elangovan, E; Ramamurthi, K. - Optoelectronic properties of spray deposited SnO_2:F thin films for window materials in solar cells - Journal of Optoelectronics and Advanced Materials , India, v. 5, n. 1, p. 45 – 54, 2003.
[2]. Natarajan, C.; Fukunaga, N. and Nogami, G. Titanium dioxide thin film deposited by spray pirólise of aqueous solution - Rev. Thin Solid Films. Kitakyushu - Japan, v.322, n. 1-3, p. 6-8. 1998