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Synthesis of SnO_2 nanoparticles for Dye-Sensitizer Solar Cells

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Abstract – SnO_2 nanostructured anodes were prepared by sol-gel methodology combined with hydrothermal synthesis. By means of the nanoparticle dispersion obtained after the hydrothermal synthesis a paste for deposition of films onto conducting glass substrate was prepared. The films were heat-treated at 420ºC for 20 minutes. The dispersion presented crystalline SnO_2 nanoparticles of about 10nm (figure 2). The films showed homogeneous morphologies and thicknesses nearly 8 μm. These films have a high potential for application in Dye-Sensitizer Solar Cels (DSSC's).

Studies of materials that can be used as anodes in DSSC's are of great interest for the development of these devices. Tin dioxide (SnO_2) has attracted attention due to its higher electronic conductivity and mobility with respect to TiO_2 which have showed the best results for this application [1]. Nevertheless, the energy conversion efficiencies reported for DSSC's assembled with SnO_2 anodes are rather poor [1,2]. Thus, SnO_2 has been intensively studied in order to improve the conversion efficiency of DSSC's.

In this work we report the synthesis of SnO_2 dispersions for nanostructured films applied to DSSC's. SnO_2 nanoparticles were precipitated from $SnCl_4.5H_2O$ aqueous solutions through the addition of ammonium hydroxide (NH_4OH, 29%) until pH 5-6. The resulting material was washed several times with deionized water to eliminate chlorine ions. The Cl^--free SnO_2 nanoparticles were dispersed in water with the addition of a non-ionic surfactant and hydrothermally treated at 240ºC in an electric furnace. The obtained dispersions were washed with ethanol and acetone and used for preparing a suitable paste for screen-printing by adding an ethanolic solution of ethylcellulose and anhydrous terpineol. The paste was concentrated until SnO_2-20% wt. Films were deposited onto glass slides coated with Fluorine-doped Tin Oxide (FTO) (10Ω sq^{-1}, Solaronix) by screen-printing [3] and sintered at 420ºC. Polyethyleneglycol (PEG-400) was added to the paste in order to increase porosity. The dispersions and films were characterized by X-ray diffraction (XRD). The hydrothermally synthesized dispersion consisted in crystalline rutile SnO_2 (Figure 1). Films were studied with scanning electron microscopy (FEG-SEM) and profilometry. Figure 2 shows the porous and homogeneous structure of particles around 10nm. The thickness was close to 8μm. These characteristics indicate that the obtained films are appropriate for DSSC's applications.

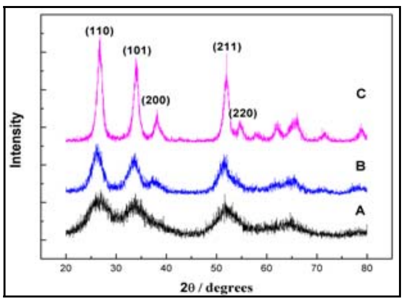

Figure 1: XDR patterns of powder obtained A) without hydrothermal, B) with hydrothermal by 180ºC/20 hours, and C) 240ºC/24 hours.

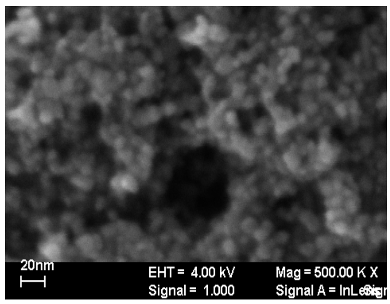

Figure 2: FEG-SEM of particles obtained after hydrothermal treatment 240ºC/24 hours.

References

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