

## ANALYSIS OF THE BEHAVIOR OF MESOPOROUS ANATASE NANOCRYSTALLINE TITANIA FILMS APPLIED TO DYE SENSITIZED SOLAR CELLS

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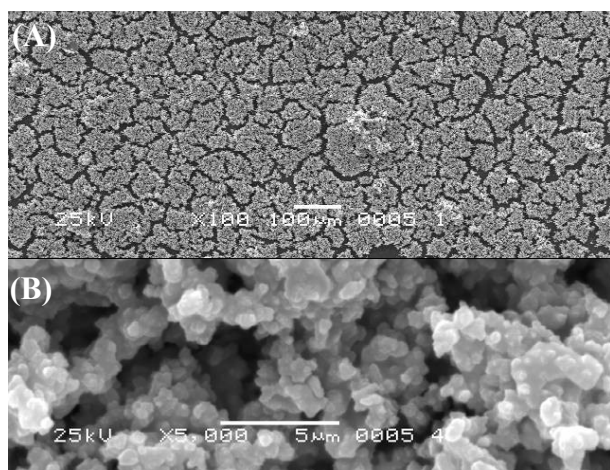
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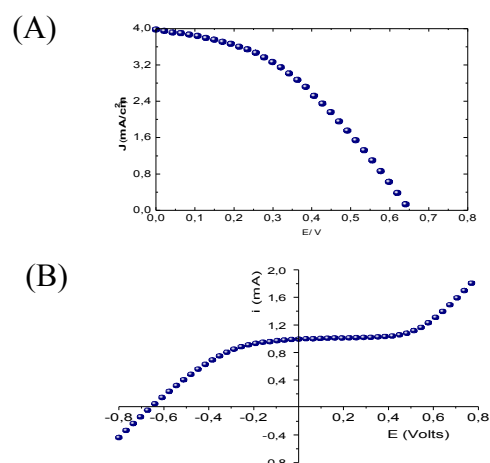
**Abstract** – In this work, mesoporous titania films were prepared and characterized using a ternary system constituted by Butanol/HCl/Pluronic P123 and titanium (IV) ethoxide as inorganic precursor. The sensitization of the films by a ruthenium dye was effective and the devices presented an overall conversion efficiency of ~ 3% under AM1.5 conditions. The TiO<sub>2</sub>/dye films also showed a capacitive behavior as could be observed during the electrochemical characterization. This feature has been associated to their mesoporous structure which traps electrons along the film and releases charge for redox reactions.

The morphology of thin films from nanocrystalline TiO<sub>2</sub> (anatase) plays a crucial role influencing the performance of practical devices including dye-sensitized solar cells, mesoporous materials have a high surface area compared to nanocrystalline anatase films. Mesoporous films have been prepared using a ternary system constituted by Butanol/HCl/Pluronic P123 and titanium (IV) ethoxide as inorganic precursor[1]. The suspension was spread onto an indium tin oxide (ITO) substrate by doctor blade technique. The films were heated at 450 °C for 1 h in order to consolidate the anatase crystalline structure. The films were sensitized by a  $0.5 \times 10^{-3}$  mol.L<sup>-1</sup> ethanolic solution of the sensitizer cis-dithiocyanate-N,N'-bis(4-carboxylate-4-tetrabutylammoniumcarboxylate-2,2'-bipyridine)ruthenium(II). Scanning Electronic Microscope images (SEM) show that the substrates were completely covered by the titania film (Figure 1A). The film surface is also porous with a good connection between the nanocrystalline grains (Figure 1B) allowing the penetration of the polymer electrolyte constituted by poly(ethylene oxide-co-2-(2-methoxyethoxy)ethyl glycidyl ether) P(EO-EM)/LiI/l<sub>2</sub>/γ-butyrolactone (GBL) in 25 mL of acetone.

Figure 2A shows the J-V curve for the solar cell using such mesoporous electrode at AM 1.5 conditions. The device displayed an impressive open circuit potential of 0.65 V and a photocurrent of 4.0 mA.cm<sup>-2</sup>. The film exhibited a capacitive behavior associated to the presence of a constant anodic current along the film as observed by linear sweep voltammetry (Figure 2B). The trapped electrons in the mesoporous structure shift upwards the Fermi level of the semiconductor film. This feature results in an increase of the oxidation current for positive potentials and indicates that there can be a surface barrier to be overcome before the complete release of charge transfer from the film into the substrate. Therefore, the mesoporous anatase nanocrystalline films can be used not only for solar cells but also as capacitors for charge storage due to their open pores structure.



**Figure 1:** SEM images of mesoporous anatase film: (A) coverage of the substrate; (B) analysis of the film porosity



**Figure 2:** (A) Curve J vs. V for mesoporous TiO<sub>2</sub> film sensitized by N719 dye; (B) Linear sweep voltammetry under AM1.5 conditions.

### References

[1] S.Y. Choi, M. Mamak, N. Coombs, N. Chopra, and G.A. Ozin, Adv. Funct. Mater. 14 (2004) 335