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Spray deposition of $CuInS_2$ on electrodeposited ZnO for low cost solar cells.

M. Berruet[1], M. Valdés[1], A. Goossens[2], M. Vázquez[1*]

(1) División Corrosión, INTEMA, Facultad de Ingeniería, Universidad Nacional de Mar del Plata J. B. Justo 4302 B7608FDQ Mar del Plata, ARGENTINA

(2) Optoelectronic materials, Faculty of Applied Sciences, Delft University of Technology Julianalaan 136, 2628 BL Delft, The Netherlands

* Corresponding author.

Abstract – $CuInS_2$ thin films are obtained via chemical spray pyrolysis on electrodeposited ZnO/TCO glass substrates. Smooth and/or nanoporous ZnO structures have been obtained changing the deposition parameters. CIS films are deposited at 350 ºC and using N_2 as gas carrier. The morphology, composition and phase identification are obtained using SEM, EDX and XRD. UV-Vis and Mott Schottky analyses. Finally, the incorporation of a buffer layer of TiO_2 to protect the ZnO layer against corrosion during the deposition of CIS is evaluated, together with its ability to enhance the performance of the cell structure solar cells trough I-V curves.

In order to reduce the production cost of solar cells based on 3D inorganic heterojunctions, new cell concepts with nanostructured materials have been developed. The present work aims at obtaining solar cells using exclusively low-cost techniques. Electrodeposition and spray pyrolysis have emerged as an alternative low-cost method for thin film solar cells reaching remarkable conversion efficiencies [1-2].

Dense and nanoporous ZnO films are obtained by potentiostatic electrodeposition on TCO substrates in one single step. Different morphologies are obtained when the composition, temperature of the bath and potential are changed. The films are annealed at 450ºC and 380ºC for 40 minutes in air respectively. Next, the samples are placed in a hot plate at 325 ºC for the deposition of the CIS films. $CuInS_2$ films are produced by chemical spray pyrolysis. A precursor aqueous solution containing defined amounts of $CuCl_2$, $InCl_3$ and CH_2SCH_2 is atomized using N_2 as gas carrier. The spray method used in this work is not continuous but in periods of 30 seconds of spray at 0.2 bar, leaving 1 minute delay.

Chemical spray pyrolysis is also used to prepare the buffer layer of TiO_2. For the TiO_2, a precursor solution of titanium IV isopropoxide (TTIP) is used as titanium source, acetylacetone (AcAc) as a stabilizer and ethanol as solvent. After that, the samples are etched in 0.5 mol/L KCN for several minutes to remove secondary phases (CuS or Cu_2S) that are detrimental for the devices.

Figure 1 presents the XRD patterns of the sprayed CIS films on d-ZnO/nc-ZnO layers. The morphology is studied with scanning electron microscopy (SEM). The composition is analyzed by X-ray Energy Dispersive Spectroscopy (EDS). The absorption coefficient and the band gap energy are calculated from the absorption spectra.

To investigate the electric response of the cells, current–voltage curves of a representative device such as TCO/d-ZnO/nc-ZnO/TiO_2/$CuInS_2$/graphite are performed in dark and under Xe lamp irradiation. Figure 2 shows good diode quality is present in the dark I-V response of the devices. Under simulated solar light a clear photoresponse has been found. At the moment the values of open circuit potential and short circuit density are low but they are a starting point for future improvements.

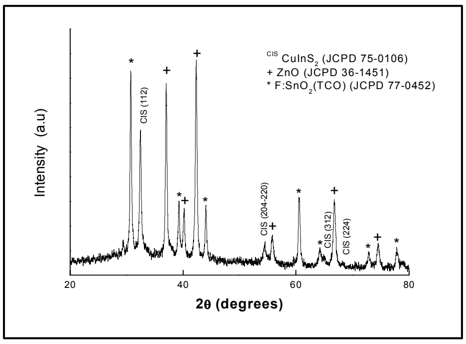

Figure 1: XRD patterns of TCO/d-ZnO/nc-ZnO/CIS films deposited on TCO substrates.

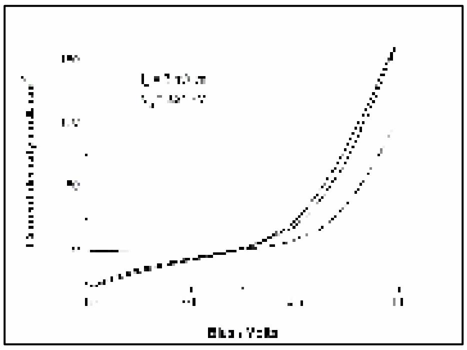

Figure 2: I-V curve (dark vs. illumination) performed on TCO /d-ZnO /nc-ZnO /TiO_2/ $CuInS_2$.

References

[1] D. Lincot, J. F. Guillemoles, S. Taunier, D. Guimard, J. Sicx-Kurdi, A. Chaumont, O. Roussel, O. Ramdani, C. Hubert and J. P. Fauvarque, Solar Energy 77 (2004) 725.

[2] M. Nanu, J. Schoonman and A. Goossens. Nano Letters 5 (2005) 1716.