Abstract #91, 223rd ECS Meeting, © 2013 The Electrochemical Society

Fabrication of ZnO/Absorber heterostructures for nanostructured solar

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The scientific community working in the domain of photovoltaic (PV) faces challenges as: the development of new semiconducting materials and innovative device concepts. All efforts are driven from the goal to prepare solar devices with high efficiency and stability contributing to low cost energy production. Our research activities are focussed on the electrochemical and chemical deposition of different semiconductors and their integration in extremely thin absorber (eta) and hybrid solar cells. The development of semiconducting materials for the extremely thin absorber (*eta*) solar cell using cheap and scalable methods is the main objectives of this work (Figure 1) [1]. The *eta*-solar cell is composed of all inorganic materials consisting of an extremely thin layer of absorbing material (1.1 <Eg< 1.8 eV) sandwiched between nanostructured transparent electron and hole conductors (Eg ≥ 3.3 eV). Compact and defect free ZnO thin film and nanowires (NWs) were prepared galvanostatically and potentiostatically. The ZnO nanowire dimensions were controlled with the ZnO seed layer or the applied current density. The photosensitization of the ZnO nanowires with conformal layers of CdS, CdSe, CdTe, $CuInS_2$ and Cu_2ZnSnS_4 prepared by successive ionic layer adsorption and reaction (SILAR) was studied [2, 3]. The improvement of the absorber structural and optical properties by annealing and chemical treatment was achieved (Figure 2). The Close Space Sublimation (CSS) for CdTe thin shell deposition. While the first method produced conformal layer formation on the entire nanowire surface (Figure 3), the second resulted in low coverage. The heterostructures prepared by both methods exhibited optimal optical features. The ZnO NW/absorber heterostructure was completed with a hole conducting CuSCN layer. The influence of the CuSCN layer (prepared by three methods) morphology on the *eta*-solar cell performance is discussed. Electrodeposited and SILAR prepared films exhibited rougher surfaces than that by the Impregnation technique (which affects the electrical conductivity). The ZnO/absorber core/shell heterostructures were also tested in a photelectrochemical cell. The recorded efficiencies (up to 2 %) for the case of CdS and CdSe photosensitizers demonstrated an improvement of the ZnO/absorber interfaces and the material quality achieved by the modified-SILAR technique. In this study we show that the SILAR technique could be extended for the preparation of materials like CdSe and CdTe. These results let us to consider that today a Renascence of the SILAR method is happening.

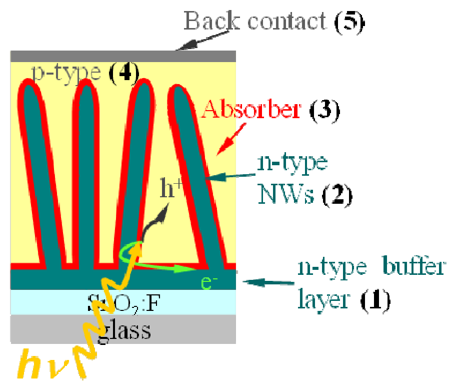

Figure 1. Schema of the nanowire-version eta solar cell.

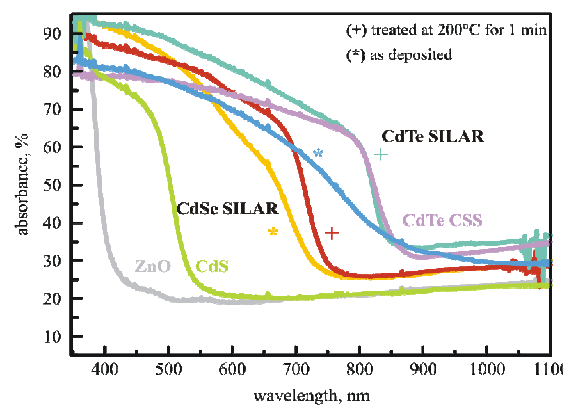

Figure 2. Absorbance spectra of bare ZnO nanowires, ZnO/CdS (40 SILAR cycles), ZnO/CdSe (20 SILAR cycles) and ZnO/CdTe (prepared by 20 SILAR cycles or 7 min CSS).

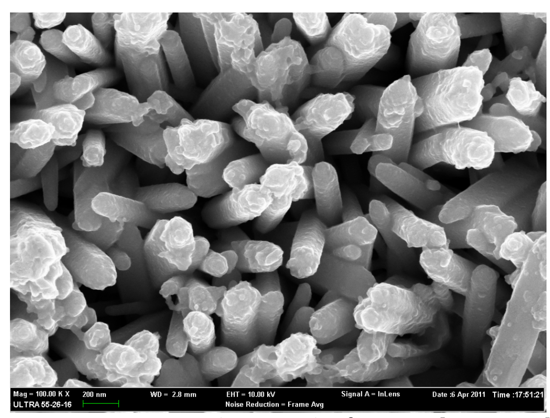

Figure 3. SEM image (top view) of ZnO/CdTe core/shell nanostructure. Core of electrodeposited ZnO nanowires and CdTe shell is prepared with 20 SILAR cycles.

References:

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