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CdTe nano-structures for photovoltaic devices

V. Corregidor [a,b,*], L.C. Alves [a,b], N. Franco [a], M.A. Barreiros [c], N.V. Sochinskii [d], E. Alves [a,b]

[a] *Instituto Tecnológico e Nuclear, Instituto Superior Técnico, Universidade Técnica de Lisboa, E.N. 10, 2686-953 Sacavém, Portugal*
[b] *CFNUL, Av. Prof. Gama Pinto 2, 1649-003 Lisboa, Portugal*
[c] *LNEG, Estrada Estrada do Paço do Lumiar 22, 1649-038 Lisboa, Portugal*
[d] *Consorzio CREO, SS 17 Località Boschetto, 67100 L'Aquila, Italy*

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CdTe nano-structures with diameter of ~100 nm and variable length (200–600 nm) were fabricated on glass substrates covered with conductive buffer layers such as NiCr, ZAO ($ZnO:Al_2O_3 + Ta_2O_5$) or TiPd alloys. The fabrication process consisted of the starting vapour deposition of metal catalyst dropped layer followed by the isothermal catalyst-prompted vapour growth of CdTe nano-structured layer of controllable shape and surface filling. The effect of buffer layers on the crystallographic orientation and thickness of CdTe nano-structured layers is investigated by means of IBA techniques, SEM and X-ray diffraction. It was shown that the formed CdTe nano-layers have a cubic structure, mainly oriented towards the [1 1 1] crystallographic direction, except for those grown on ZAO layer where the X-ray diffraction signal is very weak to be associated to any crystallographic form. The RBS spectra recorded on different areas of each sample type showed an almost constant thickness and SEM images revealed an homogeneous and dense distribution of the structures. It was also possible to study the first stage of the nano-structures grown on the Bi_2Te_3 seeds.

1. Introduction

There are a wide range of devices based on cadmium telluride with different applications where the CdTe is present as bulk, thin film or low dimensional structure materials [1–5]. In such way, we can find bulk CdTe crystals for radiation detectors able to work at room temperature or CdTe thin films used on photovoltaic energy conversion devices. This variety of applications is mostly due to its physical intrinsic properties such as direct bandgap, large optical absorption coefficient, high atomic number and high density.

In the latest years and thanks to the advances in the nanotechnology field, the low dimensional CdTe structures have opened the possibility, especially in the photovoltaic (PV) field, to obtain reasonable efficiency values using less amount of semiconductor and lower production costs [6,7]. In this sense, the use of nano-structures in PV devices has many advantages when compared with bulk or thin heterojunctions, such as the reduction of the losses in charge carrier transport to the respective electrodes and the most important, the possibility of tuning the bandgap by variation of the morphology in order to optimise the overlap between the absorption spectrum of the cell and the solar emission spectrum.

The CdTe nano-structure formation falls within a narrow window of growth parameters such as temperature or growth rate which are closely related to the nucleation process at the surface of the substrate. Neretina et al. [8] demonstrated that CdTe nanowire growth can occur when the surface is intentionally contaminated with an alcohol layer and a sustained growth is assured using Bi_2Te_3 as a catalytic seed on sapphire substrates.

The present work deals with the growth of CdTe nano-structures on glass substrates covered with different metal alloys: NiCr, ZAO ($ZnO:Al_2O_3 + Ta_2O_5$) or TiPd, which will act as the back electrode contact, with the final objective of obtaining low-cost solar cells. The influence on the elemental distribution and composition of different metal alloys on glass substrates is here studied by means of XRD, SEM and a combination of IBA techniques.

2. Experimental

For this work, CdTe nano-structures, which will act as the absorbing layer in the future PV cells, were fabricated by thermal evaporation using the technological approach and experimental setup reported early in Refs. [8,9], respectively. The challenging points of this process were found to be the starting vapour deposition of Bi metal catalyst dropped layer on commercial glass substrates (layer thickness 10–100 nm, deposition rate 0.1–0.5 nm/s,

* Corresponding author at: Instituto Tecnológico e Nuclear, Instituto Superior Técnico, Universidade Técnica de Lisboa, E.N. 10, 2686-953 Sacavém, Portugal. Tel.: +351 918965009.
E-mail address: vicky.corregidor@itn.pt (V. Corregidor).

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