PREDICTING IMPROVING THE PERFORMANCE OF THE n-V_2O_5/CdTe THIN FILM SOLAR CELL BY ADDING A BACK SURFACE FIELD LAYER

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Numerical modeling tools are more and more valuable due to the availability of high processing power. This study consists of studying the modeling and simulation of a n-V_2O_5 thin film solar cell connected to p-CdTe using the one dimensional PC1D simulation software in a personal computer. In this research, I investigate the impact of different CdTe absorber layer thickness and doping concentration 0.5 *to* 5 *μm and* 10^{14} *to* 10^{20} cm^{-3}*, without a back surface field (BSF) layer. A BSF layer was incorporated in the n-V_2O_5/p-CdTe heterojunction to improve solar cell performance. The influence of the thickness and doping concentration of the Back Surface Field layer (of* 0.5–2 *μm and* $10^{14} - 10^{20}$ cm^{-3} *respectively) was investigated. The highest efficiency of* $\eta = 19.7\%$ *with* $Jsc = 27.7$ mA/cm^2, $Voc = 0.807$ *V, and* $FF = 88.32\%$ *was achieved by the optimal doping concentration and thickness of the p-CdTe and p-ZnTe layers.*

Keywords: solar cell, PC1D software, CdTe, thin films, back surface field.

Introduction. A photovoltaic (PV) cell system is a collection of multiple components which each does a certain function to create a system that functions efficiently. Thus, there is a definite orientation of the elements, which contribute to the formation and configuration of these cells, constituting the nature and the ultimate classfication of the PV system. It presents a promising cost effective and reliable energy solution that can be used as a sustainable solution for generating energy [1]. Thin film polycrystalline solar cells have the second widest application horizon among various types of thin film solar cells [2] because

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they offer a high efficiency at a lower cost of production compared to many other thin film solar technologies. Cadmium telluride (CdTe) is one of the most famous polycrystalline material used in thin film solar cell manufacturing. Then, this material can be deposited on glass substrates to constitute inexpensive and easily manufacturable solar cells. Deposition of CdTe films is accomplished using a number of economic schemes, each with effective scalable fabrication techniques. Examples of these methods are closed space sublimated (CSS), chemical vapor deposition (CVD), and chemical bath deposition (CBD), that are employed to realize efficient production processes of thin film solar cells [3]. "The absorption coefficients for CdTe solar cells are extremely high, up to 5×10^5 cm^{-1}. This property guarantees that almost (approximately 99%) of the photons of energies higher than the energy of band gap of the material are absorbed in only the first micron of the CdTe absorption layer. The light absorption ability of CdTe cells is excellent, which make them very good in converting solar energy to electricity". "For solar cell applications, semiconductor cadmium telluride (CdTe) with an energy gap of about 1.45 eV is a desirable material because the CdTe energy gap is close to the optimum band gap for photovoltaic energy conversion". This characteristic has the distinctive property that enables CdTe solar cells to very much absorb most of the electromagnetic spectrum beyond 850 nm. CdTe is a II–VI compound semiconductor, that is, its constituents come from period II and VI of the periodic table. Perhaps its most advantageous characteristic is that it has relatively high binding energy, therefore being chemically and thermally stable. The stability of this structure minimizes the efficiency degradation with time and therefore CdTe is a well suited material for such long term applications as long term research in space and satellite based solar power generation [4]. The solar cells demonstrated commendable performance and elevated efficiency under standard solar radiation (AM1.5) at the Earth's surface [5]. Zinc telluride (ZnTe) is an II-VI semiconductor compound and is considered a prominent option for cost-effective photovoltaic energy conversion. Through the use of its high absorption coefficient, the material is an economically viable option for solar cell applications while reducing the amount of material required producing the solar cell...

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