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Si-CdTe-CdS Structures of Electronic Processes

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Abstract. The article analyzes the charge transfer mechanism in a new type of selectable (adjustable spectrum) injection photodetector based on the Si-CdTe-CdS structure of electronic processes. This structure shows that there is a mutual compensation of the drift and diffusion currents of the charge carriers. The Si-CdTe-CdS heterostructures were formed by the growth of the pCdTe-CdS layer on a nSi-pCdTe substrate using heat evaporation in a vacuum under a residual pressure of 10^{-4} Pa. studied and obtained the current-voltage curves and spectral characteristics of the nSi-pCdTe-nCdS heterostructures.
Keywords. Electrodeposition; Si-CdS/ Te-CdS; thin film solar cells; graded bandgaps;nano-materials; next generation solar cells,heterostructure, layer, film, spectrum.

INTRODUCTION

Photovoltaic (PV) solar energy conversion is an attractive method for clean energy generation. PV technology comes at the top end of the renewable energy list, and therefore worldwide research is continuing to develop low-cost and high-efficiency solar panels. The CdS/CdTe-based thin-film solar cell is progressing forward, entering into large scale manufacturing by the First Solar Company.

Although scaling up and manufacturing have been successfully established in industry [1,2], thescientific understanding of material issues and device physics need drastic improvements for further development of the device. In 1993 lab-scale device efficiency was reported as 15.8% [3]. Following this achievement there was a long period of stagnation with little progress seen in the improvement of the record efficiency moving from 15.8% to 16.5% [4]. Then due to the involvement of industry, lab-scale efficiency rapidly improved from 16.5% in 2001 to 20.4% [5] within a few years(2010–2014). A deep understanding of materials, processing steps and devices will help to make greater strides in the near future with this device.

In recent years, there has been a particular interest in the production of various functions based on Si-CdTe-CdS materials, as structures based on these materials may offer an alternative approach to the conversion of electricity from the sun. Such structures combine the capabilities of silicon solar cells and the advantages of cadmium telluride. However, it is difficult to produce high-quality Si-CdTe-CdS structures because the grid parameters of CdTe-CdS and Si-CdTe differ by 15%, which leads to the formation of a high density of surface defects at Si-CdTe-CdS interfaces. . Nevertheless, recent work has shown that it is advisable to produce high-quality Si-CdTe-CdS structures with low surface density by forming an intermediate transition layer that acts as a buffer in the nSi-pCdTe, pCdTe-nCdS structure.

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RESULTS

The aim of this work was to grow composite-graded CdTe layers on Si substrates, to determine the composition of the layers by their thickness, and to obtain the current-voltage and spectral characteristics of the nSi-pCdTe heterostructure.

It is known that thin CdTe films on different substrates can be grown in different ways [1, 2]. In recent years, such films are usually formed as a result of thermal deposition in a vacuum, i.e., an increase in the vapor phase [3]. In this study, CdTe layers were grown in this way because it allows the production of various fast-responsive photosensitive structures.

The basic material of the Si-CdTe-CdS-based solar cell used electrochemical techniques to deposit CdS. The main material used to produce this thin film solar cell was TEC-15 FTO (fluorinated doping tin oxide) sold on glass substrates. The sheet resistance of the FTO layer is 15. CdS layers are typically grown with chemical bath deposition (CBD) or electrode position (ED). These layers were heat-treated at 400 ° C in air for 20 min and deposited on CdS with CdTe-CdS electroplating. After heating in air to a temperature suitable for CdCl2 processing and carving the surface, contact was made with the metal in the interval to complete the design of the device; glass / FTO / CdS / CdTe interacts with the back metal. Most of the CdTe-CdS layers were grown on glass / FTO substrates to optimize growth and characterize materials. Then, using the best conditions, CdTe layers are grown on glass / FTO / CdS, used to test the properties of the material and to manufacture and evaluate the tools.

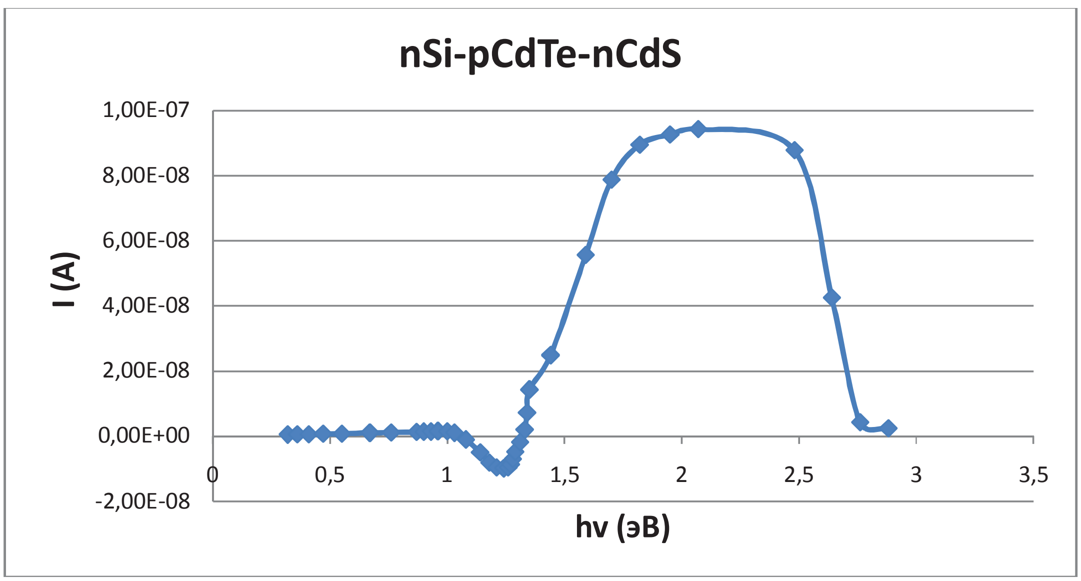

FIGURE 1. nSi-pCdTe-nCdS characteristics

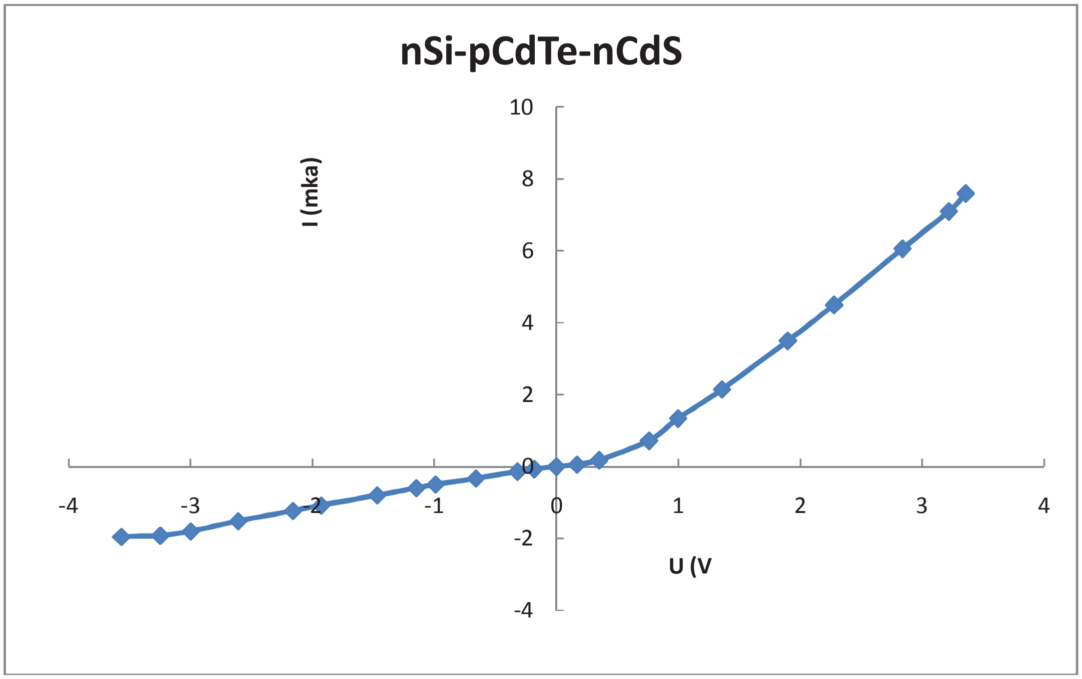

FIGURE 2. Spectral characteristics of Si-CdTe-CdSheterostructures.

We have demonstrated the feasibility of producing composite-level Si-CdTe and CdTe-CdS layers on substrates of Si-CdTe-CdS structures of electronic processes, i.e., high-quality heterofunction between Si-Cd and Te-CdS for use as solar cells.Figure-1.

In graded bandgap devices, it is possible to utilise IR-radiation also to create e-h pairs using a multi-step absorption process. This process is shown in both Figure 4, and can be considered as the "impurity PV effect". This is a classic case of utilizing naturally occurring defects to the advantages of the device through relevant device designs.

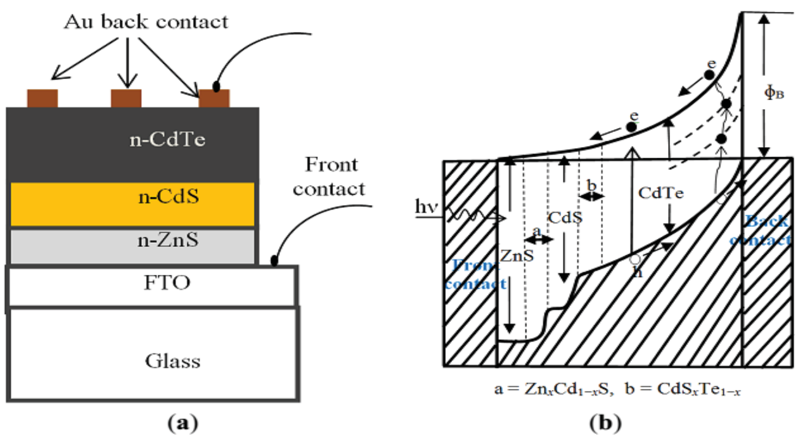

FIGURE 3. (**a**) Schematic diagram of a three-layer ZnS/CdS/CdTegradedbandgapsolar cell fabricated with n-type materials; (**b**) its energy band diagram;

CONCLUSION

The summary of a comprehensive research program presented in this paper and the combination of relevant results from the literature lead to the following conclusions.

During the study, we investigated elemental concentration depth regimes on the Te-CdS layer with an accuracy of ± 2% using the JEOL JXA-8900 electronic probe microanalysis system (data conditions: V = 20 kV, I = 10 nA; natural Cd, Te, and Si standards; synthetic FeS standard for S (Fig. 2). The results of X-ray spectroscopy are given in Fig. 1. 2 and 3, nSi on the substrate surface (vertical line 2), the amount of Si exceeds CdTe-CdS. With Si-Cd gradually decreasing and Te-CdS gradually increasing. Finally, after row 1, the amount of Si decreases to a minimum, and the amount of CdTe-CdS reaches a maximum. Figure 3.also shows the level of secondary electron layers of cadmium and tellurium. The output appears to be the highest.

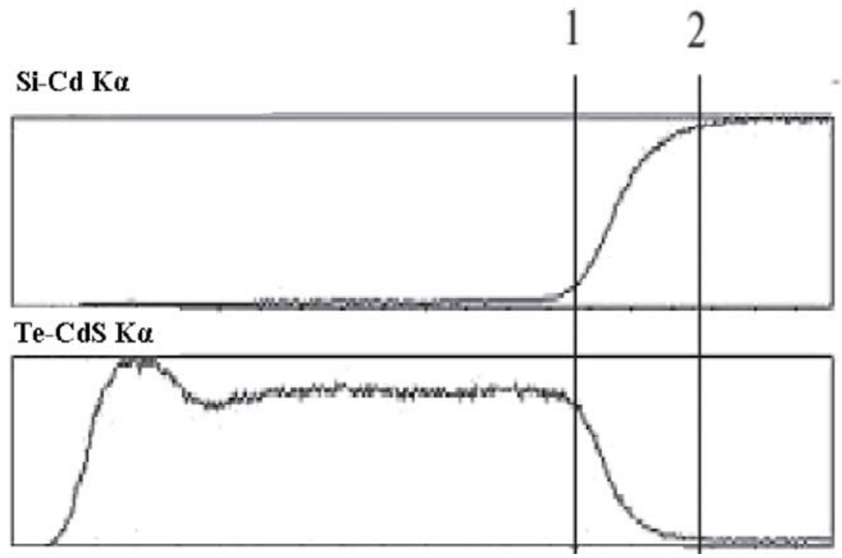

FIGURE 4. Elemental concentration profiles for Si-CdTe-CdS structures.

Si-CdTe and CdTe-CdS structures of electronic processes electrodeposition of semiconductors is a simple but powerful method for growing materials for microelectronic devices such as devices and display devices in the field of nanotechnology. However, intensive research is required to reach its full potential. Both Si-CdTe and CdTe-CdS can be electrode positioned using a 2-electrode system without a reference electrode, which is the source of the harmful electron process. The results presented show compactness, the ability to grow in one direction and to grow grains of rod or columnar type with normal properties for growth substrates. This growth model of nano- and micro-sticks can open up new applications in many other electronic devices.

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