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A Review Paper on Cadmium Telluride Films

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Abstract

Cadmium telluride (CdTe) films find applications in solar cell and electro-luminescent devices. In the starting when thin films cells were famous in late 1970 Silicon was used as an important material for solar cell fabrication, but gradually with the development of material science especially II-VI group compound are used for Solar cell fabrication. CdTe belongs the II-VI group is one of the suitable material for low cost photovoltaic devices.

Keywords: Direct Bandgap, Indirect Bandgap, Semiconductor, Solar Cell, Photo Voltaic

Introduction

Nowadays, electricity production by photovoltaic generation of sun light continues to grow. It can be assigned to the evolution of new PV (Photo Voltaic) materials and relatively cheaper production technologies, which have led to a reduction in the cost of watt-hours produced by PV process [21]. "A stable crystalline compound Cadmium telluride (CdTe) formed from cadmium (Cd) and tellurium (Te) is mostly used as the semiconducting material in cadmium telluride photovoltaic and an infrared optical window. Usually cadmium telluride is sandwiched with cadmium sulphide to form a p–n junction solar photo voltaic cell. Cadmium Telluride (CdTe) has been the subject of rigorous research because of its properties like reasonable conversion efficiency, intermediate Bandgap,low cost and stability" [18].

"Cadmium telluride (CdTe) can be alloyed with mercury (Hg) to make a flexible infrared detector material Mercury cadmium telluride (HgCdTe). Cadmium telluride mixed with a very little quantity of Zinc (Zn) makes an excellent solid-state gamma rayand X-ray detector (CdZnTe)"[9].

"CdTe is used as an infrared optical material for optical lenses and windows and it is proven that it provide a good performance over a wide range of temperatures. CdTe is also applied for electro-optic modulators. It has the greatest electro-optic coefficient of the linear electro-optic effect among II-VI compound crystals. CdTe doped with chlorine is used as a radiation detector for x-rays, gamma rays, beta particles and alpha particles.

CdTe can operate at room temperature allowing the construction of compact detectors for a wide variety of applications in nuclear spectroscopy" [2].

Review

N Nakayama et al. [10] and H Matsumoto et al. [26] have discussed the preparation of screen printed thin CdS/CdTe films. The films were deposited on Borosilicate glass which contains a very small amount of alkali(corning glass 7059). N Nakayama et al. [10] prepared CdS/CdTe solar cells with an efficiency of 6.3 %.

J. G. Werthen et al. observed the "Surface preparation effects on efficient indium- tin- oxide- CdTe and CdS- CdTe heterojunction solar cells. They prepared ITO/CdTe and CdS/CdTe heterojunction solar cells formed by electron beam evaporation of indium- tin- oxide (ITO) and CdS onto single crystal *p*- type CdTe" [25].

"Solar cells have been fabricated by T. Nakazawa et al. by reactive deposition of thin- film *n*- In_2O_3 onto single- crystal *p*- CdTe. The cell has a total area solar power conversion efficiency of 13.4% which corresponds to an active area efficiency of 14.4% at air mass 1.5 without antireflection coatings" [11].

H. Routary et al. [14] review the progress made in the CdTe based solar cells.

O Vigil-Galán et al. deposited CdTe thin films by close space vapour transport (CSVT) under variable growth conditions and post thermal and chemical treatments were studied by means of photoconductivity measurements in the temperature range of 90–300 K [24]. CSVT is a physical technique that involves the sublimation of a substance for transportation of a gas to deposit on a substrate. The mainutility of this method is the small distance, where the distance for transportation of the gas is small by which the control on the growth rate improves. With CSVT method, it is possible to get the films of thickness of 5000Angstrom.

S Sirohi et al. prepared films by Sintering process and observed from the CdTe film's absorption spectra that direct and indirect bandgap are 1.45 eV and 1.66 eV respectively in same sample. They used glass as a substrate and CdTe film's absorption spectrawere taken downwithU-3400 model Hitachi spectrophotometer in the wavelength range 6000-9000 Angstrom [20].

S Sirohi et al. observed the Optical, structural and electrical properties of CdTe sintered films [19].

"CdTe films were electrochemically deposited from an alkaline solution with the assistance of nitrilotriacetic acid (NTA) and tetramethylammonium hydroxide (TMAH) by Y. Zhang et al. CdTe film prepared at the complexing ratio of 14 : 1 was well-crystallized

and highly (111)-oriented; after annealing, it was free of voids with good interface contact. TMAH prevented the introduction of alkaline metal ions into CdTe films. This provides a novel approach for depositing CdTe films at the lower temperature" [27].

K. Deepalakshmi "developed Cadmium Telluride (CdTe) thin films on glass substrates by wet chemical process. The post annealing effect of CdTe thin film has been studied for the prepared films that are annealed at different temperatures. The structural, optical and electrical properties had been characterized for the films. XRD study had been done for the structural characterization" [3].

S. D. Gunjal et al. prepare CdTe films by Spray Pyrolysis Technique and reported XRD, FTIR, EDAX and SEM [6].

T.M. Razykova et al. prepared different composition of thin CdTe films by chemical molecular beam deposition method (CMBD) under hydrogen flow in atmospheric pressure. "The morphological, structural, electrical and optical properties of the CdTe thin films were investigated by SEM, XRD, Hall-effect and photoluminescence (PL) measurements, respectively" [13].

Honey et al. prepared CdTe films centrifugal coating followed by low temperature sintering and annealing [8].

Sekhar Chandra Ray et al. prepared CdTe films "by the dip-coating deposition technique under atmospheric pressure at different temperature. The optical band gap obtained within the range 1.63-1.60 eV. Crystallite sizes are obtained from XRD that are dependent on composition (Cd/Te) and baking temperatures. Raman spectra confirms the presence of transverse (TO) and longitudinal (LO) optical phonons in the CdTe structure. Films are good photoconductive in nature and could be used in photovoltaic applications" [17].

R. S. Patil et al prepared "CdTe thin films by chemical bath deposition technique, also known as solution growth technique using cadmium acetate and tellurium dioxide. Characterization was done by X-ray diffraction method, the scanning electron microscope (SEM) micrographs, optical spectrophotometer and the quantitative analysis using the energy dispersive X-ray analysis (EDAX). X-ray diffraction study indicates the hexagonal structure. The band gap calculated from optical spectra was found to be 1.41eV. The EDAX peaks shows the presence of Tellurium and Cadmium in the as-deposited thin film of CdTe"[16].

Chemically deposited CdTe thin films have received immense attraction due its applications in photovoltaic devices, microelectronics, switching devices, thin film transistors, etc.[4], [1], [7], [23].

S Pandey et al. deposited the CdTe films by pulsed laser deposition (PLD) using excimer laser. They characterised the film with optical property, as band gap, XRD and Atomic force microscopy (AFM). They found the band gap of CdTe films were 1.54 eV for hexagonal phase and 1.6 eV for cubic phase.AFM shows an average grain size 0.3 μm. X-ray diffraction analysis confirms the formation of CdTe cubic phase at all pulse energies except at 200 mJ. At 200 mJ laser energy, the films show hexagonal phase [12].

G G Rusu prepared CdTe film by physical vapour deposition [15].

S Ferreira et al. prepared the CdTe films by hot well epitaxy. The most important feature of hot well epitaxy is the facility to grow the film at low temperature even on polymer substrate [5].

A Ubale et al. used Successive ionic layer adsorption and reaction method (SILAR) technique for CdTe film deposition [22], [23].

Conclusion

The physical properties of the deposited thin film depend on the technology used to deposit the film. In this regard, many fabrication techniques have been attempted to grow CdTe thin films. Some of the technique for CdTe films deposition areScreen Printing [10], [26], [19], [20], Close Space Vapour Transport [24], electrochemically [27], Spray Pyrolysis Technique [6], Chemical Molecular Beam Deposition method [13], centrifugal coating [8], Dip-coating deposition technique [17], Chemical Bath Deposition Technique [16], Chemically deposited [4], [1], [7], [23], Pulsed Laser Deposition [12], Physical Vapour Deposition [7], Hot Well Epitaxy [5], Successive Ionic Layer Adsorption and Reaction method [22], [23] etc. By using different technique we can acquire film of required specifications.

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