Optimization Materials, Technologies, Deposition Methods of Thin Films Solar Cells: A Review

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Review Article

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ABSTRACT

Thin film solar cells offer the most promising and potentially important alternative for the substantially reducing the cost of photovoltaic system. This is may be the future of sustainable energy for the human civilization. A multiplicity of option in terms of materials and device are currently being developed worldwide. Day by day photovoltaic cells have been increased demands everywhere in the worldwide. The shortage of silicon supplies scientists have been tested the new semiconductor applications for solar cells. We also told that along with the silicon wafer we can also use other categories of solar cells such as cadmium chloride, CIGS, gallium arsenide, zinc telluride and organic solar cells that are having low cost and high efficiency. In the latest the performance of perovskite photovoltaics is greatly affected by undesirable defects that contribute to non-radiative losses and mitigate these losses by doping perovskite with KI to alter the dielectric response, thus defect capturing probability, resulting in inverted device with PCE of 22.3% and low voltage loss. In this review article mentioned that the much type of solar cells along with the higher efficiencies, their cost is effective and which is most useful fabrication method.

INTRODUCTION

Renewable energy is usually described as energy, which is collected from resources that are naturally replaced at a human time such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy resources exist in broad geographic areas unlike other energy sources, which are concentrated in limited countries. Rapid deployment of renewable energy and energy efficiency results in significant energy security, climate change mitigation and economic benefits. Solar energy is an important source of renewable energy [1-4]. As the world's population continues to grow, the energy requirement is also increasing and by the end of 2025, it is projected to double than it is today [5]. The energy demand requirement is mostly satisfied by fossil fuels which are limited available resources. Fossil fuel combustion also creates pollution by eliminating gases such as CO_2, NO_2, CO, SO_2, etc. , therefore, finding and exploiting renewable, environmentally clean energy sources, which replace traditional energy resources will give. Among the various renewable energy sources known today, solar energy is one of the most abundant, clean and effective energy sources for mankind. More than 80% of the current Photo Voltaic (PV) industry is based on Si-Si and PC-Si wafer technologies [6]. However, these technologies rely on an indirect band gap absorber material, requiring a thicker layer to absorb more fractions of incident solar radiations. The semiconducting materials of chalcogenide II-VI group usually have unique and suitable electrical, structural and optical properties for the fabrication of emerging semiconducting solid-state devices especially photo detectors and solar energy converters To obtain high efficiency solar modules, the right crystals are needed which contribute to high cost PV devices. Therefore as an alternative to these PV technologies, recent PV developments have focused on thin film PV technologies. These thin film PV technologies are based on direct band gap materials, such as Copper Indium (Gallium) de Salanide (CIGS), Copper Indium di Selenide (CIS) and Cadmium Telluride (CdTe) and up to the commercialization stage with the highest reported conversion efficiency of 11% have arrived in module output [7,8]. However, due to issues with the toxicity of Cd and Se and the availability of In and Te, the production of PV devices based on these absorber layer is limited [9]. As an alternative, recent attention to non-toxic, low-cost, and readily available absorbent materials has attracted considerable attention to the scientific community. Cu2ZnSnS4 (CZTS) quaternary semiconductor has emerged as a promising candidate for solar absorber materials. All the constituents of CZTS are low cost, less toxic and earth abundant. The earth contents of elements used in CZTS, CIS, CIGS and CdTe light absorbers. A thin film solar cell is an electronic device which directly converts sunlight into electricity from the photovoltaic phenomena. Light immaculate on the solar cell construct both a current and voltage to produce electricity. This process requires firstly a material in which the like the absorption of the light increase an electron to a higher energy state and second the movement of this privileged energy electron from the solar cell in to an peripheral circuit. The electron then dissipates its energy in the external circuits and returns to the solar cell. Recently research and technological developments tend to broaden the realm of photovoltaic devices, adding to the classical silicon wafer technology and to other amorphous silicon p-i-n devices, perhaps more complex but of higher conversion efficiency and at lower cost. Polycrystalline silicon thin film converters on glass and tandem solar cells built by stacking microcrystalline and amorphous silicon films in a due sequence are about to enter the market. Above the many years, William Adams and Richard day contemplate light induced photo current in selenium with having two heated platinum coated contacts. It had efficiency of nearby 1%. Now days in the recent years the attention is on the quality based silicon wafers developed for the application in solar cell devices and electronics. For the first time, substantial quantities of power were produced by photovoltaic's cells consisting of crystalline silicon. The first silicon cell was made by caption, Fuller and Pearson in 1954 having 6% efficiency. Silicon is the currently the most efficient solar cell available for residential use and account for the around above 80% of all the solar cells panels sold around the world. Nowadays II-VI group family has become a very important material for various solar cell applications. The solar cell is the basic building block of solar photovoltaic [10]. In recent years, the photovoltaic's market is growing up and very dynamic with sales almost completely influence by product based on the use of semiconductors materials like cadmium supplied, gallium arsenide, indium phosphate, cadmium telluride and CIGS, p-n junctions should have equal or better efficiencies than silicon p-n junction [11].

In the latest the performance of perovskite photovoltaics is greatly affected by undesirable defects that contribute to non-radiative losses and mitigate these losses by doping perovskite with KI to alter the dielectric response, thus defect capturing probability, resulting in inverted device with PCE of 22.3% and low voltage loss. During that time, deep understanding of photovoltaics was gained. New approaches and materials were proposed to make photovoltaic's economy, for instance photo chemical junction, polycrystalline silicon, amorphous silicon and organic conductors and so on. Silicon wafer having high costs concluded 50% of the entire module cost. Eliminating this major cost we having alone way the component is by replacing wafers by thin films of semiconductors deposited onto a supporting substrate. The sustained explosion instigating demand for silicon wafers to out-strip the capacity to supply as well as creating a market entry opportunity for a number of competing thin film deposition technologies. A second class of rising technologies is based on organ metallic dyes and polymers.

In the 2021 till the production of solar cells as per year expanded 25%-40%, which is also reduced their cost also. Solar cells have become compitives at remote locations, in navigations systems, telecommunication and as additional power in grid connected loads at peak use [11] and vis-à-vis II-VI semiconducting material group is having many application such like as optoelectronic devices, light emitting diode, lasers, and window and buffer layer for solar cells.

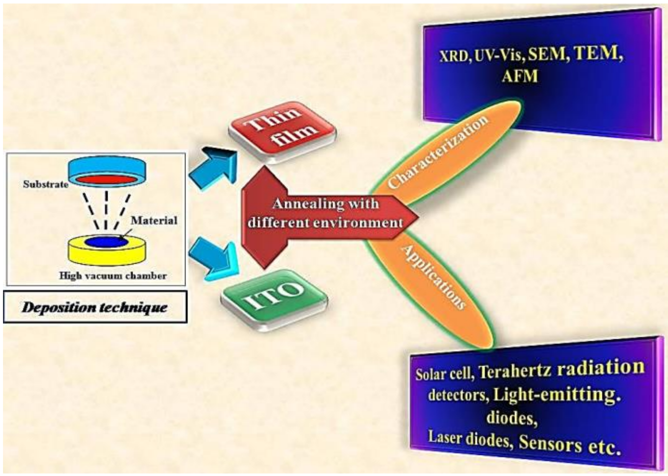
LITERATURE REVIEW

Growth of thin films market and thin film products

A thin film solar cell is a second generation solar cell that is made by deposited one or more layers of photovoltaic materials on a glass substrate. Thin films solar cells are mostly used in several technologies like Cadmium Telluride (CdTe), Copper Indium Gallium di Selenide (CIGS) and amorphous thin film silicon (a-Si, TF-Si). Nowadays thin film module are based on amorphous silicon is single junction or multi-junction arrangement as well as on the chalcogenide compounds CdTe or CIS. Now in the solar cell thin film modules based on polycrystalline silicon has been current market applicant. However since the volume attendant with the wafer based methodologies are also increasing quickly, the thin films technologies having to propagate just retain their present market share. There is a higher barrier for market entry for thin film technologies due to higher capital costs per unit output for thin films manufacturing facilities.

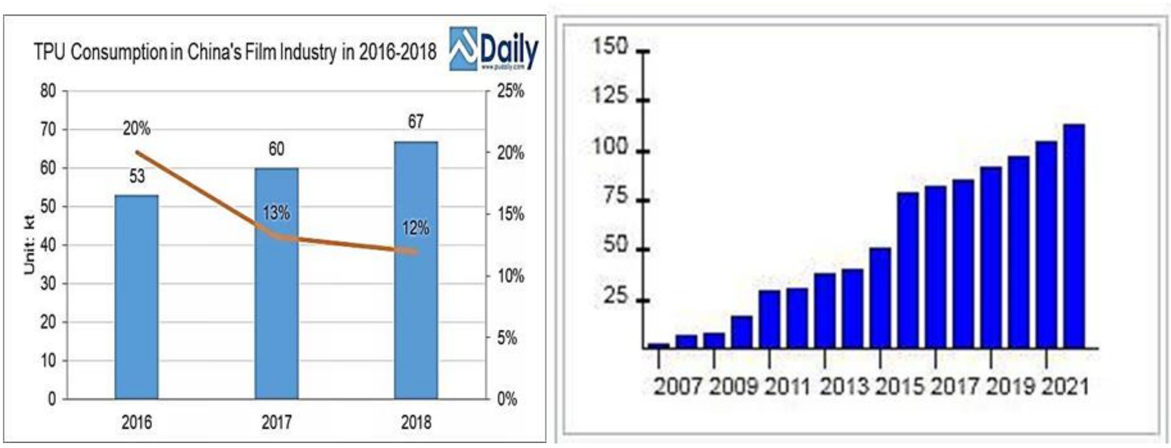
The manufacturing of the conventional wafer based modules is commonly broken down into four discretely financed procedures silicon refinement crystal growth and wafer cell processing, and cell encapsulation Figure 1 [12, 13].

Figure 1. Typical view of the graphical abstract for thin-film solar cells.



This include a thin film product an occasion to increase market segment and to inaugurate its authorizations on a market previously not all that interested at least partly due to the undeniably superb reliability and durability demonstrated by the silicon wafer based attitude Figure 2.

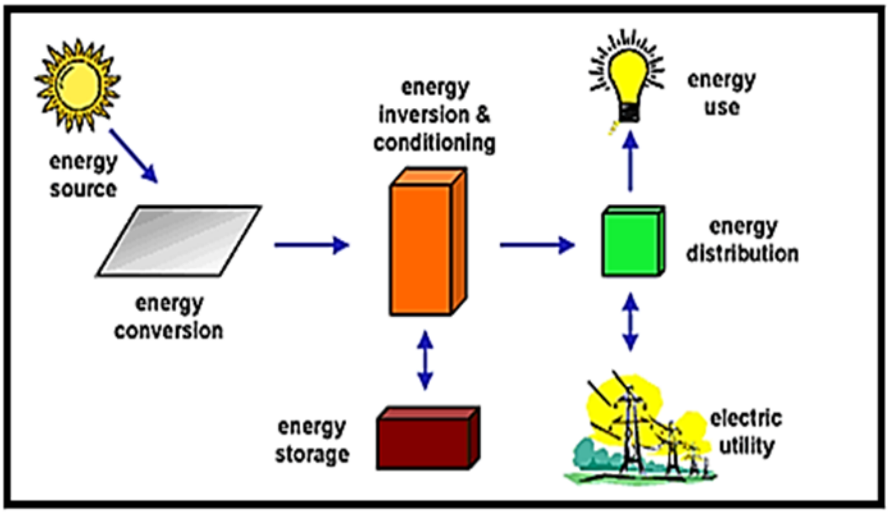
Figure 2. (a) Thin film market growth rate and (b) Historical and projected global demand for solar pv [14].



Photovoltaic effect

This effect refers to absorption of photons (having energy higher than that of the band gap of absorber layer material) by the absorber layer (of a solar cell device) resulting into excitation of electrons into a higher state of energy and thus leaving/creating vacancies i. e. holes in the valence band. These produced electrons and holes operate as charge carriers and thus an electric current is generated in the circuit [15,16]. The Photo Voltaics (PV) are best known to represent the devices which are used to generate electric power on the basis of the direct conversion of energy from the sun light to the electrical energy on the basis of the photovoltaic effect. A simple block diagram of photovoltaic process is shown in Figure 3.

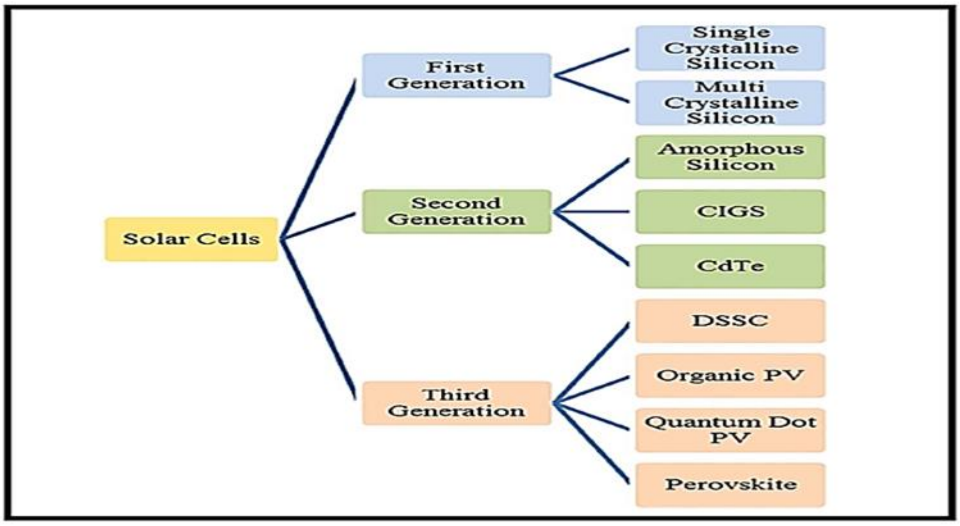
Figure 3. A typical arrangement of the complete photovoltaic effect and its applications [17].



Generation of the thin film solar cells

On the basis history and progress, the solar cell technology mainly classified into three categories as shown in below Figure 4.

Figure 4. Pictorial view of classification of solar cells.



RESULTS

First generation solar cells

This generation includes the Silicon based solar cells which are known as conventional or traditional solar cells. As stated above, the first Silicon based solar cell was developed in 1954 in the Bell Laboratories with the conversion efficiency of 6%. Since then [18], research on the improvement on the efficiency and reduction in the cost was made. First generation solar cells include two types of solar cells as under

- Single Silicon solar cells
- Polycrystalline Silicon solar cells

Single solar cells: These solar cells are also recognized as monocrystalline solar cells and exhibit high efficiency under standard operating conditions [19]. These solar cells are space efficient, having long life and perform better than other solar cells. The main drawback of these solar cells is high consumption of materials and consequently their higher cost vis-à-vis to the others [20].

Polycrystalline solar cells: These solar cells are also known as multicrystalline solar cells. Generally, these solar cells are composed of a number of different crystals, coupled to one another in a single solar cell, therefore, these are called multicrystalline solar cells. During the fabrication of the device, the cooling a graphite mold is made which contains molten Silicon [21]. The major disadvantage of such solar cells is their less efficiency vis-à-vis to the monocrystalline solar cells [20].

Second generation solar cells

The second generation represents the thin film based solar cells which are emerged due to low production cost and minimal material consumption those make these solar cells attractive to the solar cell industry. There are some basic differences between the second and the first generation solar cells where the most important difference is that the semiconductor material used in the second generation solar cell has a direct band gap whereas the Si has (first generation solar cell) indirect band gap [22]. The second generation of solar cells includes three types of solar cells as under:

- Amorphous Silicon (a-Si) solar cells
- Cadmium Telluride (CdTe) solar cells
- Copper Indium Gallium diselinide (CuInxGa1-xSe2 i. e. CIGS) solar cells

Amorphous silicon solar cell: In amorphous silicon solar cells, a thin layer is required (micron order) to absorb the incident sun light. These solar cells can be fabricated on various kinds of substrates. These solar cells have low manufacturing cost but these cells have a couple of disadvantages too. A major disadvantage is that these do not absorb photon as efficiently as other Silicon solar cells and another is that these cells degrade over time. Because of these disadvantages, the CIGS and CdTe thin film cells were developed due to their better stability and efficiencies [23]. Among Si based solar cells, the efficiency of the single crystalline Silicon solar cell is about 26% but it is the most expensive. The efficiency of multicrystalline Silicon is about 21% and it is slightly less expensive to produce. The amorphous Silicon solar cell have a very low efficiency of 16% and these are less expensive. The multicrystalline silicon is extensively used commercially due to its good efficiency and low cost [24].

Cadmium telluride solar cell: In this thin film solar cell technology, the Cadmium Telluride (CdTe) thin film of thickness 1-4 μm is used to absorb the incident sunlight. The CdTe based solar cells have shown the power conversion efficiency more than 22% at laboratory scale. The CdTe photovoltaic technology has established a good capacity worldwide due to its thermal and chemical stability. It is ideally suited for utility scale applications to reduce the cost of electricity per watt [25]. The CdTe technology costs about 30% less than CIGS technology (discussed below) and 40% lesser than amorphous Silicon solar cell technology.

Copper indium gallium dieseline solar cell: The CIGS solar cells are made from a thin layer of direct band gap semiconducting material of Copper Indium Gallium Diselenide $Cu(In,Ga)Se_2$. The CIGS cells have shown efficiency upto 23% with similar durability as that of Silicon solar cells. These solar cells are also shown lesser cost than that of traditional Si based solar cells [26].

Third generation solar cells

Due to the high cost of first generation solar cells and toxicity and as well as the limited availability of materials for second generation solar cells, a new generation of solar cells has been emerged. Third generation solar cells are naturally different from the earlier two generations. There are some popular solar cells which are included in third generation as described under:

- Dye-Sensitized Solar Cells (DSSCs)
- Organic Solar Cells (OSCs)
- Quantum Dot Solar Cells (QDSCs)
- Perovskite Solar Cells (PSCs)

Dye-Sensitized solar cells: A sensitized solar cell is a low price solar cell technology which belongs to the third generation group of thin film solar cells. It is based on a semiconductor prepared between a photosensitized anode and an electrolyte, a photoelectron chemical system. A DSSC is made up of a porous layer of TiO_2 enclosed with a molecular dye that absorbs sunlight, such as chlorophyll in green leaves. Herein the light absorbing dye is used to coat these TiO_2 nanoparticles in order to convert sunlight into electricity [27].

Quantum dot solar cells: In these solar cells, the quantum dots are used an absorber material to absorb incident light. Quantum dots are special category of semiconductors which can confine electrons where the band gap of these quantum dots could be tuned by different treatments. The aim of such solar cell is to replace the Silicon, CIGS and CdTe based solar cells. Quantum dots have bandgap that is tunable across a wide range of energy levels by changing their size. Even though the quantum dot based solar cell's efficiency is less than 9% but it has attracted researchers because of its adaptable property, low cost and lightweight materials.

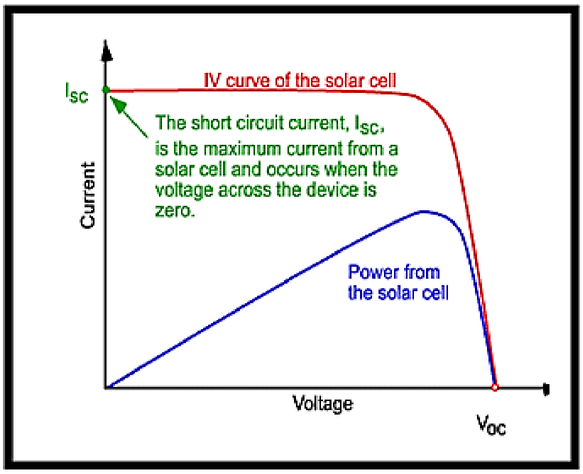
Perovskite solar cells: Since the first incorporation of perovskite structure like methyl ammonium lead iodide ($CH_3NH_3PbI_3$ or $MAPbI_3$) organic inorganic hybrid lead halide compound into liquid-electrolyte based Dye-Sensitized Solar Cell (DSSC) in 2009, an unprecedented work has been carried out on perovskite solar cells (PSCs) that leads to achieve efficiency of more than 25% within the last ten years of active research. The Perovskite Solar Cells (PSCs) consist of perovskite structured (ABX3) material as an active/absorber layer. This is a very attractive alternative for commercial applications because these types of cells are very inexpensive during the scale up process. Perovskite solar cells have emerged as most outstanding solar cells in terms of efficiency. Therefore, the researchers have shown tremendous attention in Perovskite solar cells. Flexibility, lightweight and semi conductivity are some of the valuable features of these solar cells.

Performance parameters of solar cell devices: Some parameters termed as solar cell performance/characteristic parameters are defined and on the basis of these parameters, the rating of solar cells is decided. These parameters describe that how efficiently a solar cell can turn light into electricity. Generally, the four parameters *viz.* short circuit current density (Jsc), open circuit voltage (Voc), Fill Factor (FF) and efficiency (η) are known as performance/characteristics parameters for a solar cell device.

Short circuit current density of solar cell

The short circuit current (Isc) is the current that flows from an external circuit when the electrodes of the solar cell are short circuited. The short circuit current of a solar cell depends on the incidence of photon flux on the solar cell, which is determined by the spectrum of incident light. For the distinctive solar cell measurements, the spectrum is standardized to the air mass 1.5 (AM1.5) spectrums. The Isc depends on the area of the solar cells, thus short circuit current density (Jsc) is measured. The short circuit current density is often used to describe the maximum current delivered by the solar cell which is strongly depends on the optical properties of the solar cell, such as absorption and reflection in the absorption layer. Typical diagram representing the short circuit current is shown in Figure 5.

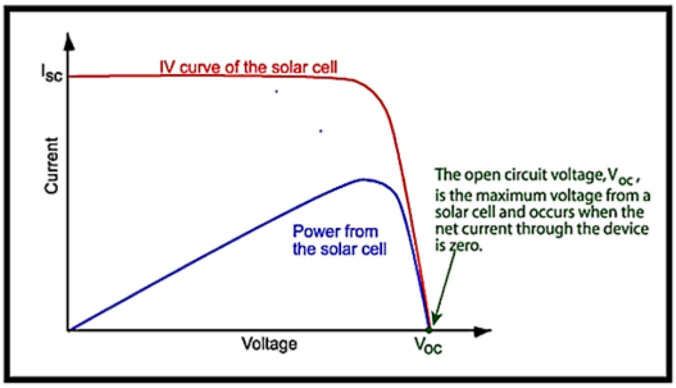
Figure 5. Typically I-V curve of a solar cell showing the short circuit current.



Open circuit voltage of solar cell

The open-circuit voltage (Voc) is the maximum voltage obtainable from the solar cell at the zero current. The Voc corresponds to the forward bias voltage, at which the dark current density compensates the photocurrent density. The Voc depends on the photo generated current density. The open circuit voltage is represented in the below I-V curve as given in Figure 6.

Figure 6. Typically I-V curve of a solar cell showing the open circuit voltage.



Fill Factor of solar cell (FF)

The fill factor effectively determines the quality of the solar cell. It is defined by evaluating the maximum power to the power that would be output at both the open circuit voltage and short circuit current together. In other words, the fill factor is the ratio of maximum power (Pm) to the product of the short circuit current density (Jsc) and the open circuit voltage (Voc) of the solar cell and mathematically given as:

$$FillFactor = \frac{p_m}{V_{OC} \times I_{SC}}$$

The highest value of fill factor is one which is the ideal condition.

Efficiency of solar cell (η)

The efficiency is mainly common the parameter to evaluate the performance of one solar cell to another solar cell. The power conversion efficiency is defined as the ratio between the maximum produced power and the incident power i. e the ratio of maximum power density delivered at operating point (Pmp) to the incident light power density (Pin). The solar cells are measured under the STC (Standard Terrestrial Conditions), where the incident light is represented by the AM1. 5 spectrum and has an irradiance of Iin=1000 W/m^2 where AM stands for air mass. Mathematically, the efficiency of a solar cell can be expressed as given.

$$Efficiency(\eta) = \frac{p_{mp}}{p_{in}} \sim \frac{p_m}{1000}$$

$$(\eta) = \frac{I_{mp} \times V_{mp}}{1000}$$

Thin films solar cells

The thin film solar cells are second generation solar cells which comprised CdTe, CIGS and amorphous Silicon based solar cells. The fabrication processes which are employed to deposit these photovoltaic materials for large scale productions are vacuum evaporation, closed space sublimation, plasma enhanced chemical vapour deposition etc. In CdTe based photovoltaic technology, thin layer of CdTe is deposited as absorber material to absorb incident light. Conventionally, CdS is used as window layer for an asymmetric junction which is environmental hazardous due to toxicity of the Cd. The CdS window can be replaced by Zn based buffer layers which are nontoxic. The thin film solar cell consists of different thin layers of dissimilar materials i. e. substrate, Transparent Conducting Oxide (TCO) layer, window layer, absorber layer and metal contacts which are the necessary part for the same. These layers have different physical and chemical properties and affect the overall performance of the device concerned. A brief discussion about the role of each layer in solar cell is as under:

Substrate: Substrate plays vital role in thin film solar cell devices as it is a passive component. Therefore, a mechanically stable, matching thermal expansion coefficient with deposited layers and inert substrates are essential for highly efficient solar cells. There are two ways to configure a solar cell device either in substrate or in superstrate structures. In substrate configuration, metal or metallic coating on a glass/polymer is used as substrate which also works as contact whereas in superstrate configuration, the substrate is transparent and the contact is made by a conducting oxide coating on the substrate.

Transparent Conducting Oxide (TCO): In order to make a low resistive contact to the device and to transmit maximum solar irradiance to the absorber layer concerned, a transparent conducting oxides layer is used which generally possess n-type conductivity and has high transparency in the visible spectrum.

Window layer: In the thin film solar cells, a window layer is used to create an asymmetric junction (in hetero-junction form) with absorber layer concerned with transmitting the maximum amount of sunlight to the absorber material. An efficeint window layer should have larger band gap as well as thickness of this layer should be as low as possible.

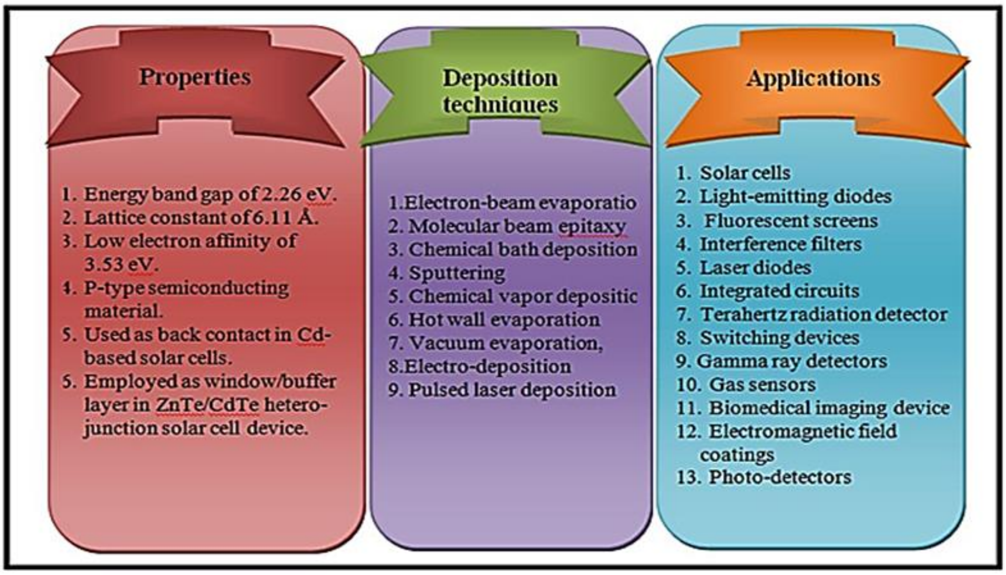
Absorber layer: The solar cells are recognized by their absorber layer concerned where the absorber layer absorbs incident spectra and generates charge carriers which contribute in photocurrent. Different thin film solar cells possess absorber layer of different semiconducting materials. An absorber layer should have high absorption coefficient as well as the optical energy band gap should be in the vicinity of the optimal band gap i. e. 1. 4 eV in view of solar irradiance AM1 and 5G at the earth surface.

Metal contact: A solar cell device is comprised of metal contacts which should be ohmic and for the formation of an ohmic contact, a metal with relatively higher work function than that of the absorber layer (e.g. p-type CdTe semiconductor) is used which should be almost aligned with the valence band edge.

Thin film deposition techniques

The properties of the thin films can be established by choosing actual technique of film deposition. Thin film deposition methods can be predominantly classified in the chemical or physical methods. The dissimilarity between the chemical and physical thin film deposition methods is based upon the method of depositing thin film material on the substrate. In the chemical deposition technique, fluid precursor is used which may be chemically behave with the substrate. Since the thin film material is conducted through the fluid precursor, chemical deposition is conformal proceed toward the substrate without precedence to a particular direction. A conformal is a dissimilar interface with the body and has a constant thickness on horizontal and vertical surfaces Figure 7.

Figure 7. Overview of the ZnTe thin films.



Physical deposition technique includes the following methods

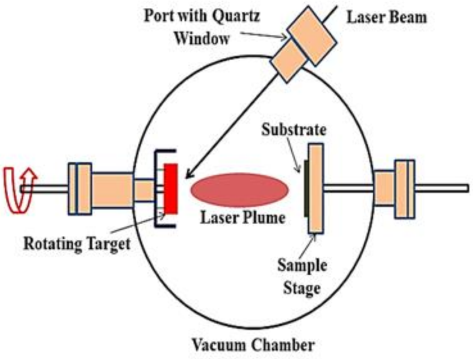
Molecular Beam Epitaxy (MBE): MBE having a combines advantages of both chemical and physical methods of thin film deposition technique. Initially, the target semiconductor materials to be deposited are heated directly until they convert from solid into gaseous form. After then the gaseous elements are allowed to react chemically with the substrate to grow the thin film. In MBE, target material is deposited in the form of layers but only one layer at a time. MBE is a slow method as well as to another deposition methods but the MBE having degree of purity is very high.

Sputtering: This is type of physical vapor deposition technique is called Sputtering method in which the atoms from a target material are unrestricted and come to rest on the substrate. The target material is kept at low temperature.

In this method, plasma of a noble gas such as argon is used as a target material (The formation of plasma environment by the discharge of neutral gas such as helium, Neon). Noble gas does not allow any undesired chemical reactions therefore it is a fast and an effective method to achieve the preferred level of film thickness.

Pulsed Laser Deposition (PLD): Pulsed Laser Deposition is an ablation method of physical deposition technique. Firstly the high power pulses of laser light are focused on the surface of the board material in the vacuum chamber. This results in vaporization of the target material. The atoms ablated from the target material and that get deposited on the substrate. Figure 8 is showing the pulsed laser deposition technique.

Figure 8. Pulsed laser deposition technique.



Thermal evaporation method: In this deposition technique the source material kept by the crucible and thereafter it will be deposited is evaporated in a vacuum by using an electron beam or resistive heating and created inside a high vacuum coating chamber by the vacuum pump. The vacuum allows the vapor particles to journey directly on the substrate where the particles abbreviate back to a solid state to form a thin film.

Chemical deposition technique includes the following methods

Chemical Vapor Deposition (CVD): Chemical Vapor Deposition (CVD) is a widely used process for coating of metallic or ceramic compounds. During CVD, the constituents of a vapor phase, often diluted with an inert carrier gas, are broadcasted into a reaction chamber and adsorbed on heated substrate surface, which result in a solid coating via a chemical reaction. In the process the substrate temperature is precarious and can encouragement the incidence of different reactions. There are several types of CVD process, including metal-organic CVD, atmospheric pressure CVD, photochemical vapor deposition low-pressure CVD, plasma-enhanced CVD, laser CVD, chemical beam epitaxy, chemical vapor infiltration and plasma-assisted CVD etc. The other coating deposition technique is physical vapor deposition which is accomplished under vacuum situations using the evaporation of a solid or molten source or by the energetic gaseous ions in gas plasma which sputter the atoms from a source target. These atoms or molecules then travel concluded a vacuum or a very low pressure gas phase, encroach on the substrates, and finally abbreviate on the surface to form the film [28].

Plasma enhanced chemical vapor deposition method: In the Plasma enhanced chemical vapour deposition plasma is formed in a reaction chamber which transforms gaseous precursors into reactive particles ions, neutral atoms and molecules. These atoms and molecular extent sinter mingle with a substrate and due to this chemical reaction a solid layer develops on the surface on the substrate. In PECVD, the low temperature (300~350 degree centigrade) is used for the manufacture of thin film however, high temperature (600~90 degree centigrade) in CVD is used to improve thin films.

Atomic layer deposition method: In the nuclear layer deposition technique, two or more gaseous precursors are used to reactively with the substrate to react at one time. The thin films acquired by this process are analogous. The process of ALD is separated into two half reactions. In these reactions, the precursor is the evacuation and evacuation of the reaction chamber which moves in sequence and is repeated for each precursor. This chemical reaction happens as a result of the formation of desired film thickness on the substrate. ALD is a phased process therefore it is slow but can also run at lower temperatures.

Sol-Gel method: Sol-gel is a chemical solution declaration method in which forerunner solutions are highly regulated for deposition of films. The sol-gel method comprises alcoxide where after these poly-condensation reactions the macrolycular oxide network is obtained through the hydrolysis of the Alkoxy group. In the physical drawing techniques mechanical or electrical methods are used to accumulation thin films on the substrate. The material deposited on the substrate depends on temperature pressure and other physical conditions. In these physical methods thin films produced are directional on nature because the particles will be following a straight path that targets the substrate.

DISCUSSION

During the last few decades, the thin film materials have been exploited to a huge area in optoelectronics device applications. The need for suitable miniaturization has made the use of thin and thick films mandatory. The growth of computer technology requires very high density storage techniques that lead to the most research on the magnetic properties of thin films. In order to generate new ideas for optoelectronic devices, the fundamental research has led to dramatic improvements in understanding thin films and surfaces. Thin films are also used in space and defense programs where the cost of the device is less significant than its lighter weight and other advantages.

The thin film technology has encountered as useful tool owing to large range of applications in the field of optoelectronics, photovoltaic devices and nanotechnology. Thin films have already been used in semiconductor devices such as integrated circuits, rectifiers, transistors, light crystal displays, light-emitting diodes as well as these films are more used in optoelectronic and communications areas like solar cells, wireless communications, telecommunications, photoconductors, magneto-optic memories, audio and video systems, compact discs, electro-optic coatings, memories, multilayer capacitors, flat-panel displays, smart windows, computer chips, magneto-optic discs, lithography, Micro Electro Mechanical Systems (MEMS) and multi-functional emerging coatings as well as similar other emerging cutting technologies.

Future scope of thin film solar cells

Thin film solar cell market is have been strongly stabilized and as well as its market growing up very quick. The future of thin films is very strong as a growths and development of new technologies of thin films solar cell. Although serious obstacles, amorphous silicon has established itself as a feasible challenger for wafer based crystalline silicon devices. Meanwhile the next generation of thin films CIS and CdTe shows stronger technical concert (efficiency and stability) and related or potentially lower cost. In the latest the performance of perovskite photovoltaics is greatly affected by undesirable defects that contribute to non-radiative losses and mitigate these losses by doping perovskite with KI to alter the dielectric response, thus defect capturing probability, resulting in inverted device with PCE of 22.3% and low voltage loss. Thin film goals should be met and by that means, low-price PV will happen to real. The explanation will be the resources and patience needed to overcome technological challenges.

CONCLUSION

Now a days the thin films solar cells module market are widely enlarge as well as its giving a better opportunity to potentially very low cost approach to setting up these identifications vis-a-vis in market already used the silicon wafer cell having with a good efficiency. In the market several deposition techniques are available as I mentioned in this report and with the many different thin film solar cells are now available such like as either based on silicon in amorphous, polycrystalline, CIGS, GaAs, CdTe andon chalcogenide element sides is based. The proposed review is mainly focused on the development of thin films with various pre and post treatments followed by optimization of physical properties for the fabrication of high performance and low cost of thin films solar cells.

COMPETING INTERESTS

The authors have no Competing interests.

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