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A Review on analysis of Traditional Silicon Solar Cells and Thin-Film CdTe Solar Cells

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Abstract: Most of the power is produced by using fossil fuels, which emits Tons of carbon-dioxide and other pollutants in every second. Because of increase in demand of clean energy, the solar industry is the most growing forces in the market. Solar energy is one of the most important sustainable and non conventional energy sources. Photovoltaic is the straight conversion of sunlight into electrical energy with the help of solar batteries. There are many materials and techniques which are used for the fabrication of solar batteries which is based on low and high conversion efficiency. The first material use to make solar cells is silicon but its drawbacks are costly and less efficient .In recent time the solar cells manufacturing technologies are the thin-film solar cell which are use to produce electrical energy. On the basis of higher efficiency, the Thin-Film solar cells are manufactured and compared with traditional silicon solar cells. The Thin-Film solar cells are composed of several layers that reduce the current losses. When sunlight strives at the solar cell, photons with higher energy will be absorbed by higher layers and vice versa and low energy photons will be absorbed with lower layers which are made of thin film solar cells that lead to prevention of wasting energy. The comparison between thin film CdTe and traditional solar cell technology carried by other researchers to compare the thin film solar cells such as traditional silicon and cadmium telluride solar cell to indicate that thin film solar cells like CdTe are more economical than the traditional solar cells.

Keywords: Photo voltaic, thin film solar cells, CdTe Thin-film, Photo voltaic, Solar cell fabrication, silicon thin film.

1. INTRODUCTION

The solar cell is acceptable when it has low manufacture cost and good conversion efficiency. For higher efficiency thin film solar cell is considered. These cells have various levels in one cell which reduces the losses in solar cells. When solar energy strikes on the surface of solar cells, few energy of the photons will be absorbed and converted in to electrical energy and some energy will convert in to heat and rest energy will be lost. For improving the quality of solar cells, the different absorber and moderate layers are used. The required amount of material in making the active material of solar cell is diminish by using thin- film technologies. The modules are mostly makes of the thin-film solar cell which sandwiched between two panes of glass. Only one pane of glass is used in silicon solar panels but thin-film panels are approximately two times heavy as compared crystalline silicon panels. The success of maiden solar cell is due to lower cost as compared to wafer silicon cells. The thin film solar technologies have enjoyed large investment but they did not become mainstream solar products because of large area consumption per watt production and their lower efficiency. Cadmium telluride (CdTe), amorphous silicon (A-Si), Copper indium gallium Selenide (CIGS) are thin-film technologies which are often used as outdoor photovoltaic solar power production. CdTe technology is less costly as compared to CIGS and A-Si technology. The solar cell is valuable by low manufacture cost and consideration of conversion efficiency. Thin film solar cell is proposed higher efficiency. CdTe technology cost less about 30 % as compared to CIGS and about 40 % less as compared to A-Si technology. By gathering information of traditional silicon solar cells and CdTe cells, this research shows that the Thin-film are more economical in comparison to the traditional silicon solar cells(by saving time, cost and energy). So this is the reason why Thin-Film technology was started and is extending and become popular day by day.

2 .THIN FILM APPROCHES

For the solar cell production the large number of materials can be use which exhibits the photovoltaic effects, however for useful solar cells some requirements needs satisfy are as following:

(a) Conversion efficiency should be high. (b)The material should be non toxic, available and inexpensive. (c) The method should be simple, low cost and fast for cell production. (d) The performance of the solar cell should be stable for a long period such as 20 years. In today's scenario virtually more than 80% of commercial solar modules are made of silicon. Some other materials such as CdTs, CIGS etc has been investigated for use in Thin-film solar cells. CIGS promise of higher efficiency and CdTe shows the promise of low cost production. The Thin-film has the most potential for low cost and high efficiency photovoltaic cells in comparison to other photovoltaic technologies. The main advantage of Thin-film solar cell technology is their relatively low cost for the required material and large scale production is possible. Thin-film solar cell compound semiconductors have great potential to attain high efficiency and stability in comparison to a-Si solar cells. Many methods of deposition have been used to produce polycrystalline CdTe layers are such as electrode position, closed spaced sublimation, screen printing, sputtering and spraying. The parameters used to characterized solar cell output such as short circuit current (Isc), fill factor(FF) and open circuit voltage (Voc). Fill factor ideally can be expressed with Voc. For determining the electrical conductivity of solid the energy gap is a major factor. The band gap refers to the energy difference between the top of the valence band and the bottom of the conduction band in insulator and semiconductor in graph of the electronic band structure of solids. This is the equivalent energy required to free an outer shell electron from its orbit about the nucleus to become a mobile charge carrier able to move freely with in the solid material. The optimum energy gap for maximum output of solar cell is between the ranges of 1.3 to 1.6 ev, the CdTe solar cell have energy gap of 1.45 ev which is suitable energy gap for optimum cell output. The choice of best material of photovoltaic cells based on following criteria.

(a) The nature of band to band transition and value of energy gap.
(b) Ability of the solar cell work eventually under concentrated radiation.
(c) The value of photo carrier life time as a fraction of doping and defects.
(d) The ability to form collecting structure and ability of material to be fabricated economically large area.

3. TRADITIONAL SILICON SOLAR CELLS

Traditional solar cells are made of silicon. These are currently most efficient solar cells available for residential use, around more than the 80% of all the solar panels sold around the world. Silicon based solar cells are more efficient and longer lasting in comparison to non silicon based solar cells but they are at more risk to lose some of their efficiency at high temperature than Thin-film solar cells.

(A)MONOCRYSTALLINE SILICONE CELLS: The thin wafers of silicon is the oldest, most popular and efficient solar cell technology to make the solar cells. These are called mono crystalline solar cells because the calls are sliced from large single crystals that have been painstakingly grown under the carefully controlled condition. The cells are few inches across and a number of cells are laid out the grid to create a panel. You will obtain more electric power given area of panel relative to other type of cells because they have higher efficiency (up to 24.2%). It is useful if you have a limited area for mounting your panels. The growing of large crystals of pure silicon is difficult and energy intensive process, so the production cost of this type of solar cell is the highest of all the solar panels. As the temperature increases about the 25 C the solar panels made from mono crystalline silicon cells losses their efficiency which is a serious issue so they need to be installed in such a way as to permit the air to circulate over and under the panels to improve their efficiency.

(B)POLYCRYSTALLINE SILICON CELL: The calculators and many small electronic devices uses the solar cells are mostly made from amorphous silicon cells. In amorphous silicon cells the silicon is deposited in a very thin layer on to a backing substrate such as a metal, glass or plastic. Sometimes several layers of silicon doped in slightly different ways to respond to different wavelength of light are laid on the top of one another to improve efficiency. The production methods are less energy intensive but more complex than crystalline panels and prices have been coming down as panels are mass produced using this technology. The panels can be made flexible by using thin layers of silicon. These are less efficient per unit area(up to 10%) and generally not suitable for roof installations. You would typically need nearly the double the panels for the same power output.

(C) HYBRID SILICON CELLS:
The emergence of hybrid silicon cell and several companies are now exploring ways to combining different materials to make solar cells with better efficiency; longer life at reduced cost is the recent trend in the industry. Samyo recently introduced a hybrid HIT cell, where by a layer of silicon amorphous silicon is deposited on the top of single crystal wafers. It is an efficient solar cell that performs well in terms of indirect light and is much less likely to lose efficiency as the temp climbs.

4. CdTe THIN-FILM

To produce solar cell fabrication based on low cost and high efficiency the various materials and technologies are used. One of these solar cells is the CdTe solar cell. The thin film CdTe based photovoltaic cells are one of the most promising cells for low cost photovoltaic energy conversion because of the possibility of of higher efficiency with reduced materials, reliable and stable cell operation. CdTe based solar cells are produced from polycrystalline materials and glass. The layers Of the CdTe solar cells can be deposited using different low cost techniques. CdTe has direct optimum band gap (1.45ev) with high absorption coefficient over 5x10power15 per centimeter. So it means that within a few micrometers of CdTe absorber layers all the potential photons with energy greater than the band gap can be absorbed. So it makes the cost of material for CdTs based solar cells comparatively very low which is the objective of photovoltaic cell research ture which is using less material by making the cell thinner. We can modify the base line case to increase the efficiency and reduce the cost by choosing the baseline CdTe solar with super saturate structure. The ways by which we can modify the baseline cases are

(a)By inserting suitable buffer layer reducing the thickness of the front contact and also reduces the cost. The morphology of the window layer is increases by the buffer layer and the leakage current reduces due to the pinholes buffer layers such as ZNO.
(b) Choice of suitable window layer with reducing its thickness and with the high energy gap which increases the blue region response of the cells and reduces the surface recombination current in the window layer.
(c) By inserting the suitable back surface field layer which reduces the barrier height of holes. The Voc and Jsc and efficiency also increase.
(d) By increasing the doping and minority carrier life time of absorber layer which increases the filling factor and

Voc. The theoretical maximum efficiency of CdTe cell at a standard spectrum is about 29%.

5. COMPARISION

The band gap for a layour to have optimum Voc and Jsc is between 1.4 to 1.6 ev by the energy gap of silicon cell is 1.1 ev which is lower than CdTe thin film. Traditional silicon cells are non toxic and is abundant compared to CdTe cells.
The advantages of the thin- film solar cells in comparison to other solar cells are as the following.

(a)Reduced mass
(b) Less support is required when placing panels on the roofs.
(c) The panels can be fitted on light or flexible materials, even textile.

The disadvantages of thin film solar cells are as the following.

(a)The efficiency of Thin-film solar cells are lower compared with wafer-based solar cells.
(b)Broad spectral absorption range means high carrier mobilities.
(c)Increased toxicity

The advantages of traditional silicon cells are as following.

(a)Requires the expensive manufacturing technology
(b)Sawing and growing is a highly energy intensive.
(c)Fairley easy for an electron generated in another molecule to hit a hole left behind a previous photo execution.
(d)A lot of the energy of higher photons at the violet and blue and blue and the spectrum are wasted as the heat.

6. CONCLUSION

From this study it is find that the new generation of the solar cells can be guaranteed as the future energy in the world. So the second generation of the solar cells provides many advantages in the comparison to traditional solar cells. The second major finding was the evaluation of solar cells based on high conversion efficiency and low cost of solar cells. Pure silicon is needed to have a quite high efficiency compared to CdTe Thin-film cells in the traditional silicon cells and due to energy requiring process the price is high as compared to the power output. The ultra Thin CdTe solar cells decreases the required material, required energy, required time and cost of the CdTe solar cells and increases the efficiency. Hence the Thin-film solar cells such as CdTe solar cells are proffered to use. So the objective of this research shows that the Thin-film solar cells such as CdTe are more economical and solar cells compared to the traditional silicon solar cells.

REFERENCES

[1] M. Matin, N. Amin, K. Sopian, A. Zaharim, L. PerlovskyL. Zadeh, M. Kostic, C. Gonzalez-Concepcion, D. Dionysiou and H. Jaberg, "Ultra thin high efficiency CdS/CdTe thin film solar cells from numerical analysis,"in WSEAS International Conference Proceedings Mathematics and Computers in Science, and Engineering 2009.
[2] M. A. Green, "Third generation photovoltaics: solar cells for 2020 and beyond," Physica E: Low-dimensional Systems and Nanostructures, vol. 14, pp. 65-70, 2002.
[3] G. Conibeer, R. Corkish, M. Green, Y. Cho, E. C. Cho, C. W. Jiang, T.Fangsuwannarak, E. Pink, Y. Huang, and T.Puzzer, "Silicon nanostructures for third generation Photovoltaic solar cells," Thin Solid Films, vol. 511,pp.654-662, 2006.
[4] H. Keppner, P.Torres, D. Fischer, J. Meier, and A. Shah," Microcrystalline silicon and micromorph tandem solar cell," Applied Physics A: Materials Science &Processing, vol. 69, pp. 169-177, 1999.
[5] X. Wu, "High-efficiency polycrystalline CdTe thin-film solar cells," Solar Energy, vol. 77,pp. 803-814, 2004.
[6] S. Husni and W.Mariam, "the Influence of Malaysian Climate on the Efficiency of Polycrystalline Solar Cells", 2006, pp. 54-57.
[7] C.T. Sah, R. Lutwack and K. A.Yamakawa "Effects of thickness on silicon solar cell efficiency, " Electron Devices, IEEE Transactions on, vol. 29, pp.903-908, 1982.
[8] J. Meier, U. Kroll, J. Spitznagel, C. Bucher, S. Fay, A. Shah and T.Moriarty "Potential of amorphous and microcrystalline silicon solar cell, " Thin Solid Film, vol.451, pp. 518-524, 2004.
[9] B. Rech, T.Repmann, S. Calnan, M. Berginski, T.Kilper, J. HÃ, H. Stiebig, M. Van den Donker and S.Wieder, " Challenges in microcrystalline silicon based solar cells technology," Thin Solid Films, vol. 511, pp. 548-555,2006.
[10] D. Bonnet, "The CdTe Thin-film solar cell-an overview," International Journal of Solar Energy, vol.12, pp. 1-14, 1992.
[11] C.Ferekides and J. Britt, "Thin-film CdS/ CdTe solar cells with 15.7% efficiency," Applied Physics Letters, vol. 62, pp. 2851-2852, 1993
[12] Kalogirous, Soteris, "Solar Thermal Collectors and Applications," Progress in Energy and Combustion Science, 2004, 231 –295,http:// www.docstoc.com/docs/122124695/Solar-thermal-collectors-and-applications
[13]. Kalogirous, Soteris, Solar Energy Engineering: Processes and Systems, 2009
[14]. Sorenson, B., Breez, P., Renewable Energy Focus Handbook, 2009, Academic Press
[15]. Hussain Ahmad Siddiqui, "Cheaper Options of Solar Power." Technology Times, April 16, 2012, http://www.technologytimes.pk/2012/04/16/cheaper-options-for-solar-power-2/
[16]. German Solar Industry Association (BSW-Solar) and European Photovoltaic Industry Association, Solar Photovoltaics: A Powerful Way to Combat Climate Change. 2011
[17]. Research and Markets, Crystalline Solar Photovoltaics PV Panel Systems Market Shares, Strategies, and Forecasts, Worldwide, 2011 to 2017, August 2011, http://www.researchandmarkets.com/ reports/1875283/crystalline_solar_photovoltaics_pvpanel_systems