IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676 Volume 4, Issue 6 (Mar. - Apr. 2013), PP 49-52
www.iosrjournals.org

High Efficient Solar Photo Voltaic Cell

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Abstract: *World much more concerned about the fossil fuel exhaustion,eco system damage& global heating. Therefore researchers should always thinks about green and eco friendly electrical power generation & application. Solar Photo Voltaic (PV) cell is a device which directly converts solar energy into electrical energy by means of photovoltaic effects. Photovoltaic cells are made of semi conductors which generate electricity when they absorb light. PV cells generate electricity by using the renewable energy technology which generates green power.*

The purpose of this research paper is two folds:

- *To bring out the latest innovations to better the performance of PV module*
- *Improve the conversion efficiency.*

Basically, there two approaches to increase the efficiency of PV cells: First selecting the semi conductures materials required energy gap which match solar spectrum and optimize there optical & electrical properties; and second innovative device engineering which enables more effective charge collection as well as better utilization of solar spectrum through single & multi junction approaches. According to current scenario solar cell classified into four different efficiency regimes: Moderate efficient solar cell, High efficient solar cell,Very high efficient solar cell, Ultra high efficient solar cell. This paper gives latest progress in solar PV cell efficiency base on PV technologies.

Key words: *Renewable energy sources ,Semi conductor, solar photo voltaic cell, , PV technologies, optical, efficiency, innovation, green power*

I. Introduction:-

World is much more concerned about the fosil fuel exhaustion,eco system damage and finally global warming .Photovoltaic cell is generate green power but it has low efficiency with high cost of material. These issued needs to solve in near future. By use of better material and latest innovation, conversion efficiency of solar cell will improve. In this research paper there are two ways to increase efficiencies of PV cells: first selecting the semiconductor materials with proper energy gaps to match the solar spectrum and optimizing their optical, electrical and structural properties and secondly innovative device engineering which enables more effective charge collection as well as better utilization of solar spectrum through single and multi junction approaches .Utilizing above theory, solar cells are classified on four selected group as per their different efficiencies regimes: ultra high efficiency(UHE) solar cells ,very high efficiency(VHE) solar cells, high efficiency(HE) solar cells, moderate efficiency(ME) solar cells. The efficiency of any electrical device is defined as ratio of output power to input power. To better way understand performance of any electrical device, efficiency should express in percentage(%).Ultra high efficient solar PV cells efficiency are more than 30% while moderate solar cells efficiency are less than 12%.

Moderate Efficiency Low Cost Solar Cells:

This type of solar cells have less efficiency and they are having very low cost. This type cells have efficiency less than 12%.The highest efficiency of dye sensitized photochemical solar cell is about to 11%. This type solar cells based on dye sensitization of nano crystalline film of TiO_2 in contacts with a non aqueous electrolyte. The cell is very much simple to fabricate and its colour can be tuned through visible spectrum from transparent to black opaque by changing the absorption characteristics of dye. Due to low cost option, this cell use to PV power window and photo electro-chromic windows.

High Efficiency Solar cell:

This type of solar cells have efficiency between 12% to 20% (□ □ □ □ □ □ □ □ □ □Multi crystalline& thin film solar cells are belong to this PV technology. They are used large scale commercial purpose. Under this group cells are poly crystalline silicon solar cells, Amorphous silicon thin film Solar cell ,Copper indium gallium Diselenide (CIGS) solar cell, Cadmium telluride thin film solar cell. Brief note on innovation & conversion efficiency of these cells are following:-

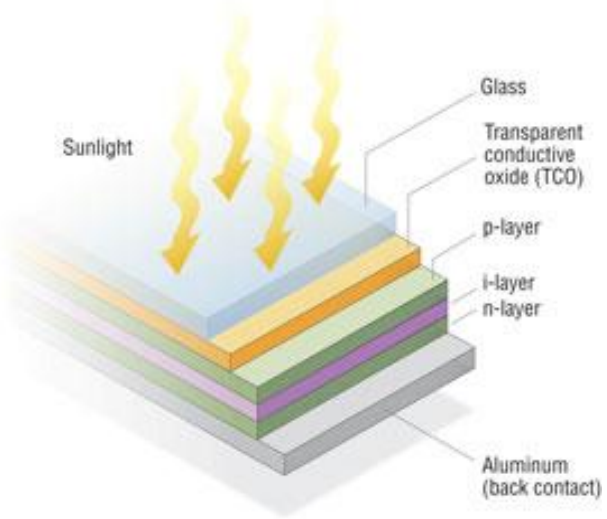
POLY CRYTALLINE SILICON PV SOLAR CELL :

Polly crystalline silicon cell are made from square cast ingots. These cell are less expensive due to manufacturing process than mono-crytalline cells. Presently cast of poly crystalline solar silicon(Mc-Si), accounting for nearly 50% of Si based solar cells manufactured worldwide, is a dominated PV technology. This solar cells have efficiency of 18.2%. Further improvement in cell efficiency to 18.6 has been achieved by decreasing the rear surface recombination velocity 20 m/second (or 0.02 km/second) with deeper Al alloys.

THIN FILM SILICON PV SOLAR CELLS (CdTe, A-Si, CIGS):-

Thin film PV is fastest growing sector of the solar cell manufacturing industry. Thin film cells are manufactured by applying very thin layers of semi conductor material to inexpensive material such as glass, plastic or metal. Thin film semi conductor materials are absorb light very easily than c-Si. It has theoretical possibility to achieve 17% efficiency in a 2 micro- m thick silicon if grain size is larger than 10 micro m and dislocation density is less than 10 cm^{-2}.A 17.6 conversion efficiency for thin film silicon solar cell deposited by chemical vapour deposition into a highly doped, electrically inactive Si wafer has been reported by New South Wale University(NSWU).Doping is process by which adding some suitable trivalent or pentavalent atoms are added in pure semiconductors. "STAR" cell has achieved 9.8% efficiency in 3.5 micro- m poly silicon thin film.

AMORPHOUS SILICON THIN FILM SOLAR CELLS;-

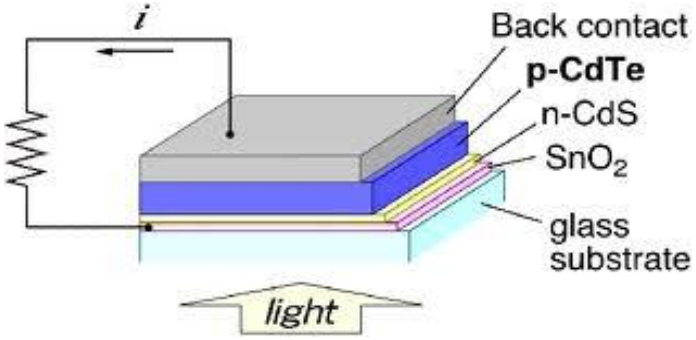


Thin film amorphous silicon(a-Si) solar cells are commonly known as hydrogen generated amorphous(a-Si-H) SOLAR cells .Currently laboratory scale cell achieve conversion efficiency of 12.5% where cell manufacture high volume processes have efficiency ranging from 6% to 9%.The most efficient a-Si solar cells are typically produce by silane base glow discharge induce by RF voltage or plasma enhance chemical vapour deposition(PECVD) with other gases added for doping & alloy.

THIN FILM COPPER INDIUM GALLIUM DISELENIDE(GIGS) SOLAR CELLS

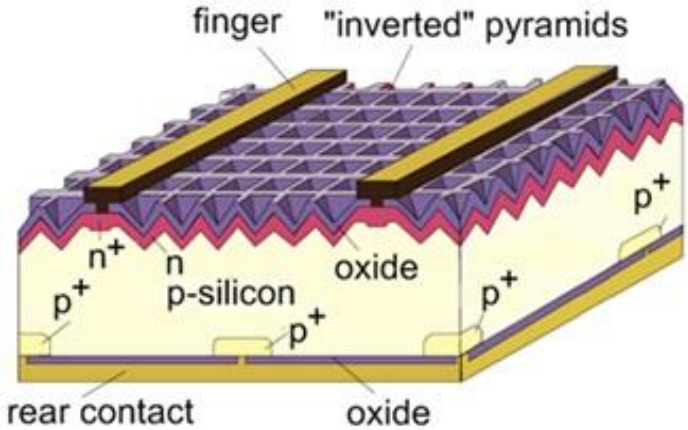
Copper Indium Gallium Diselenide has been able to reach to the highest efficiencies in production 13-20%.Recent,a record efficiency of 18.8% has been achieved in typical device structure consisting of glass/mo/CIGS/CdS/ZnO Fabricated by physical vapour deposition(PVD) techniques, PVD techniques are prefered method for high efficiency CIGS solar cell fabrication but variety of techniques can use. These techniques are sputtering, spray pyrolysis, close space sublimation(CSS),molecular beam epitaxy (MBE) and electro deposition are currently be in use. Among these techniques electro deposition technique is very popular and having very low cost option for fabricating.

CADMIUM TELLURIDE THIN FILM SOLAR CELLS:



This cells have efficiency between 10% to 16 %. Most recently, a record of 16% efficiency has been reported in this cell. High efficiency solar cell use a superstrate device configuration in which CdTe is deposited on the Cds window layer. In this cell a typical structure consist of glass/CdS/CdTe/Cu-C/Ag .In most cases, the post deposition heat treatment of CdTe layer in the presence of $CdCl_2$ essential for optimization of device performance.

(3)VERY HIGH EFFICIENCY SOLAR CELL:



Very high efficiency solar cells have efficiency more than 20%.When single cristal silicon material grown by the Czochralski(CZ) AND Float zone(FZ) methods show 22%& 24 respectively. Passive Emitter rear localized(PERL) is developed by New South Wales University(NSWU). Recent research and development team modified the PERL cell by random pyramid passivated emitter and rear cell(RP-PERC). RP-PERC has more advantage over PERL.RP-PERC has led to a new record value of 22% of efficiency for CZ-_Si.

PV solar cell conversion efficiencies more than 25% have obtained on single junction cell fabricating on epitaxially grown GaAs on a single crystal substrate.

ULTRAHIGH EFFIENCY III-V SOLAR CELL:-

Ultra high efficiency solar cells have efficiency between 30% to 40%.Tandem cells structures can designed two ways: In first method individual cells are grown by separately and then mechanically stacked one above the other and in second method each cell can grown monolithically with atunnel junction interconnected. The tandem cell combination of $GaInP_2$ and GaAs theoretical efficiency of about 36%. Monolithic tandem cell which consist of $GaInP_2$ at top & GaAs at bottom give 29.5% efficiency. The efficiency of two junction tandem cell has reached a practical limit and any further improvement will require incorporation of third junction consisting of a semi conductor. The additon of a third junction involving Ge has been boost the efficiency further and the efficiency can be increase more than 35% if third junction can be fabricated by 1 e V material.

II. Conclusion:

PV solar cells efficiencies are improving by selecting appropriate semi conducters matterials and innovative device engineering .The three junctions ultra high silicon solar cells have more than 30 % efficiency which are use for space application. Remarkable progress has made in recent year in improving the conversion efficiencies of a number PV solar cells.

Acknowledgment:-

I would like to express my profound sence of appreciation and gratitude full team of IOSR members for publicing of my PhD research paper. I am very grateful to my guide Dr A Prasad professor in mechanical engineering dept JNT university Hyderabad for his precious suggestion& moral support.

Swatantra Prakash Singh

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