# A Review on Different Generation of Solar Cells

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***Abstract:*** Solar cells provide clean safe renewable energy. Pollution free and environment friendly photovoltaic (PV) technologies are now generally identified as an alternative solution to many global-scale problems free such as energy demand, pollution, and environment safety. Our primary solution to this increasing electricity consumption has been to burn more fossil fuels (coal, oil, or natural gas) or build more nuclear plants. However, the greenhouse gasses produced by burning fossil fuels have been responsible for global warming, and safe disposal of high-level radioactive waste from nuclear plants raises several issues. Renewable energy is perceived as a sustainable solution to ensure future energy supply as well as being carbon dioxide emissions free or neutral. In this paper we compare different type of solar cell regarding construction and efficiency and processing cost.

***Index Terms*- Solar cell, photovoltaic, renewable energy, environment safety.**

## I. INTRODUCTION

In today's era electricity produced by solar is growing technology have variety of application ranging from consumer electronics to industrial scale. Electricity produced by solar is safe, clean and pollution free also its obtain at user end so it free from transmission loss and cost.

Though there is a lot of significant development done at past decade but still a lot of population away from using this technology. Therefore a need of new technology solar cell that manufactured with new technology with cheapest material that leads to low price. Today electricity consumed by world is around 12 to 13 TW . While earth receive the solar energy in 01 hour than is energy used in 01 hour globally So we should make a system which can grab these radiation in very large percentage. Renewable energy is produced by natural resources such as sunlight, wind, rivers, etc. [4]

## II. DIFFERENT TYPES OF SOLAR CELL

In this section different types of solar cell manufacturing with different technologies are described .

### (i) SILICON SOLAR CELL USING PASTE CONTAINED COMPOUNDS

For industrial type solar cells, to reduce the manufacturing cost, front contact fabrication techniques is used. Which uses screen printing of silver pastes that require a highly doped and deep junction to obtain acceptable contact resistance for avoid to metallic impurity penetration toward the junction region. This can be achieved by diffusion techniques one from liquid $POCl_3$ second solid $P_2O_5$ sources in open tube furnaces. in this process Fill factors are very low (below 76%) because of the higher contact resistance of device and the lower metal conductivity of screen-printed contacts of strips [1,2].

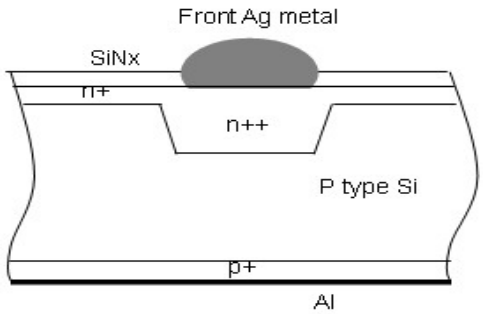


**Fig1-**Structure of POP solar cells [1]

We fabricated solar cells by using selective phosphorous doping and contact opening process in crystalline silicon solar cells. This POP (Phosphorous doping and contact Opening Process) solar cell free from contacting problems with simplified selective emitter process with very fine gridlines.

The design of the POP solar cell different from screen printed solar cells. The process is based on a simplified selective emitter diffusion techniques diffused by phosphorous compounds. The first step includes saw damage removal and random texturing. The next steps were a light phosphorous diffusion and deposition of PECVD SiNx layer. Then we could make pattern and heat for formation of selective emitter diffusion with compounds contained phosphorous and open narrow pattern for gridlines.

Normally high efficiency laboratory cells are fabricated with photolithography techniques which allows for more accurate prediction of solar cell behavior. In this technology, metal-Si specific contact resistance is generally very low (1X10-50-cm2)

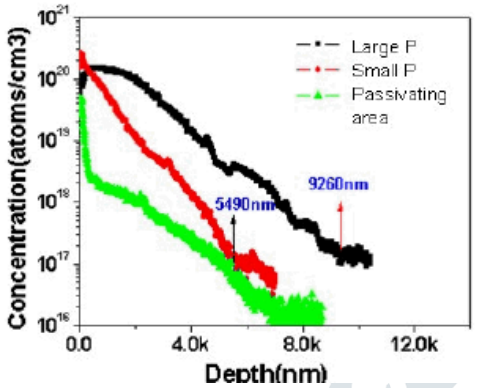


**Fig2-**Depth profiles of different emitter regions.

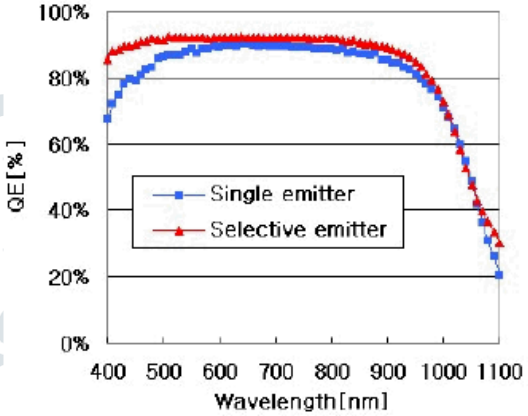


**Fig3**- Improved spectral response of POP solar cell. The comparison between homogeneous emitters and non-homogeneous emitter via PC-1Dsimulation , resulting in a loss of approximately 2.5% [1,2]

## (ii) SILICON HETERO JUNCTION SOLAR CELL WITH LOW-TEMPERATURE EPITAXIAL SILICON

In these techniques diffusion layer is deposited by PECVD techniques on Czochralski (CZ) (100) n-type 1ohm- cm 500- m–thick, polished silicon wafers. The Si wafers are etched in 0.5% diluted hydrofluoric acid solution before the introduction in the PECVD vacuum system. Separate chambers are used for the deposition of intrinsic n-type and p-type layers. The standard plasma frequency for all samples is 13.56 MHz. Then 1x1 cm2 solar cells were fabricated using the structure Ag/ITO/p a-Si:H/buffer layer/n c-Si/n c-Si/Al. For front contact Ag and for back contact Al is used.. The indium tin oxide (ITO) film was deposited by RF (13.56 MHz) magnetron sputtering at 0.5 W/cm power densities [3] Hetero junction solar cells with different p a-Si:H emitter thicknesses (7, 14, and 30 nm) and with no intrinsic buffer layer at the a-Si:H/c-Si interface were deposited. The short-circuit current density JSC reduces when emitter thickness increases.

A dependence of the open circuit voltage $V_{OC}$ on emitter thickness is also considered. The Voc decreases from about 590 mV for a 30-nm-thick emitter down to 550 mV for a 7-nm-thick emitter. The Voc trend can be explained by a partial or complete charge depletion of the p-doped emitter layer, with a consequent decrease of the device built-in potential [10] Transparent conductive oxide (TCO) on the top of the device has a low work function and the band bending

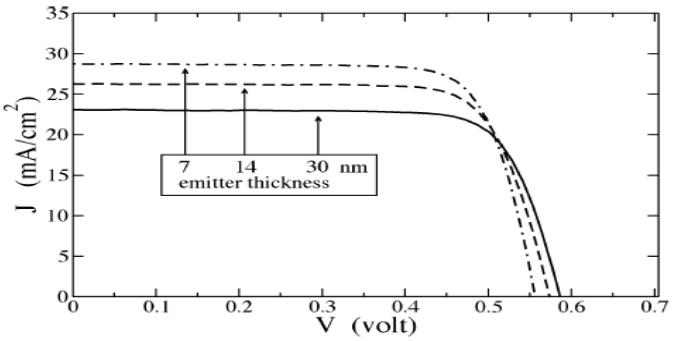


**Fig4**-Experimental *J–V* curves under illumination of p a-Si/n c-Si heterojunction solar cells having various emitter thicknesses and no buffer

at the TCO/a-Si interface strongly contributes to the emitter depletion, resulting in a large decrease of the built-in potential even with a good quality emitter layer [6].

**(iii)POLYMER SOLAR CELLS**

Polymer solar cell are efficient collection of photons in which absorption spectrum of the photoactive organic layer should match the solar emission spectrum and for absorb all incidents light the layer should be sufficiently thick . A better overlap with the solar emission spectrum is obtained by lowering the band gap of the organic material, at the cost of the open-circuit voltage. Increasing the layer thickness is advantageous for light absorption, but at the cost of burdens the charge transport. Production of charges is one of the main steps in photovoltaic devices in the conversion of sun light into electrical energy. In this reaction an electron is transferred from an electron donor (D), a p-type semiconductor, to an electron acceptor (A), an n-type semiconductor. The reaction the first step is excition of the donmor (D*) or the acceptor (A*) followed by creation of the charge-separated state consisting of the radical cation of thedonor (D•+) and the radical anion of the acceptor (A•-).
D + A + hν → D* + A (or D + A*) → D•+ + A•- For an better charge generation, it is important that the charge-separated state should be thermodynamically and kinetically for better pathway after photo excitation[7]

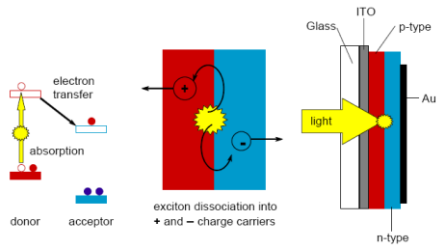


**Fig5**-Schematic drawing of the working principle ofan organic photovoltaic cell. Illumination ofdonor (in red) through a transparent electrode(ITO) results in the photo excited state of thedonor, in which an electron is promoted from the highest occupied molecular orbital (HOMO) to the lowest unoccupied molecular orbital (LUMO) of the donor.

The electrical current densities are poor due to incomplete utilization of the incident light due incomplete match of the absorption spectrum of the active layer with the solar emission spectrum, and low chargecarrier motilities of the organic or polymer semiconductors. In this respect, the use of$P_3HT$ which is known to have a high charge-carrier mobility and reduced band gap compared to MDMO-PPV, has been considered for use in solar cells in combination with PCBM. P3HT/PCBM blends indeed provide an increased performance compared to MDMO-PPV.33,34 These higher efficiencies were obtained through the use of post-production treatment. After spin coating of the active layer and deposition of the aluminum top electrode, treating P3HT/PCBM solar cells with a potential higher than the open circuit voltage and a temperature higher than the glass transition temperature led to an improved overall efficiency. This post-production treatment enhances the crystallinity of the $P_3HT$ and improves the charge carrier mobility. Photovoltaic devices of $P_3HT$/PCBM with external quantum efficiencies above 75% and power conversion efficiencies of up to 3.85% have been reached [8]

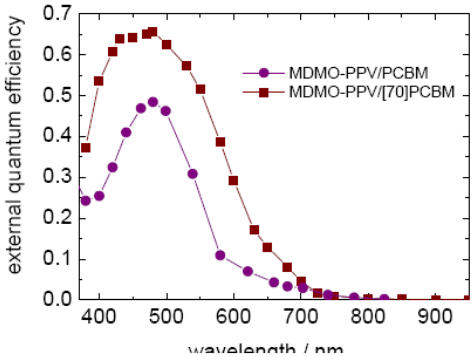


**Fig6**-External quantum efficiency (EQE) of bulk- Hetero junction solar cells with MDMOPPV PCBM (purple circles) and MDMO-PPV/[70]PCBM (brown squares) active layers.

been considered also. In this respect it is important to note that PCBM–which may amount to as much as 75% of the weight of the photoactive layer–has a very low absorption coefficient in the visible region of the spectrum.

**(iv) DYESENSITIZED SOLAR CELL**

Now days dye-sensitized solar cells (DSSCs) have received considerable attention as a cost-effective alternative to conventional silicon solar cells. DSSCs operate on a process that is similar in many respects to photosynthesis, the process by which green plants generate chemical energy from sunlight. Dye molecules absorb light in the visible region of the electromagnetic spectrum and then "inject" electrons into the nanostructured semiconductor electrode. This process is accompa4nied by a charge transfer to the dye from an electron donor mediator supplied by an electrolyte, resetting the cycle. Dye-sensitized solar cells (DSSCs) are an alternative to silicon devices and have solid-liquid junctions. So far, relatively high levels of power conversion above 10 % have been achieved with dye-sensitized TiO2 nanoparticle cells,[9] but no DSSC has managed to achieve conversions able to compete with silicon based cells. Conversion efficiency of 12 %.[9] DSSCs are additionally advantageous in their insensitivity to temperature changes. It has been shown that increasing the temperature from 20 to 60 °C has little effect on the power conversion of a DSSC, whereas silicon cells show a decrease in power conversion of about 20 % under the same conditions.[10]

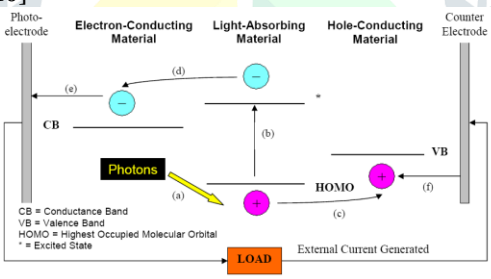


**Fig7**-Generalised Electron and Hole Orbital and Cell movement in DSSCs

DSSCs comprise of three principle components: a light-absorbing material, an electron-conducting material and a hole-conducting material. In a non-dye-sensitised cell, the light absorbing and electron conducting materials are the same. In a dye-sensitised cell, it is the dye that absorbs the light, creating an electron/hole pair.[8] Thus, the efficiency of solar cells depends on:

A. the spectral absorbance of the light-absorbing material and the electron/hole injection efficiency;

B. the electron transport and recombination rates, which are dependent on the electron-conducting material; and

C. the hole transport and stability, which is related to the hole conductor used

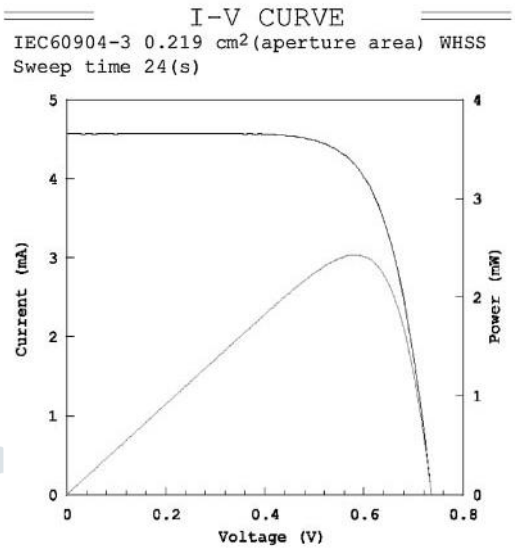


**Fig8-** I-V curve of DSSC's

In any semiconductor process when temperature is increasing some electrons jump into the conduction band "mechanically". The traditional silicon cells protected by the elements, by encasing them in a glass box similar to a greenhouse with a metal backing for strength. Such systems suffer noticeable decreases in efficiency as the cells heat up internally. DSSCs are normally built with only a thin layer of conductive glass on the front layer, allowing them to radiate away heat much easier, and therefore operate at room temperatures.

**III.CONCLUSION**

The compounded paste phosphorous silicon solar cell presented high efficiency solar cell with well passivated surface, low series resistance and low grid shadowing are observed. HR-TEM is better techniques that is different from amorphous phase technology. The epitaxial silicon layer process uses very low temperature for depositing. This solar cell produces 13.5%.
The polymer solar cells that are manufactured by very cheap role to role production found that lab efficiency about 7 to 8 % and field efficiency 5 to 6 %.

DSSCs are currently the most efficient third-generation cell with thin film technology with efficiency between 5 to 13 % while traditional commercial panel showing the efficiency between 12 to 15 %.

A advantage, DSSCs are need not to required clean room and heavy machinery. The major disadvantage to the DSSC is the use of the liquid electrolyte, which has temperature stability problem which can be leak at high temperature during operation.

**REFERENCES**

**[1]** A. Goetzberger, J. Luther, G. Willeke, "Solar cells: past present, future", *Solar Energy Materials & Solar Cells*, **74** 2002, pp. 1–11.

**[2]** E.J. Lee, D.S. Kim, S.H. e, "Ni/Cu metallizationfor low-cost high-efficiency PERC cells", *Solar Energy Materials & Solar Cells*, 74**,** 2002, pp.65– 70.

**[3]** M. A. Green, *Silicon Solar Cells: Advanced Principles and Practice*. Sydney, Australia: Bridge Printery, 1995.

**[4]** M. A. Green, Jianhua Zhao, Aihua Wang, and Stuart R.Wenham, "Very high efficiency silicon solar Cells science and technology", *IEEE ransactions on Devices*, Vol. 46 NO. 10, October 1999

**[5]** Sangwook Park*,a, Eunchel Chob and Deawon Kima a SAMSUNG SDI Co., LTD., 575, Shin- dong, Yeongtong-guuwon-si, Geonggi "TOWARD A HIGH EFFICIENCY SILIOCN SOLAR CELLS-SIMPLIFIED CELL ROCESSING USING PASTE CONTAINED PHOSPHOROUS COMPOUNDS" 443-391, Korea b Center of Excellence for Advanced Silicon Photovoltaics and Photonics, UNSW, Sydney Australia

**[6]** M. Tanaka, S. Okamoto, S. Tsuge, and S. Kiyama, "Development of HIT solar cells with more than 21% conversion efficiency and commercialization of highest performance HIT modules," in *Proc. Conf. Photovoltaic Energy Conversion*, 2003, pp. 955– 958.

**[7]** Uchihashi, N. Nakamura, S. Kiyama, and O. Oota, "HIT cells high efficiency crystalline Si cells with novel structure," *Prog. Photovolt: Res. Appl.*, vol. 8, pp. 503– 513, 2000.

**[8]** M. Graetzel, in *European Conference on Hybrid and Organic Solar Cells*, Paris, 2006

**[9]** D. L. Talavera, G. Nofuentes, J. Aguilera, M. Fuentes, *Renewable Sustainable Energy Rev.* 2007, *11*, 447.

**[10]** Y.-J. Lin, L. Wang, W.-Y. Chiu, *Thin Solid Films* 2006, *511-512*, 199