Photovoltaic Device Review on the Evolution, Efficiency and Future Growth

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Abstract— The proposed review analysis the performance metrics of photovoltaic devices and its improvement over period of years. Study on the photovoltaic devices was carried out and the future improvement in the performance is highlighted in the paper.

Key words: Evolution, Efficiency and Future Growth

I. Introduction

Solar power in one form or any other is the source of almost all strength on the planet. PV is stylish approach of harnessing the solar power. Photovoltaic means conversion of solar energy to DC using materials of semiconductors with unequal band gap. This type power generation gives distributed renewable energy source. This generates power without any noise and any movement of materials. It is the third most renewable energy generation technology. PV gadgets (solar cells) are specific in that they at once convert the incident solar radiation into power, and not producing a noise, pollution or transferring parts, making them robust, and dependable and durable[1].

Interface between two regions is known as hetero-junction, semiconductor materials are used for interfacing with unequal band gaps. These are applicable in lasers, transistors and photovoltaic. The hetero-structure forms with the unequal band gaps when we join multiple hetero-junctions together. Proposed photovoltaic device has improved current density when compared to the normal PN PV device. In the HJ photovoltaic, the short circuit current and the open circuit voltage are dramatically improved [1].

II. Efficiency and Evolution

In the 1980s exploration into silicon PV cells paid off and si based PV cells started to expand their productivity. In the year 1985 silicon PV cells accomplished the point of reference of 20% effectiveness. Throughout following decade, the photovoltaic business experienced enduring the development rates around 15% and 20%. The year 1997 saw a development rate of 38% and the currently Si based PV cells are identified not only as a methods for producing power and expanded personal satisfaction for the individuals who actually don't have the grid access, yet they are interested in method which essentially minimizing effect of natural damage created by traditional power production in advanced nations [1, 2, 3].

Efficiency is the most regularly considering parameter to think about execution of one photovoltaic to other solar cell. Efficiency is characterized as proportion of vitality yield from solar cell to information vitality from the sun [4]. To reflect execution of the solar cell itself, efficiency relies on upon range and force of the incident daylight and the temperature of the solar cell. The conditions under which efficiency is measured must be precisely controlled with a specific end goal to contrast the execution of one device with another. The physical PV cells are measured under the (Air Mass) AM 1.5 conditions and at temperature of 25°C. Solar cells expected for the space use are measured under AM0 conditions.

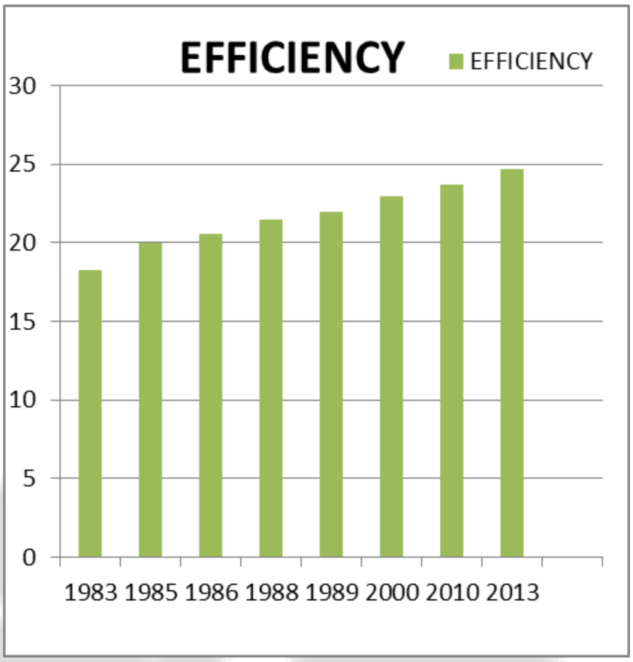

Fig. 1: Graph for evolution of PV efficiency

By embedding good characteristic Si layer between Si wafer and the doped a-Si layer utilizing low-harm method, the surface dangling obligations of Si can be very much passivized. At point when this compelling passivation on both surfaces empowers us to acquire a HIT PV cell with a high Voc com-pared with the routine Si based PV cells and prompts a high change efficiency as well as a superb temperature coefficient. The great temperature coefficient of the HIT PV cells benefits shoppers on the grounds that the PV frameworks regularly work at temperatures of more than 25 C. As appeared in the HIT PV cell has symmetrical structure that gives two focal points. One will be immaterialness of cell to the supposed two faced module, which can create more power than the common module, and other is a less focused on structure, which is very important for more slender wafer preparing [6].

The Voc of HIT cell has been consistently exaggerated step by step. We reported the terribly high worth of zero 745 V in the year 2011 with decrease in surface recombination velocity to 2cm accomplished by optimizing the wafer getting ready before Si deposition and by modifying the deposition method of a-Si layers [8].We conjointly according that with associate excellent passivation quality we have tendency to might create a-Si layers within the primary surface diluting without sacrificing the Voc and will increase the Jsc with band gap widening of the Si layers[7,8].

Year	Voc (V)	Jsc(mA/cm^2)	Efficiency %
2009	0.74	38.8	22.8
2011	.745	39.4	23.7
2013	.750	39.5	24.7

Table 1: Efficiency table

It was reported a particular thickness of the layer would be necessary to complete well-passivized surface for specified Voc [9, 10] but we've found there are still how to beat the exchange between Jsc and Voc. In the year 2013 trial, utilizing information we have a tendency to had increased within past, we have tendency to reviewed our material once more and the improved film properties and therefore the optimized thickness with great care. As result, we have a tendency to able to improve Voc from 0 to 0.75. The optical losses in a-Si layers and the TCO layers are problems peculiar to the HIT star cells and must be improved. Absorption loss in short wavelength region is diode by the layers on the front facet of the HIT electric cell, which consists of a-Si and TCO layers. Absorption loss within TCO layer on the rear caused by the free carrier absorption lowers quantum efficiency at the close to infrared region. The advances of TCO are described later [11].

From our understanding, there are still some possibilities for raising conversion efficiency even a lot of by reducing the recombination losses with higher quality and lot of uniform deposition of a-Si layer. We have currently upgraded our target of conversion efficiency in HIT cell in R&D to 25.5% and are aiming to win that within the close to future [11].

Jsc however, has remained at same level for these past two years. The shadow loss by the conductor on the front surface of the cell is main reason and is hard to eliminate utterly. To beat this in the sensible PV modules, it's important to manage the optical path of sunshine incident on an electrode part in a complete PV module rather than the specific cell. This appears to be key for raising Jsc of HIT PV module to high level of rear contact sort PV module [8].

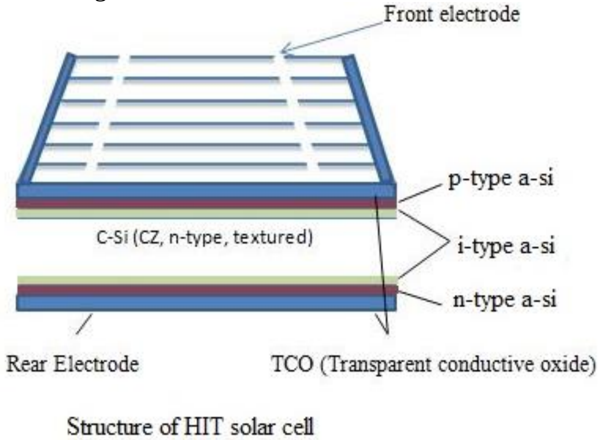

Fig. 2:

Continuous increase of efficiency is other cornerstone of the LCOE (Levelized cost of energy) improvement. Increase within the efficiency and additional electricity output per unit space, leverages almost all price relevant requirements of the PV system. Principal loss mechanisms of the crystalline Si photovoltaic cells are understood since many years and that they resulted within the record lab efficiencies of up to 25% by M. Green et al. [3, 4]. Never ending the challenge is, to introduce the options for achieving the highest efficiencies in the lowest economy surroundings and to the general scale back LCOE of the PV system [7].

Since the most price driver of a PV module is that the still Si, we should always focus on the R&D activities towards high efficiency ideas that area unit applicable to the multi and therefore the mono material, giving the maximum flexibility for fabric usage. Since bulk of all PV product is based on terribly versatile and therefore sturdy double sided contacted, the screen written star cell, it'll be terribly favorable if high efficiency options used area unit compatible with majority of put in primarily based, e.g. equipment used for module producing

In 1983 worldwide photovoltaic production exceeds 21.3 mw, and the sales exceed $250m. In 1985 the 20% efficient silicon cells are created by Centre for the Photovoltaic Engineering in the University of New South Wales .By year 1999, the total worldwide installed photovoltaic power reaches 1,000 megawatts. By the 2000 Best cell efficiency of 24.2% was achieved [12-18].

This improvement in efficiency is achieved by the following major factors:

Incorporation of the incident light capturing, reduction of the recombination by using improved material of good quality, cleaner preparing, and the surface passivation. The reduced contact scope and upgrades in the comprehension essential physical procedure critical in the cell operation. For example recombination and transporter transport in the intensely doped regions [19-24].

III. DOPED ZNO

ZnO is a material of choice for the photovoltaic devices due to its wide bandgap. By adding doped ZnO material into PV device, it improves the charge transport. Among oxides of block d-metal, zinc oxide (ZnO) is thought to be a standout amongst the other critical semiconductor material for innovative applications, gas sensors, drugs, field effect transistors, window layer for thin film PV cells, transparent electrode, surface acoustic wave device, and the optoelectronic device because of its wide band gap, high transmission coefficient in visible and near infrared range and the extensive excitation binding energy (60 mev) at the temperature 25 C [25].

Al-Doped ZnO and Mg-Doped ZnO are the promising candidates, because of their ability to enhance the light-harvesting characteristic of the cell and it increases the charge collection efficiency and by blocking holes thereby reducing recombination rate. Both the optical and electrical improvement increases maximum power produced and the efficiency of the Hetero-junction PV cell [26].

IV. CONCLUSION

Study on the efficiency of the photovoltaic devices has been carried out in this paper and the possible ways to improve the efficiency is studied. Moving beyond the performance metrics of the existing systems can be achieved by heterojunction photovoltaic devices with the ZnO based device structures. Future prospects on the work will include the device modlling and simulation of the proposed ZnO based Photovoltaic device structures.

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