Improvement in the performance of solar cells through the deposition of nano particles for avoiding surface reflections

Rajesh Kumar B.[1]*, Sundararaju K.[2], Ishwarya S.[2] and Senthil Kumar R.[3]

1. Department of Electronics and Communication Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, INDIA
2. Department of Electrical and Electronics Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, INDIA
3. Department of Electrical and Electronics Engineering, Sri Krishna College of Technology, Coimbatore, Tamil Nadu, INDIA

*rajuae2011@gmail.com

Abstract

In 21st century the conversion from fossil fuels into renewable energy sources occurs and it was the challenge faced by humans. The solar cell manufacturing industries was grown rapidly due to tremendous interest in renewable energy sources. Recent technology used in solar industry has little chance to emulate with non-renewable energy sources or grids. For huge energy generation the cost of the system is high. Cost plays a vital role in achieving a favorable outcome in solar technology.

The improvement in nanotechnology may lead to the manufacture of low-cost solar cells. Nanotechnology showed a sudden change in the solar technology. Nano imparting technology has been used to enhance the efficiency of Photovoltaic solar cells, but the challenge faced by the scientists is the reduction in cost. Obtaining energy from a solar cell should preserve the surroundings. This system predicts about the drawbacks in conventional sources and research made in order to overcome the disadvantages and science that are used to utilize maximum energy.

Keywords: Nanotechnology, Conventional Energy, Solar Cell, Quantum dots.

Introduction

Renewable energy sources were more important and it is utilized globally. Photovoltaic cells convert the potential of rays from the sun into charge[1,2]. Before discuss about upcoming developments in solar cells, it is important note to know about the basics ofnormal cells. Solar cells which utilize energy as heat in sunrays are called photovoltaic cells. Silicon is majorly used for production of solar cells. When light falls into the cells, they engage majority of energy though photons. The soaked-up energy hits the electrons in the solar cell made of silicon allow them to proceed.

By enumerating different contaminants to the silicon an electric field can be setup. The electric field produced from silicon material acts as a diode, since it permits the electrons to allow in one direction [3]. The final stage is the majority of electrons which is very familiar to us as electricity.

Normal solar cell has two disadvantages mainly; one is the less efficiency which is unavoidable in silicon material. In that the incoming photon must have enough energy to knock out the electrons. The photon energy may more or less when compared to band gap energy, accordingly the photon either may pass through or wasted as heat. For this process alone 70% of occurrence of the radiant energy on the cell is wasted. Nanoparticles are very less compared to the width of human hair [4–7]. Nanoparticles atoms dwell on their surfaces rather than in their interiors were more. It shows surface interactions govern the nano particles behavior. They often have different characteristics when compared to the same material. Nanotechnology was incorporated into system mainly to lower cost and increase efficiency [8]. The solar cells consist of Nano structured layers has three significant qualities. In first phase, the actual optical track is more than actual thickness because of several reflections.

In latter phase, recombination losses were lowered because of the light produced electrons holes has to travel along a minimum path. As an outcome of system, the nano structured solar cells have an absorber layer and its thickness is as thin as 150 nm in place of numerous micrometers in the conventional thin film solar cells. At last, the third phase is the various layers where the energy band gap is made according to the preferred design by changing the size of nano elements. It made for the solar cells design flexibility.[9]

Thin film is one of the high costs in which the solution is made up of thin coating component which was available at very low cost. Only very low material is required which is approximately <1% and prices were reduced. Many cells use amorphous silicon, which does not have a crystalline structure and efficiency is reduced (8%), however the manufacturing cost is low. According to Lawrence Berkeley National Laboratory, the maximum output was attained nowadays was about 25%.[10]

Material and Methods

Nowadays, Solar cells are not capable of converting entire received light to proposed energy since few particles of light can evolved into the air. Added to it, light rays occur in a multi colors and the cells are fastened in changing bluish light and functions at slow rate in conversion of reddish light. Reduced energy level of the light passes through the cell which is not utilized. When the energy becomes greater than the band gap it is exhausted in the form of heat which is shown in fig. 1. The excited electrons must recombine

***** Author for Correspondence***

with holes when the electrons were left free or it was not utilized.[11,12]

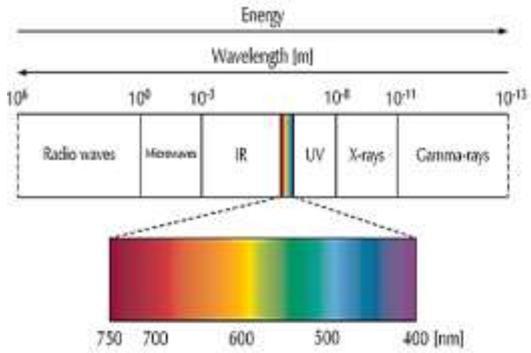

Fig. 1: Spectrum of Visible Light Rays

Normal solar cells, ultraviolet light is majorly utilized by silicon and it can be changed into damaging heat and it cannot be converted into electricity. A thin film of silicon nanoparticles was integrated and the silicon cell of 1 nm will increase the performance of the cells by 60%.

The diameter is very small for Nano crystal compared to the Bohr radius of particles. Due to Bohr thesis, the electron energy levels in "continuous band" cannot observe continuous and hence it becomes discrete. The atom size variation changes the band gap in the boundaries between two quantum dots. Adjustment in the shape of quantum dot readily results in variation of the band gap energy level which is shown in fig. 2

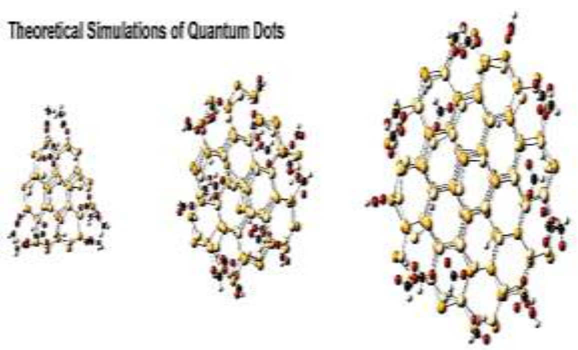

Fig. 2: Size of quantum dots

In order to improve solar cells, the scientists were planned to convert bulk silicon into separate nano sized substances. Owing to size of the solar cell the nanoparticles fluorescence into several colors. Nano particles of different size were separated into isopropyl alcohol which distributes into edges of the solar cell. Since, a film of densely packed nanoparticle was speed up securely and the alcohol evaporates.[13,14]

Solar cells covered by nm size, blue luminescent particles exhibit a power improvement almost 60% in UV spectrum, then it is reduced in visible range below 3 %. The red particle in solar cell exhibits a development of about 67% in the UV area which is coated with 2.85 nm and 10% in visible spectrum area. The heavily mono dispersed luminescent Si nanoparticles of ultra-thin films are directly segregated in polycrystalline Si solar cells[15]. The blue luminescent film of 1 nm or red luminescent Si nanoparticle of 2.85 nm produces increased in improvement of voltage through increase in performance of power of about 60% in the UV/blue area of the spectrum. In visible spectrum, the improvements are approximately reached 10% in case of red particles and 3% in case of blue particles. The solar cells key feature is mainly nanorods can be adjusted to guzzle several light wavelengths. It will improve the efficiency of solar cell. Single walled carbon nanotubes manufactured with titanium dioxide nanoparticles, the ultraviolet light efficiency is changing to an electron which is twice after analyzed with the nanoparticles performance [16].

Carbon Nano Tubes: The solar cell electrons produced must follow a complex track to extent an electrode. To increase the efficiency Researchers utilized carbon nanotubes through electrons to reach the electrode. The electron ballistic transport on solar cell surface was initiated with CNT along its axis with the capacity of high current density which has reduction in loss. The association of CNT with the substrate polymer gives a photovoltaic conversion with increased efficiency. In order to enhance the energy conversion polymer composites results in producing increased area. Based on the laboratory scale the overall output is about 50%. The maximum output was produced with aligned CNTs with poly 3-octyl thiophen on reference with PV cell. High electric field within nanotubes the exciton breaks to form electrons and holes which enable quick transfer of electron with better efficiency of quantum with greater than 50%.

Results and Discussion

Quantum Dots (QD) technique to increase the efficiency: With the reference to Semiconductor quantum dots, band gaps were adjusted in order to convert longer wave light and output is increased. As the system for QD solar cells, the material combination is chooses based on the semiconductor atoms.

Advantages of using semiconductors in solar cells are:
1) Absorption of light was higher in the infrared area of the spectrum,
2) Closeness with normal silicon solar cell production,
3) Increasing the photovoltaic current at high temperature,
4) Radiation hardness was raised associated along with renewable solar cells.

Fig. 3 shows the stacked architecture of solar cell to improve the efficiency using Quantum Dot concept. Different combination of stacking will improve the efficiency up to 5%.

Solar Cell Improvement: Nowadays, because of lower cost the traditional one is chosen when compared to present nano solar cells. In the deep-rooted nanotechnology versions have been used to increase efficiency when compared to conventional ones.

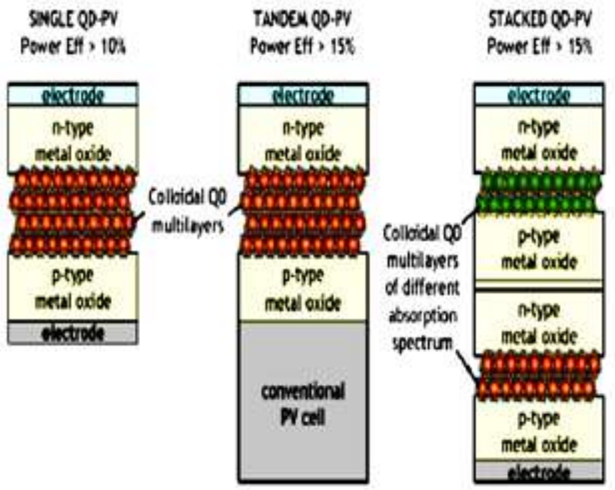

Fig. 3: Stacked Architecture of solar cell

Coating the nanoparticles with semiconductor crystals when compared to the normal materials, single photon can generate just only single electron; quantum dots has ability to change energy photons to several electrons. QD functions as similar, but they produce more than two electrons for each photon interaction with the rays that knockouts the dots. Electrons excited to conduction band from the valance band. The efficiency is high as 65%. The quantum dots can be used by making carrier cells with high temperature. The extra energy formed in the photons with the effect of higher energy leads to higher voltage[7-9]. The electron movement through the particle is a main damage to attain efficiency in adapting a nanostructure electrode. Usage in network of CNT was the great support in semiconductor particles via executing the transport of electron to collect the surface of electrode in DSSC. The charges excited to SWCNT excitation from CdSe nano particle. Under visible light irradiation CNT involved in CdSe and CdTe which enhance the transfer of charged particles. To increase the effect of short circuit current density, they boost the interconnection of titanium dioxide particles and the MWCNTs in the porous titanium dioxide film[8].

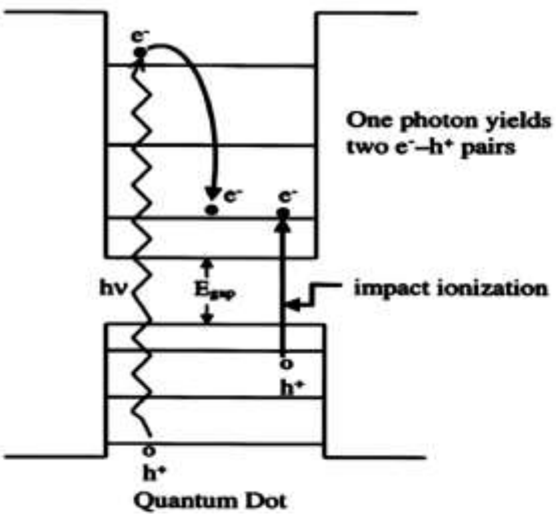

Fig. 4: Multiple Exciton Generation

Fig. 4 shows the multiple exciton generation concept. The electron hole pair generation can be increased per photon by the multiple exciton generation process, in which one photon absorption will emit 2 plus excitons that means more than two electron hole pairs whereas only one electron hole pairs are generated in normal solar cells. It has greater solar spectrum which is shown in fig. 5.

Reduce the Cost by using Nanotechnology: To increase the efficiency of Nanotechnology, the challenge in implanting nanotechnology is the decrease in production cost. Berkeley identified a path to make plastic solar cells at very low cost that must be painted on any surface which is shown in fig. 6. 1.7% efficiency was achieved in case of new plastic solar cells. Paul Alivisatos put forth an idea that, "There is essential potential to ensure a lot better which creates an attractive strong path to make this achieve much better" [10-12].

The tiny nanorods within a polymer are the new plastic solar cells. When nanorods absorb light of a precise wavelength they produce electrons and act as wires. The flow of electrons to the nanorods will extent the aluminum electrode and they joined to produce a current and are consider as electric charges[13-15].

Significance of Nanotechnology:
1) Nano technology with utilization of solar cells would help to preserve the environment.

2) The inexpensive photovoltaic cells which are enough to cover with the roofing materials. This will decrease the fossil fuels and helps to reduce pollution.

3) The military implication also includes the nanotechnology in solar cells.

4) The Konarka technologies were already hired by US army to plan a improved method to control the soldier electrical procedures. Daniel Mcgahn, the vice president of Konarka technologies says that the field soldiers usually carriers the 1.5 pounds of batteries. For the special operations, soldiers usually carriers the 140 pounds to create an efficient work. It will greatly improve the soldier mobility.

5) The rural areas can use the inexpensive solar cells to provide better electricity. It provides the greatest efficiency to one-third of the country. Merits of nowadays is the demand of electricity is low in the peculiar areas. It is not easy to connect them in an electric grid.

6) Lightning, hot water, medical devices and even cooking uses cheap solar cells.

7) The nanotechnology improves the standard of living up to billions of people. To generate the power the car coating with photovoltaic solar cells and solar cell windows were used.

Table 1
Comparison of different Photo Voltaic Cells

Sub types	Mono Crystalline	Poly crystalline	CdTe	CIGS	a-Si	Multi Junction
	Purity 99.999999%	Purity 99.999999%	Low temperature sensitivity	Captures large spectrum	Amorphous silicon	GaAs/CIS a-Si/mc-Si
Description	Crystalline silicon wafers		Semiconductor is deposited directly on glass			
Module Efficiency	High		Low			
Performance under heat	Performance degrades with higher temperature		Up to 60% lower heat coefficient than crystalline silicon modules, making it a good in hot climates			
Space required per kWp	Poly crystalline:10cm^3 -30 cm^3		Glass-glass laminate ~25cm^3			
Degradation	Degradation		Degradation			
Amount of photo voltaic material needed	Poly silicon:8g/W		CdTe:0.22g/W			
Efficiency (production)	15-20%	13-15%	10%	12%	7%	36%
Efficiency (Lab)	25%	21%	16%	20%	10%	40%

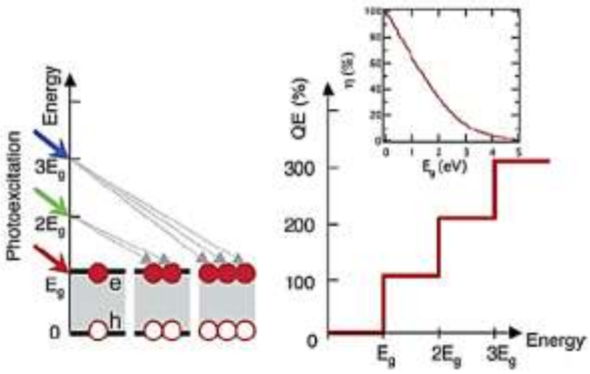

Fig. 5: Altered Energy Gap

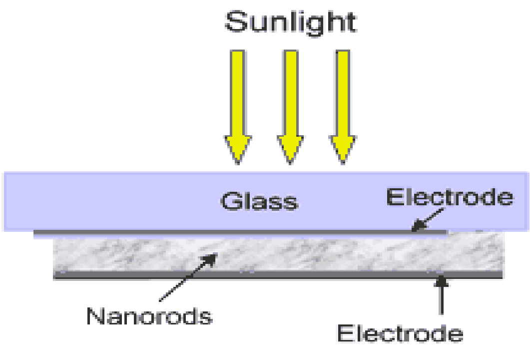

Fig. 6: Solar Cell with Nanorod

Conclusion

Nano technology improves the efficiency of solar cells. Moreover, reduce the manufacturing price. The nano technology is highly effective for low power devices comparing to the high-power devices. Adequate energy was supplied in case of low power devices. It helps to developing countries to provide the electricity. Nano technology is boon to human society, future energy source for mankind. Inexpensive solar cells nano science would help to preserve the environment. Nano technology Solar cells are cheaper than burning of coals. It is used in information technology, molecular electronics, nano tube and nano wires, communication technologies.

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