AN EXPLORATORY STUDY OF SOLAR CELLS APPLICATION IN NANOMATERIALS

Yassar Parvez Rounyal[1], Dr.(Lt.) Rajeev Kumar Singh[2]

[1]*Research Scholar, Department of Physics, Bhagwant University, Ajmer, India*
[2]*Associate Professor, Department of Physics, Bhagwant University, Ajmer, India*

ABSTRACT

In this paper we are discuss An Exploratory Study of Solar Cells Application of Nanomaterials. Manufacturing costs are generally reduced as a result of using a low temperature process similar to printing rather than a high temperature vacuum deposition process to produce conventional cells made of crystalline semiconductor materials. (Nanavark Spotlight) Graphene-based nanomaterials have many promising applications in energy-related fields. In particular, there are four major energy-related areas where Graphene will have an impact: catalysis for solar cells, supercapacitors, lithium-ion batteries, and fuel cells (read more: "Graphene-Based Nano Technology in Energy Applications"). The solar energy industry has developed rapidly in recent years due to strong interest in renewable energy and the problem of global climate change. Nanotechnology has already shown enormous success in the solar field. Nanotechnology may be able to increase the capacity of solar cells, but the most promising application of nanotechnology is the reduction in manufacturing costs. The use of nanotechnology in expensive solar cell will help in preserving the environment. This paper provides an overview of current solar cell technologies and their drawbacks. Then, it explores the research area of nano solar cells and the science behind them. The potential impact of these technologies on our society is also discussed.

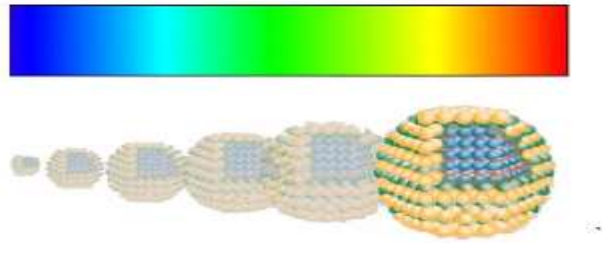
Keyword : - *Global, Climate*, *Solar Cells, Impect, CNTS etc.*

---

1. INTRODUCTION

CNTs provide superior electron ballistic transport property along their axis with high current density capability on the surface of the solar cell without causing much damage. Alignment of CNTs with polymer composite substrate gives very high efficiency in photovoltaic conversion. Polymer composites increase the contact area for better charge transfer and energy conversion. In this process, the efficiency of the solar cell is about 50% on the laboratory scale. Optimal efficiency was achieved with CNTs aligning with poly 3 -octyl thiophene (P3OT) based PV cells. P3OT within the polymer has improved properties due to polymer - and nano tube junctions. The high electric field within the nano tube splits excitons to electrons and pores, and enables rapid electron transfer with improved quantum efficiency of more than 50%.

Solar cells coated with a 1-nanometer film, blue luminescent particles, showed a power increase of about 60 percent in the ultraviolet range of the spectrum, but less than 3 percent in the visible range. Solar cells coated with 2.85 nanometers, red particles showed an increase of about 67 percent in the ultraviolet range and about 10 percent in the visible range of the spectrum. Ultra-thin films of highly mono-dispersed luminescent Si nanoparticles integrate directly onto polycrystalline Si solar cells. Films of 1 nm blue luminescent or 2.85 nm red luminescent Si nanoparticles give rise to larger voltages with better performance of 60% in the UV / blue range. Visually, enhancements are ~ 10% for red and ~ 3% for blue particles.



Solar energy is the energy, the earth receives from the sun, primarily as visible light and other forms of electromagnetic radiation. The solar portal provides an overview of the information on energypedia related to solar energy. Look for specific topics, latest articles or uploaded documents and announce upcoming events.
• 2014 on track to being among hottest on record
• The global average air temperature over land and sea surface for January to October was about 0.57° Centigrade (1.03 Fahrenheit) above the average of 14.00°C (57.2 °F) for the 1961-1990 reference period
• Lima Talks - goal is to reduce greenhouse gas emissions to limit the global temperature increase to 2 degrees Celsius above current levels
The operation of a photovoltaic (PV) cell requires 3 basic attributes:
1. The absorption of light, generating either electron-hole pairs or excitons.
2. The separation of charge carriers of opposite types.
3. The separate extraction of those carriers to an external circuit.

2. NANOTECHNOLOGY IN SOLAR CELLS

The use of nanoparticles in the manufacture of solar cells has the following advantages:
Typically using a low temperature process similar to printing instead of a high temperature vacuum deposition process to produce conventional cells made of crystalline semiconductor materials resulted in a reduction in manufacturing costs.
Reduction in installation costs derived from the production of flexible rolls instead of rigid crystalline panels. Cells made of semiconductor thin films will also have this feature.
Currently available nanotechnology solar cells are not as efficient as conventional ones, although they are reduced due to their low cost. In the long term nanotechnology versions should have lower costs and, using quantum dots, be able to reach higher efficiency levels than conventional ones.

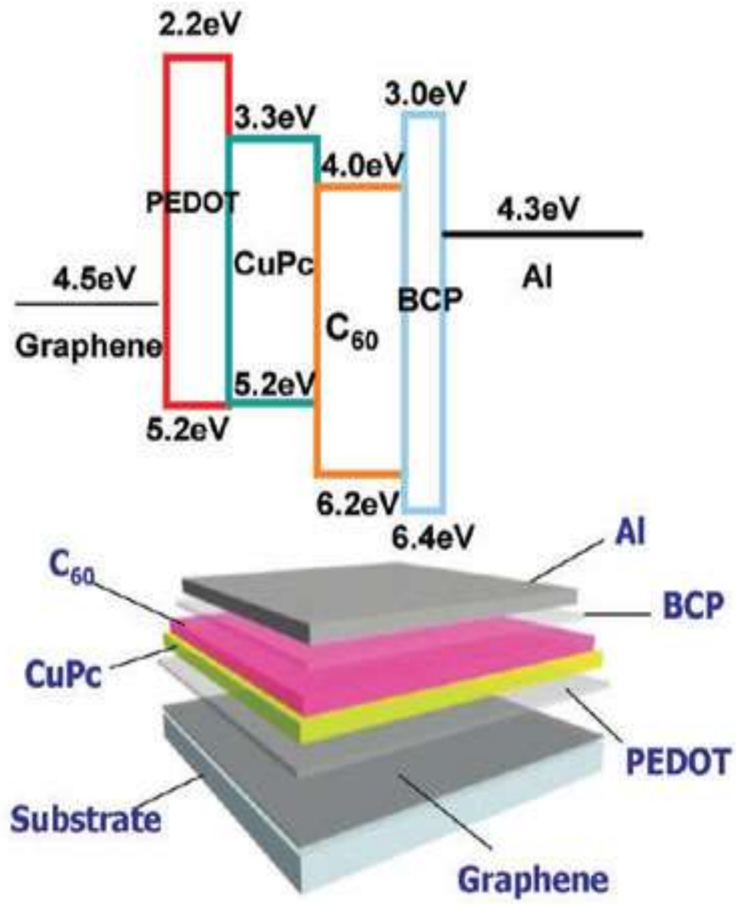
3. NANOMETRIAL APPLICATIONS UNDER DEVELOPMENT

Flexiable layers of nanoporous germaniun to produce lightweight solar cells for mobile applications.
Titanium dioxide nanotubes filled with a polymer to form low cost solar cells
Combining lead selenide quantum dots with titanium dioxide to form higher higher efficiency solar cells.
Combining carbon nanotubes and buckyballs to produce solar cells. Some researchers combine the nanotubes and buckyballs with a polymer, while another group of researchers are only using nanotubes and buckyballs. A third research group is also using nanotubes and buckballs along with graphene to build a solar cell.
Researchers at Stanford University have found a way to trap light in organic solar cells. The idea is that the longer light is in the solar cell the more electrons will be generated. The researchers found that by making the organic layer much thinner than the wavelength of light and sandwiching the organic layer between a mirror layer and a rough layer the light stayed in the solar cell longer and excited more electrons.
Semiconductor nanoparticles applied in a low temperature printing process that results in low cost solar cells.
Organic molecules to lower costs.
Using light absorbing nanowires embedded in a flexible polymer film is another method being developed to produce low cost flexible solar panels.
Using light absorbing graphene sheets to produce low cost solar panels Organic solar cells that are self repairing
Organic solar cells that can be applied by spray painting, possibly turning the surface of a car into a solar cell.
Researchers at Lawrence Berkeley have demonstrated an inexpensive process for making solar cells. These solar cells are composed of cadmium sulfide nanowires coated with copper sulfide.
(Nanavark Spotlight) Graphene-based nanomaterials have many promising applications in energy-related fields. In particular, there are four major energy-related areas where graphene will have an impact: catalysis for solar cells, supercapacitors, lithium-ion batteries, and fuel cells (read more: "Graphene-based nano technology in energy applications"). Graphene's extremely high electron mobility - electrons move through it with about 100 times mobility in silicon under ideal conditions - combined with its superior strength and the fact that it is nearly transparent (2.3% of light is absorbed; 97.7% transmitted;), making it an ideal candidate for photovoltaic applications. It can be a promising replacement material for indium tin oxide (ITO), a transparent electrode used for LCD displays, solar cells, iPads and

smart-phone touch screens, and electrodes in organic light-emitting diode (OLED) displays. Current standard content for. For TV and computer monitor.

For example, a report came out yesterday ("Nanotechnology researchers make a big leap towards graphene for solar cells"), indicating that graphene retains its impressive set of properties.

Hen It is coated with a thin silicon film. These findings give way to completely new possibilities to use in thin film photovoltaic. Pro. A new review in Advanced Energy Materials ("Graphene-based Materials for Solar Cell Applications") by a team of scientists from Nanyang Technological University, led by Hua Zhang, provides an overview of recent research on Graphene and its derivatives, solar A special focus on synthesis, properties and applications in cells



4. NANOTECHNOLOGY IMPROVES THE SOLAR CELL

To coat nanoparticles with quantum dotted semiconductor crystals. Unlike traditional materials, in which a single photon produces just one electron, quantum dots have the ability to convert high-energy photo-tones into multiple electrons. Quantum dots work in the same way, but they produce three electrons for each photon of sunlight that hits the dots. The dots run through the valence band in the electron conduction band also hold more spectrometers of sunlight waves, thus increasing the conversion efficiency by 65 percent. Another area in which quantum dots could be used is making so-called hot carrier cells. Usually the extra energy supplied by a photon is lost as heat, but with a hot carrier cells the excess energy from the photon results in higher energy electrons which in turn leads to a higher voltage [10, 11].

The transport of electrons into particle net-work is the major problem in achieving high photo-conversion efficiency in nanostructured electrodes. The use of CNT network support to anchor light harvesting semiconductor particles with the aid of electron transport across the assembled electrode surface in DSSCs. Charge injection from excited CdS in SWCNT stimulation of Cdc nanoparticles. CNTS when attached to Cdse and CdTe can induce a charge transfer process under visible light irradiation. The enhanced correlation between titanium dioxide particles and MWCNTs in the porous titanium dioxide film was concluded to cause an improvement in short-circuit current density. [11]

5. IMPROVING THE EFFICIENCY OF SOLAR CELLS BY USING SEMICONDUCTOR QUANTUM DOTS (QD)

One of the starting point for con-version growth. The efficiency of solar cells is the use of semiconductor quantum Dots (QD). Through quantum dots, band gaps can occur Especially for adjusting too long wave light and Thus the capacity of solar cells increases. These so-called Quantum dot solar cells, currently still subject to Research. As material systems for QD solar cells, III / Vsemiconductors and other material combinations such as Si / Ge Or Si / Be Te / Se is considered. Potential benefits of these Si / Ge QD solar cells are:

1) High light absorption, especially in infra-red Spectral region,
2) Compatibility with standard silicon solar cell production (Unlike the III / V semiconductor),
3) Increase of photo current at high temperature
4) Better radiation hardness compared with conventional solar cells.

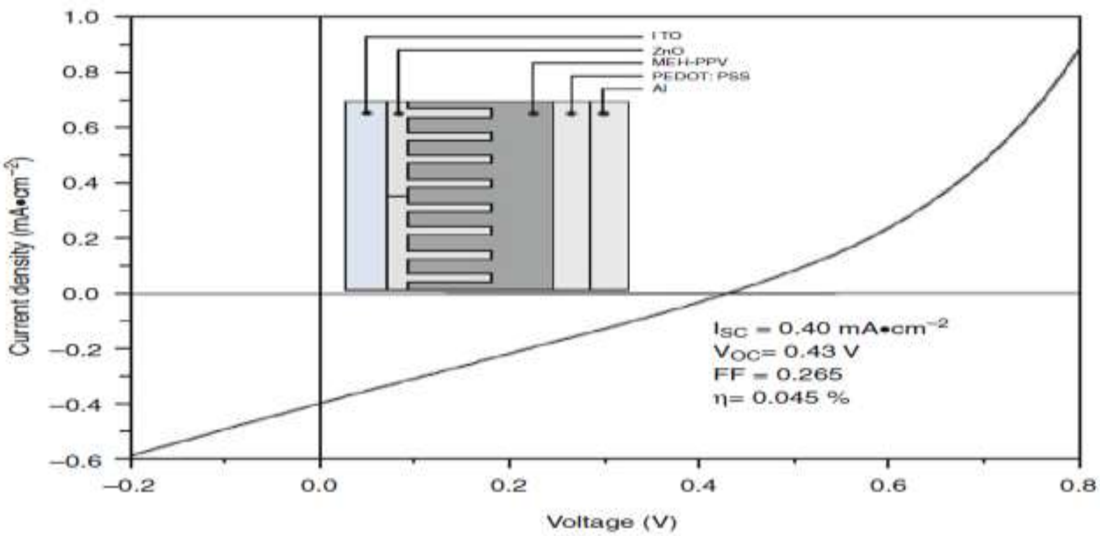
6. NANOMATERIAL-BASED SOLAR CELL PERFORMANCE

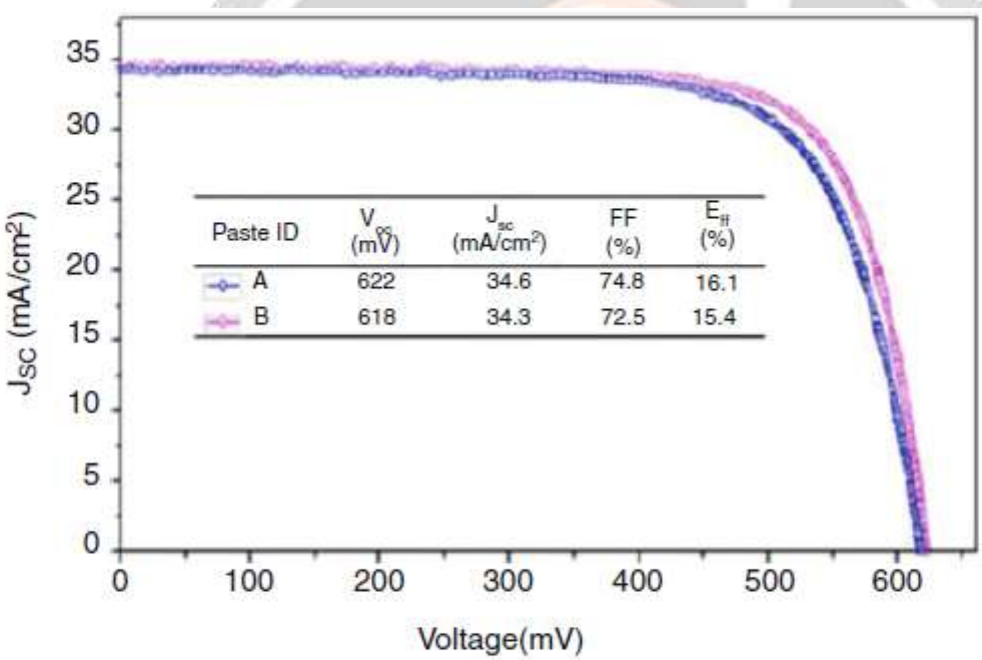
Anodic titanium oxide (ATO) nanotube-based dye-sensitive solar cells have shown to have a fill efficiency of 2.9%, 3.9% and 0.51, 0.65, respectively and without reactive doping treatment below. Characterization for the I (V) CdS NW core and Cu2S shell (figs. 1 and 2). Organic solar cell performance is shown in Table 1: With respect to nanocon silicon solar cells, their performance is reported in Table 2. Thus, efficiency is increased when adopting nanocon architecture. The effect of nanomaterial size is confirmed. The characterization of the structure of FTO / TiO2 / CdS with and without gold nanoparticles is shown in Table 3. SWNTs, in other words "single-walled carbon nanotube semiconductors": using this material,
Zhang et al. Has achieved a solar cell with a conversion efficiency of 12.6% . For dye-sensitized solar cells (DSSCs), based on TiO2 nanocrystalline electrodes, Andra de Morris et al. Their efficiency is improved by the introduction of acid-treated multiwall carbon nanotubes (MWCNT-COOH). Conversion efficiency of 3.05% was achieved for DSSC based on MWCNTTOO2 and 2.36% for DSSC based on TiO2.

P3HT:PCBM (2:1)	V_{oc} (V)	J_{sc} ($mAcm^{-2}$)	FF	η (%)
Barrier	0.82	3.63	0.68	2.04
Atm. annealed	0.83	3.96	0.67	2.19
Vacuum annealed	0.83	4.30	0.67	2.37

P3HT:PCBM (2:1)	V_{oc} (V)	J_{sc} ($mAcm^{-2}$)	FF	η (%)
Barrier	0.80	2.83	0.65	1.48
Atm. annealed	0.78	3.27	0.62	1.58
Vacuum annealed	0.80	3.59	0.66	1.90

Electrode	V_{oc} (V)	I_{sc} (mA/cm^2)	FF	η (%)
$FTO/Au/TiO_2/CdS$	0.56	7.11	0.41	1.62
$FTO/TiO_2/CdS$	0.47	5.72	0.38	0.82





REFERENCES

[1]. Singha, R., Rangarib, V., Sanagapallia, S., Jayaramana, V., Mahendraa, S., Singha, V. (2004).Nano-structured CdTe, CdS and TiO2 for thin film solar cell applications. Solar Energy Materials & Solar Cells, 82, 315- 330.

[2]. Chopra1, K., Paulson, P. and Dutta1, V. (2004). Thin-Film Solar Cells: An Overview. Progress in Photovoltaics,12, 69-92.

[3]. Konenkamp, R., Dloczik, L., Ernst, K., Olesch, C. (2002), Nanostructures for solar cells with extremely thin absorbers. Physica E, 14(1- 2), 219-223.

[4]. Paul Preuss. "An unexpected discovery could yield a full spectrum solar cell."Research News. Berkeley Lab. 18 November 2002. .

[5]. M. Topinka 'Carbon nanotube electrodes for solar cells'. SPRC Workshop: Solar Cell Technology Options: Paths to Lower $ per Watt, Stanford University, Stanford, Calif. (Feb. 24, 2007).

[6]. K.R. Catchpole and A. Polman "Plasmonic Solar Cells,", Optics Express, Vol. 16, Issue 6, December 22, 2008, Focus Issue on Solar Energy edited by Alan Kost, University of Arizona.

[7]. B.J.Landi, R.P. Raffaelle , S.L.Castro , S.G.Bailey ,C.M.Evans (May2005) ‘CdSe quantum dot single Wall carbon nanotube complexes for polymeric solar cell’ Solar Energy Materials and Solar Cells 87(1-4): 733-746.

[8]. Sanders, Bob. “Cheap, Plastic Solar Cells May Be On The Horizon.” UC Berkeley Campus News. 28 March2002.

[9]. Claudio Pelosi and Matteo Bosi.” Light concentration increases solarcell efficiency and reduces cost “,17 May 2007, SPIE Newsroom. DOI: 10.1117/2.1200704.0689.