

Chapter One

Introduction

1.1 Prelude

Solar energy is the mother of energy above our planet, where emit rays all energies because they are moving all the machines and the mechanism of the land heats the surrounding air and land and the generation of wind and push water recycling cycle, and heating the oceans, and develop the plants and feed the animals and with the time the fuel is fossil in the ground and this energy can be converted directly or indirectly to the heat and cold, electricity and a driving force in ways. Sunlight electromagnetic spectrum visible rays constitute 49% of them and the unseen as ultraviolet (2%), and infrared 49%. Solar vary depending on the movement and then from the ground, vary sunlight and severity density above ground a map by seasons of the year over the hemispheres and the distance from the Earth and tendencies and put it above the geographical locations throughout the day or during the year according to the clouds density, which eclipsed because they reduce or control the amount of radiation that link the land unlike the sky free wakes clouds or fumes. The rays of the sun fall on the walls and windows of buildings and land and water, and absorb radiation and store in a block (material) thermal, this stored heat radiate then into buildings. This thermal mass is considered a solar heating system is the same function as the batteries in an electric system, solar (photovoltaic) voltages. Both store the sun's heat to be used later. Convert all those solar energy into electricity is very expensive and most solar cells are made from silicon metal, silicon found in abundance in the earth's crust, the sand and this needs such as chips for manufacturing processes difficult include the use of a clean room and booths air circuit and as a result, the cost of generating electricity from solar energy about four times the cost generated by conventional means Raised Nano solar cell technology a lot of

interest based on what in the field of energy from the important expectations not only in academia as well has produced a unique ability to build new structures on a large scale at the atomic level, new materials and devices with the possibility of job applications in a large number of vital areas and allowing developing nations to join the developed economies, nanotechnology is the second industrial revolution, social, economic and environmental benefits and applications in the field of private energy after the rapid expansion of research and technological development where he was able to provide many and promising solutions, including what is the user, including what is the use phase where he managed to make a cheap and flexible cells can be sprayed on walls or printed on paper or even fabric Helps solar cells developed nanotechnology to increase the conversion efficiency of light using quantum or grapheme patches up its efficiency to between 30 and 40% at the present time because of the quantitative limitation of electrons, which means that the photon and one could cause the release of more than electrons and therefore gives higher efficiency solar cell It also contributes to further reduction of pollutants emitted from combustion engine through the use of Nanofilters can purify and clean the exhaust mechanically through transformers motivating and based on noble metal nanoparticles or molecules through envelopes catalyst on the walls of the cylinder and catalytic nanoparticles.

1.2 Research Problem

The high cost of solar cells is the biggest challenge facing the manufactured article, for silicon used in solar panels manufacturing are expensive.in addition to being toxic and non-recyclable.And the process of converting sand into silicon is an expensive process, "After getting on the sand, we have to do many operations are complex to address the sand and

must also work in a clean room and only material dating back to the oxidation state again.

Also the properties of silicon may be corrupted if subjected to heat or humid

1.3 Objectives of The Study

The importance of nanotechnology in the field of solar energy.

- Reduce the cost of solar cell manufacturing.
- Increase the efficiency of the solar cell by improving the methods and properties of materials using quantum points or grapheme.
- The development of solar cells made of semiconductor repainted by Nano-materials or replacing organic materials – polymer.
- Improving the traditional silicon cells Properties.

1.4 Literature Review

Examples of previous studies in the field of the thesis are:

Ying Guoi, Alan L. Portrait, Lu Hoagie, (January 2017)[1]:

Nanotechnology-enhanced, thin-film solar cells are a promising and potentially important emerging technology. This paper examines global research patterns to assess development prospects. We apply the “tech mining” approach to R&D publications in this field. Records are compiled from Web of Science for the time period 2001-08. These indicate that the United States (US) is the leading author on nanotechnology-enhanced, thin-film solar cells. In addition, quality-related measures place the US in an even stronger position. Germany and Japan show slowed research growth rates in terms of both quantities and quality. China and India show dramatic rise on both counts, but they cannot yet match the US. We also find that collaboration

patterns within the US and Germany are quite different. In the US, we see little cooperation between institutes and no absolute leading institute; however, Germany shows the opposite attributes. Finally, this paper illuminates that Nano-structured ZnO is particularly promising in thin-film solar cells, showing a sharp rise in publications since 2005, led by China.

Almantas Pivrikas, Helmut Neugebauer, (October 2012)[2]:

Research and development towards high efficiency plastic solar cells have been accelerating in recent years. Polymer-based bulk hetero junction solar cells are offering an attractive and inexpensive concept for large scale production by solution processing as well as advantageous flexible and aesthetic form factors. The thin film Nano-morphology of bulk-hetero junction solar cells has been shown to dramatically influence the photovoltaic performance of the devices. This article reviews the different methods used to control the film Nano-morphology of bulk-hetero junction solar cells focusing on the chemical additives during solution processing. All power conversion efficiency limiting mechanisms of bulk-hetero junction solar cells are discussed in detail. It is shown, how the formation of optimal percolation pathways between donor and acceptor influences the photovoltaic device performance. It is explained how the film Nano-morphology relates to light absorption, free charge carrier generation as well as charge transport to the electrodes.

Lorena Macro, Roberto Gómez, (July 2009) [3]:

Solar cells based on a mesoporous structure of TiO₂ and the polysulfide redox electrolyte were prepared by direct adsorption of colloidal CdSe quantum dot light absorbers onto the oxide without any particular linker. Several factors cooperate to improve the performance of quantum-dot-sensitized solar cells: an open structure of the wide band gap electron

collector, which facilitates a higher covering of the internal surface with the sensitizer, a surface passivation of TiO_2 to reduce recombination and improved counter electrode materials. As a result, solar cells of 1.83% efficiency under full 1 sun illumination intensity have been obtained. Despite a relatively large short circuit current ($J_{\text{sc}} = 7.13 \text{ mA cm}^{-2}$) and open circuit voltage ($V_{\text{oc}} = 0.53 \text{ V}$), the colloidal quantum dot solar cell performance is still limited by a low fill factor of 0.50, which is believed to arise from charge transfer of photo generated electrons to the aqueous electrolyte.

Minatorivola and Jan haalm, (September 2009) [4]:

This review presents an overview of the current state of research on nanostructured titanium dioxide dye solar cells (DSCs) on alternative substrates to glass. Replacing the traditionally used heavy, rigid, and expensive glass substrate with materials such as plastic foils or metal sheets is crucial to enable large volume cost-efficient roll-to-roll type industrial scale manufacturing of the cells and to make this solar cell technology properly competitive with silicon and thin film photovoltaic devices. One of the biggest problems with plastic substrates is their low-temperature tolerance, which makes sintering of the photo electrode films impossible, whereas with metals, their corrosion resistance against the iodine-containing electrolyte typically used in DSCs limits the amount of metal materials suitable for substrates. However, significant progress has been made in developing new materials, electrode film deposition and post-treatment methods suitable for low-temperature processing. Also, metals that do not corrode in the presence of iodine electrolyte have been found and successfully employed as DSC substrates. The highest power conversion efficiencies obtained with plastic and metal substrates are already 7–9%, which is not far from the best glass cell efficiencies, 10–11%, and comparable also to, for example, amorphous silicon solar cell efficiencies. One of the most important of the remaining research challenges of DSCs on flexible substrates is to ensure that the long-

term stability of the cells is realistic to consumer applications, for example, with providing efficient enough encapsulation to prevent water and other impurities penetration into the cells. Degradation mechanisms specific to metal-based cells are another issue that needs deeper understanding still. More exotic approaches such as depositing the DSC structure on optical fiber or employing carbon nanomaterial's to increase the cell efficiency.

1.5Presentation of the thesis

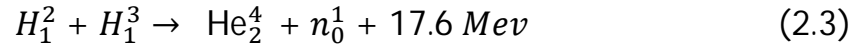
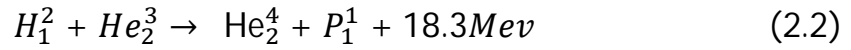
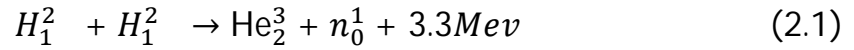
Chapter one is an introduction to the thesis, chapter two presents the solar Radiation; chapter three covers the properties of the solar cell efficiency as well as the types of solar cells, and nanotechnology. Chapter four dealt with solar cell manufacturing nanotechnology in details. Chapter five is simply conclusion and recommendations.

Chapter Two

Solar Irradiance

2.1 Sun Source of Energy on the Earth's Surface

The sun's mass equivalent to 99.7% of the total mass of the solar group and its mass actually does revolve solid as a body, as the center of the outer regions every 30 days. The sun is the source of nuclear fusion reactions that occur in the soles of the sun (the sun center consists of elemental hydrogen and helium in the plasma state); where the pressure and temperature prohibitively high, and the results from this interaction merger of hydrogen atoms to produce helium atom [13].



The energy produced from these topic interactions may be caused by the mass of deuterium and tritium largest blocs of helium and neutron output, the difference in the mass is the one who has turned into energy according to Einstein formula for the equivalence of mass and energy

$$E = \Delta mc^2 \quad (2.4)$$

Sun is composed mainly of hydrogen, which reach 80% of the mass of the sun, and helium which has a 19% and be other elements carbon and nitrogen 1% of the mass of the sun and the result of this interaction is converted 6×10^{11} kg of hydrogen into helium every second and this information can estimate the age of the sun at about 8.5×10^{10} years of the sun, the source of inexhaustible energy [13].The sun shines an average of 3085×10^{23} kJ and

receives the ground of this energy is equivalent to 107×10^{14} kJ, but 70% of this energy is located on the sea and uninhabited spaces, such as mountains, deserts and cannot take advantage of them. However, the solar energy that can be exploited more than human need and long interval the solar radiation that reaches the earth issued mainly layer votesphere can assume that the sun surrounded hating nuclear oven and has a surface Black radiant in a constant temperature of 5762 degrees Kelvin and the issue of radiation in all directions[12].

2.2 Solar Cycle in Nature

The solar energy reaching the Earth in the year of about 1.5×10^{11} kJ/h 30% of this energy is reflected by the Earth's atmosphere, 0.47% absorbs directly crust ground for re-radiate once again on the image rays heat with wavelengths great, 23% of which is absorbed Seawater evaporation updated drag and rain 0.15% suck in atmospheric air to give wind and waves this also could be used to generate power, 0.02% goes as energy used in photolithography processes of photosynthesis produces about carbohydrates and greases proteins. And up the resulting energy from the tides and the root to 20 part from millions of solar energy.

Radiation incident on the atmosphere surrounding the Earth

Solar radiation that reaches the surface of the gaseous envelope surrounding the Earth is not completely fixed but varies from time to time, so as to two reasons [12]:

First: the changes that occur inside the sun, which arise from sunspots, which occur from time to time in a way almost periodic and affect the amount of hard solar system.

Second: The distance between the earth and the sun is not constant throughout the year, leading to a change in the amount of radiation at a rate of +3% to calculate the density flux of radiation from the sun's surface at a temperature of 5762 Kelvin, we find that:

$$q = \hat{\sigma}T^4 = 5.67 \times 10^{-8}(2562) = 6.25 \times 10^7 \text{wm}^{-2} \quad (2.5)$$

Where q is the radiation flux density of the black body in absolute temperature (Kelvin)

$\hat{\sigma}$ Stephen is Boltzmann's constant.

This radiation released in all directions in space every square meter of the surface of the sun either the total radiation that comes from the total surface of the sun

$$P = \pi R^2 \hat{\sigma} T^4 = 3.91 \times 10^{26} \text{ W} \quad (2.6)$$

Where R is the diameter sun

This radiation in all directions in space and is spread and the greater the distance has increased the spread of radioactive energy.

If you want to calculate the amount of solar radiation that we take a spherical surface of the sun known surface area gauss:

$$q_x = \pi x^2 \quad (2.7)$$

To get the intensity of radiation flux q_x that is appropriate inversely with the square of the distance from the sun:

$$q_x = \frac{4\pi R^2 \hat{\sigma} T^4}{4\pi x^2} \quad (2.8)$$

If we assume that x is the distance between the sun and the earth will be the amount of radiation is reaching the square meter of the surface of the atmosphere around the Earth and defines this amount of solar Boltzmann and the code name of q_x :

$$q_x = \frac{4\pi R^2 \hat{\sigma} T^4}{4\pi} = \frac{R^2 \hat{\sigma} T^4}{X^2}$$

$$q_x = \frac{R^2 \hat{\sigma} T^4}{X^2} \quad (2.9)$$

2.3 Hard Solar

It is defined as the amount of solar energy that falls every second to every meter of orthogonal from solar radiation above the gaseous casing surround earth surface. Solar and hard especially important if you cannot be in any part of the earth to get more Solar deal of this magnitude is a benchmark in many solar energy accounts currently measured using planetary and satellite measurements show that it is equal to 1367 Wm²[12].

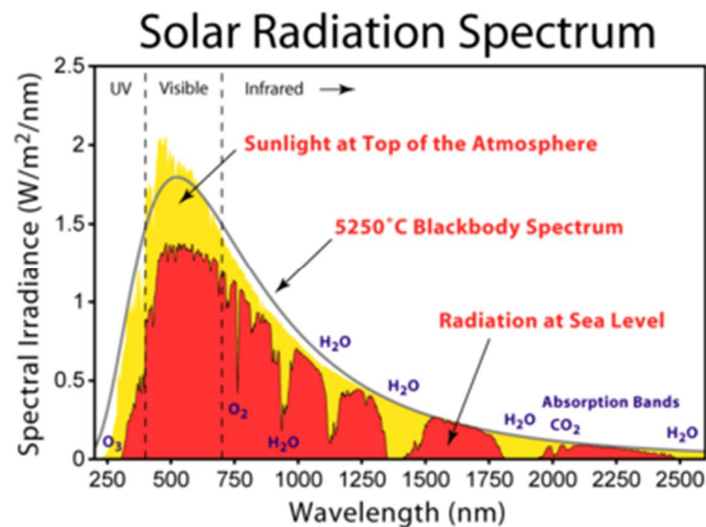
2.4 Solar Radiation above Gaseous Surrounding the Earth

Solar radiation is an electromagnetic waves of different lengths can be split term total waveform spectrum of solar radiation incident on the cover of gaseous to several spheres her :sphere Ultraviolet rays that at least over the waves than 0.4 microns and the sphere of visual rays that have over the waves confined between 0.4 to 0.7 microns and sphere infrared waves throughout at least about 0.7 microns can distribute the amount of solar radiation spectrum above the atmosphere by the amount of hard solar to[15]: -

- **UV radiation:** an estimated 96Wm⁻² amounting to a percentage of the total radiation ratio of about 7%.
- **The visible radiation** 674Wm² estimated at about 47%.
- **Infrared** estimated 625Wm² and percentage to the total radiation 46%

It is clear that the visible portion of solar radiation above the atmosphere at least 50% for the total radiation. Due to the high temperature of the sun, the

radiation of electromagnetic issued by it, ranging in length from 10^{-12} meters as in the gamma ray and X-ray, which consists of cosmopolitanism ray few kilometers as in radio waves long and all these rays have one to a Natures are spread through space at light $10^8 \times 3$ meters per second



2.5 The Atmosphere and Changes in Temperature, Density and Pressure

Featuring state of the atmosphere with several of variables, including: temperature (T) and density (q) and pressure (p) of these transactions vary from one place to another since these variables are difficult to predict the theoretical conclusions of radiation falling on the earth difficult to be asylum to approximation and the use of experiential equations.

The so-called flat atmosphere, which is characterized by its components this Atmospheric flat strata. Change the degree of atmospheric important scientific different ones meteorology study solar radiation and for this purpose are divided into four layers: -

- troposphere: Best layers of the earth's surface and extends from the surface of the sea to 12 kilometers above the surface and decreasing the temperature at a rate of 6 per grade at kilometers as altitude increases.

- Stratospheric: extends from the height of 12 kilometers to 50 kilometers increased temperature increased headroom where temperatures in January Celsius at a height of 20 kilometers.
- Mesosphere: extends from the height of 50-85 kilometers above sea level, where the temperature drops again an air density of 1% of the density on the surface of the ground.
- Thermosphere: the last layer that keeps above the height of 85 kilometers above the sea surface temperature increases again [19].

2.6 Radiation That Reaches the Earth's Surface Components

Scatters some of the solar radiation as it passes through the atmosphere and absorbs some of the atmosphere is reflected in part to the space outside of the atmosphere, and thus the solar radiation that reaches the earth's surface composed of two parts, the first radiation in the form of a beam or direct radiation and the other part radiation-extensive or widespread as a result of part of the scatter radiation by the atmosphere. And less than the sum of direct and diffuse radiation flow at the local site for the value of the radiation flow out of the atmosphere to the same location [15].

And the way that decreases the flow of solar radiation while passing

The atmosphere of the Earth is summarized as follows:

And the way that decreases the flow of solar radiation while passing:

1- scatters partial absorption of radiation by dry air molecules accurate size and called scatters Riley Rayleigh Scattering.

2- Scatters partial absorption of radiation by dust airborne.

3- Part by absorption of water vapor and carbon monoxide and carbon dioxide.

4-Reflection and absorption in the clouds layers atmosphere layers. And stop ratios flow of radiation that reaches the earth's surface to the atmosphere and the high region above sea level components and the position of the sun for the

location The final factor determines the distance that must be breached solar radiation before arriving at the site and used meteorologists unit (air mass) gives a measure affecting the distance traveled by the radiation from outside the atmosphere until it reaches a site

And be air mass value of one right when the sun is above the site is located directly in sea level while the summit is zero if we imagine the lack of atmosphere and thus air mass is defined as the ratio of the distance that penetrates the beam in the atmosphere until it reaches the site to the distance that penetrates the beam if The sun was directly over the site and the location at sea. The rovers can measure the total direct and diffuse solar radiation by a device called pyrometer and using an umbrella with an annular Pyrometer (in order to obscure the direct radiation) can flow diffuse radiation measured value, and the value of the excretion produces the flow of direct radiation .

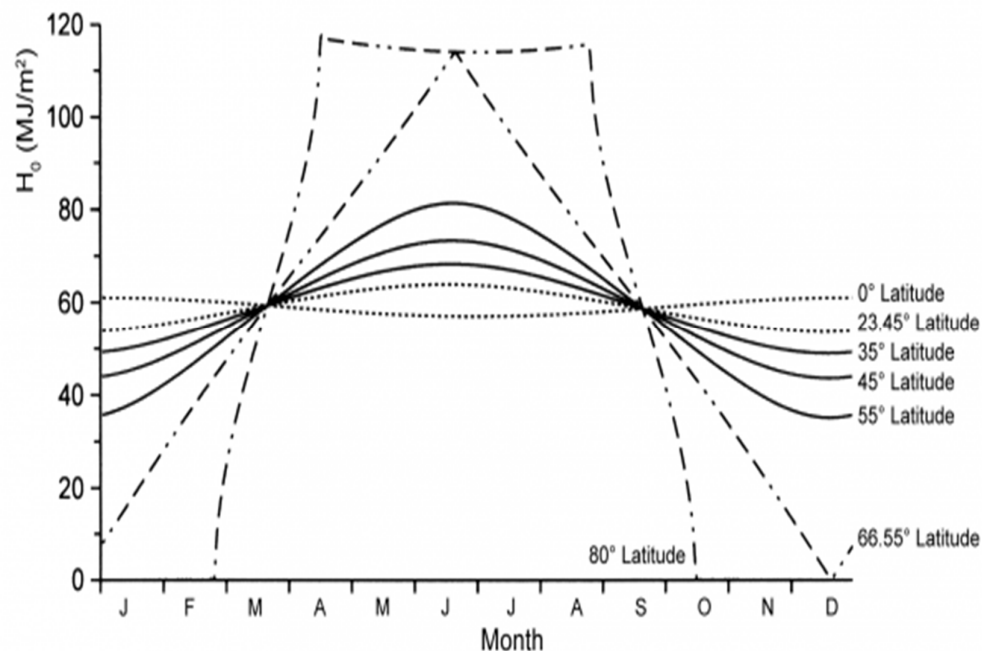


Figure 2-2: The total daily amount of extraterrestrial irradiation on a plane perpendicular to the Sun's rays (H_0) for different latitudes

2.7 Earth's Movement around the Sun

Solar Today: You can find out the length of the solar day by measuring the difference in the time at the time of disappearing in two days consecutive known as ephemeral moment when the sun cross a line and placebo in the sky from the North Pole to the South called oriented, which shows the change of the solar day to offset the time [14].

2.8 Solar Angle:

Solar angle important in all solar radiation accounts and all solar energy applications [5].

2.8.1 Angle Breadth Line (W): is the angle which lies between the equator and the line connecting point between the earth's surface and the center of the Earth

2.8.2 Slat Angle of the Sun(S): is the angle of the sun locale the equator and located between the line connecting the center of the sun to the earth center and birthplace of this line at the leveler of the equator calculates the relationship:

$$S = 23.5 \sin (360(384 + n) 365) \quad (2.10)$$

Where **n** is the number of days of the year.

The slat angle of the sun known values where 235 when the sun is vertical above the Tropic of Cancer occurs summer solstice, be 235 when the sun is vertical above the Tropic of Capricorn and happens winter solstice be angled zero when the spring equinox and autumn when the sun is perpendicular above the equator.

2.8.3 Azimuth Angle (A): is the angle which lies between elided direct beams on the surface of the horizontal and line obsolescence circle it containing a vertical line on the surface. This angle shows the geographical location of solar radiation falling on the surface of the land package. There is a vertical azimuth angle shows the amount of italicize beam relative to the Surface of the earth

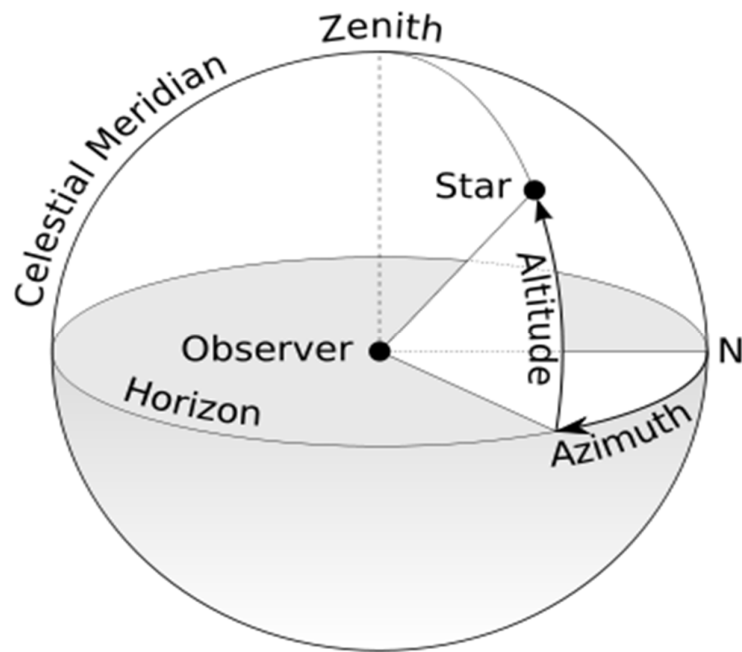


Figure 2-3: The azimuth is the angle formed between reference directions (North) and a line from the observer to a point of interest projected on the same plane as the reference direction orthogonal to the zenith

2.8.4 Angle Time (W): is the angle between the level at which the line connecting the center of the sun to contain center of the earth and the plane containing the Longitude and be zero at noon time (14:00 solar time) and be positive before disappearing and negative after the calculated relationship

$$24/360 \times W = (12 - t_s) \quad (2.11)$$

$$W = 15 (12 - t_s)(2 - 11)$$

t_s where the solar time in hours Sun rise angle (α):

2.8.5 Sun Rise Angle (A): It is the angle between the confined direct solar beams falling on the horizontal surface of the horizontal line which passes a point of falling pack.

2.8.6 Angle Of Incidence on the Line Horizontal Zenith Angle θ_2

Know the vertical azimuth angle which is the angle between packages the direct and vertical beam on the surface of the horizontal passing point land

2.8.7 Angle Of Incidence on the Surface Italics

It is the angle between the vertical and direct solar radiation on the surface, which pilaster oblique angle italics of the landlocked central African oil horizontal package.

2.8.8 Angle of Sunrise and Sunset Angle

Is the angle between the solar beam confined pack or a sunset and the line vertical surface of the horizontal line and disappearing at this time $Q_2 = 90$ and be $\cos Q_2 = 0$ and the ratio is similar to the sun's movement around the ends of the meridian that angle = Sunrise Sunset angle.

2.9 Throughout the Relative Path of the Radiation (M)

Is the relative length of the path of a package of solar radiation in the atmosphere and its length is equal to the correct one when the sun is pilaster on the horizontal surface at sea is also considered the relative path to zero over the gaseous envelope surrounding land[13].

2.10 The Number of Daylight Hours (N)

Is the angle of sunrise or sunset important in calculating the length of the day in any location, including the Sunrise measured from the meridian angle equal to the angle of the sunset, the whole angle $2w_s$ As the sun moves for scenes at a rate of 360 degrees per 24 hours, the length of daylight hours

$$\frac{24}{360} = \frac{2w_s}{15} \times N = 2 w_s$$

$$N = (2/15) \cos^{-1}(-\tan w \tan s) \quad (2.12)$$

Locating solar radiation package for surface italics:

The amount of solar energy that falls on the surface sloping at an angle of inclination depends surface for radiation and specifically by cosine ($\cos \theta$) where θ is the angle between the vertical confined falls on the surface and direct radiation angle and know this function by a factor of Milan is calculated by:

$$\cos \theta = \cos \theta_z \cos \theta + \sin \theta_z \sin \cos(A - Y) \quad (2.13)$$

Where "Y" angle italic surface.

In the case of devices that correspond to movement of the sun perpendicular to the sensitive device with the direct radiation and be

$$\theta_z = S \quad (2.14)$$

$$A = Y \quad (2.15)$$

Chapter Three

Type of Solar Cells

3.1 solar cells

Is a consisting slice of layers ranging total thickness of between 0.2 to 0.25 cm and with an area of 0.1 to 0.2 square meters consisted of a bilateral link, the link of positive words of silicon laced with impurities of the three-element such as boron, As for link the negative, it is also of silicon pure laced with some impurities such as phosphorus quintet of parity , solar cell consists of two slidesIs extracted from the solar cell silicon dioxide (silica) by several chemical processes and mining silicon dioxide and then turns to the so-called Silicon Solar is a multi-layer high-purity silicon[13].And then take place technological processes either by dragging or molding is then cut into slices to turn out in the end to what looked like a rivetIt conducts several operations shall be one surface-negative and the other positive It covers the bottom surface of the cell (material p) the whole layer of thin metal, such as aluminum for the formation of polar terms used end connected to materialperforations It is the end of the delivery of positive, while the upper surface of the cell (material (N) covers him chip on one aspect of a classless form of accounting for an area not to exceed 5% for use in end connected to negative uses metal cover in reticular form until being the largest area of this surface to sunlight ^[6] produced the first solar cell in 1986 and was the efficiency of 1% converted only 1% of the energy of light falling on them to electricity and after the scientists used the membership of new vehicles in the nineties of the last century increased efficiency to about 5%, scientists hope to raise the efficiency to 10% within a few years[14].

3.2 Properties of the Solar Cell

Solar cell differs from the link bilateral regular used in the evaluation of the AC and other current of uses in the surface interval between the upper region and the region lower known surface petition or region transit widely space and a gallery of light, so it is designed the cell so that the surface is too big to absorb most amount possible of solar radiation and also have this surface close to the cell surface solar radiation show that any class that enters the radiation must be very thin[15].

3.3 SolarCell Work

When the fall of light on the link (p-n) and each electron has more energy than 1.1 electron volts, will consists of a pair of except for electrons and holes in the area are stated located near the transit between the p-type and n area and cause positive ions in n while gravitating holes towards the negative ions in the P this leads to the concentration of free electrons in the n-type region are stated in a letter to the moving current impact spreading away from the transit area and are stated n headed towards the edge of the far right, while the of perforations current moves far north [12]

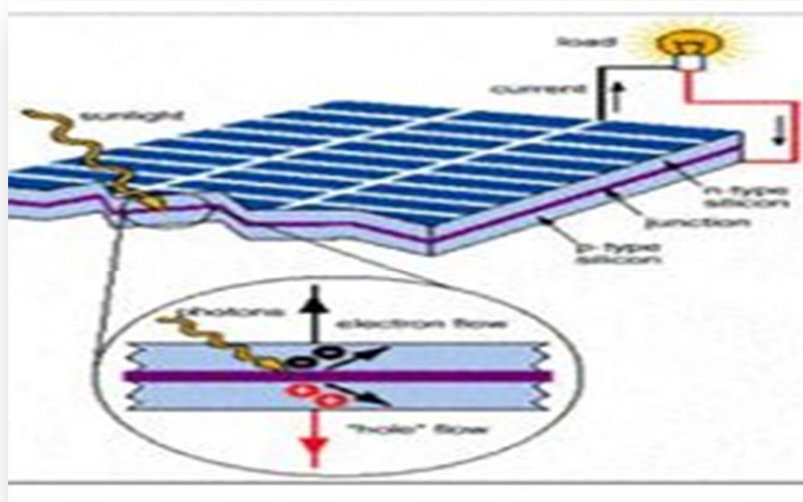


Figure 3-1: solar cell work

3.4 Efficiency Solar Cell

There are three variables used to study the performance of the solar cell of the type P-N which is the main parameters of the left solar cell:

Short circuit current I_{sc} :-

Is a closed-circuit current which passes through the interface under the influence of Luminosity when the neutralization is equal to zero effort and be the upper limit of the current short circuit generated from the material of the cell is linked to a flood of photons Fallen, which owns more energy from the energy gap prohibited substance that can generate pairs of (electron -photon) can calculate this energy in terms of the wavelength of the incident photons.

$$E_{ev} = \frac{1.24}{\lambda} \quad (3.1)$$

We find that the smaller the gap width banned the short circuit current density increases because much of the Fallen photons possess sufficient energy to produce a pair (electron - gap).When the fall of light on the divider bilateral component of the solar cell to be current by the equation

$$I = I_0(e^{BV} - 1) - I_{Ph}(3.2)$$

To find a small stream circle I_{sc} find current at $V = 0$

$$I = I_0(e^0 - 1) - I_{Ph}(3.3)$$

$$I_{sc} = -I_{Ph}(3.4)$$

Open circuit voltage V_{0C} :

Calculated from the relationship:

$$V_{0C} = \frac{AKT}{q} \ln \left[\frac{I_{Ph}}{I_0} + 1 \right] (3.5)$$

Where: I_{ph} is current generated optically I_0 is the only current bilateral beam to get the highest value for V_{0C} I_0 must be as small as possible.

3. FF filling factor

Defined according to the equation:

$$FF = \frac{P_m}{V_{0C} I_{SC}} (3.6)$$

Is considered a measure of the output characteristics of reference and value for cells with acceptable efficiency, be between 0.85 - 0.7 [7]

3.5 Types of Solar Cells

1. Crystalline Silicon Cells Unilateral

Until recently, most cells manufactured from pure silicon with a continuous structure without impurities. Monocrystalline silicon monocrystal is usually made from small grains of crystal. Drawn slowly melted of the mass of silicon. Multi-crystalline, the efficiency of this type of cells reach 11-16%, which means that the absorption of these cells from the upcoming radiation from the sun its power $1000 \text{ W} / \text{m}^2$, and so on a sunny day near the equator means that the wattage of these cells produces (110-120) W [8].

In spite of high-efficiency feature that are specific to these cells, but the price tag is too high they are made from multi-high purity crystalline silicon

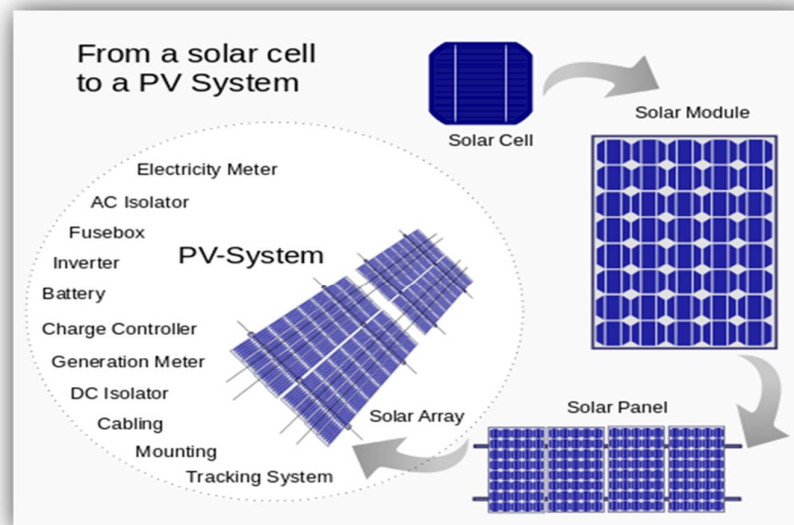


Figure 3-1: solar cell to PV- system

2. Multi-Crystalline Silicon Cells

Multi-crystalline small granules of silicon crystal composed and can produce a thin layer of the multi-crystalline silicon by alloy formation of multi-crystalline silicon dissolved and then cut into slices square the. Many Cells crystalline wafers of silicon crystals scraped off of the cylindrical silicon chemically treated in furnaces to increase electrical properties and then paint the surfaces of cells in anti-reflective, These cells have an open circuit voltage of .5V DC and a short circuit current of 155mA despite the fact that the cells of this type of cells are cheaper and easier than unilateralism cells crystallization but they are less efficient because efficiency up 9-13%, because the charge carriers generated before [16].

3. Gallium Arsenide Cells

Silicon is not the only material used in the photovoltaic industry, there gallium Arsenide which owns the structure of crystalline similar to silicon as consisting of successive atoms of gallium and the arsenide with a high absorption for the light coefficient, can work under the temperature conditions somewhat without a decrease in its performance cells silicon and cost high higher than the cost of silicon cells and used this kind in space applications.

Gallium arsenide is used in the manufacture of devices such as microwave frequency integrated circuits, monolithic microwave integrated circuits infrared light-emitting diodes, laser diodes, solar cells and optical windows[5].GaAs is often used as a substrate material for the epitaxial growth of other III- V semiconductors including: Indium gallium arsenide, aluminum gallium arsenide and others[9].

4. This kind with the membranes of cells (zero crystallization)

And the silicon material are deposited on the body thin layers on the surfaces of glass or plastic, so that its technology is characterized by easy but less efficiency

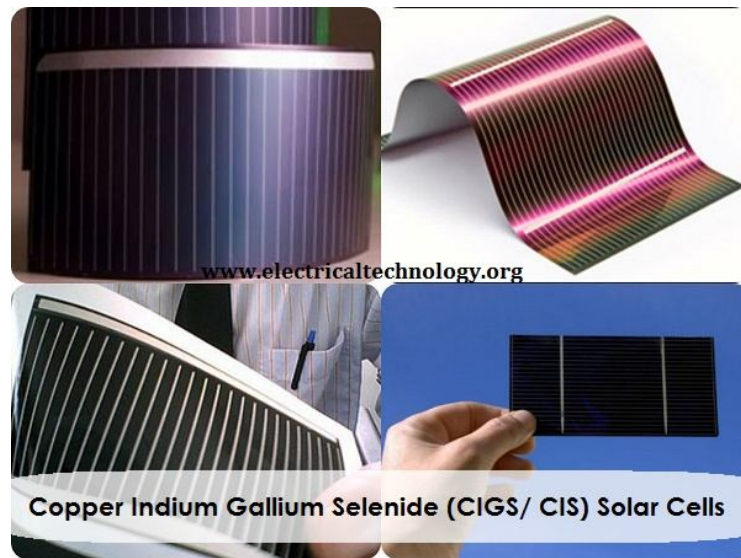
• *random silicon cells*

Silicon atoms are in this type of arrangement is less of the kind of crystalline cells, there is no correlation complete with the neighboring atoms are connected as linked to the so-called ligament Dangler. The manufacturing process are made by mixture of a gas contains silicon and hydrogen (SiH_4) (a small amount of impurities such as boron, which decomposes electrically by a way that could be a thin layer of silicon on the random pillars Suitable flexible as steel material, hydrogen and The hydrogen gas by providing electrons contains additional combine with silicon links dangling to be a layer of silicon, hydrogen and affect impurities present in the gas distribution charge carriers to improve printability conductivity of the material, of the features of these cells it thinner and cheaper than silicon cells are crystalline and more absorption for the solar beam It is an appropriate solar cells to not continuous use and efficiency of up to 12% and decreases with exposure to the sun for random silicon cells differ from cells manufactured for the area correlation (P - N) This type of cells have an area called (P - IN)

• *The copper indium selenite cells*

A semiconductor composites of copper, indium and selenite (CIS) and reaches the efficiency of this type of cells to 12% and cons of this type is limited in the membrane thickness slave to these cells is greater than the random silicon cells .Sometimes CI (G) S or CIS cell) is a thin-film solar cell used to convert sunlight into electric power. It is manufactured by depositing a thin layer of copper, indium, gallium and selenite on glass or plastic backing, along with electrodes on the front and back to collect current. Because the material has a high absorption coefficient and strongly absorbs

sunlight, a much thinner film is required than of other semiconductor materials [17].



- ***Cadmium cells telluride (CdTe)***

Another semiconductor material suitable for the use of photovoltaic cells, the pros of these cells is the ability to manufacture using simple and cheap operations of electroplating¹

Cadmium telluride (CdTe) is a stable crystalline compound formed from cadmium and tellurium. It is mainly used as the semiconducting material in cadmium telluride photovoltaic and an infrared optical window. It is usually sandwiched with cadmium sulfide to form a p-n junction solar PV cell. Typically, CdTe PV cells use an n-i-p structure CdTe is used to make thin film solar cells, accounting for about 8% of all solar cells installed in 2011[12].

5. Nano-cells

The efficiency measure of the ability of the solar cell a certain area (be Surface) coming from the sun energy is absorbed and converted by (30%) into electrical energy, and there are several types of relevant competencies and different features solar cells, but there is a theoretical efficiency of the different solar cells. Among the most famous of solar cells, which have been

marketed are silicon cells of 27.5% efficiency and this percentage seems small, but if we assume that we have a solar panel (made up of several cells) with an area of one square meter box, Will be produce 275 watts, this energy is covered energy consumed cost b \$ 12 per year, but These techniques Not used, the proportion of the high cost of manufacturing solar cells from silicon to these efficiency of 27.5% per square meter is \$ 150, and here comes the role of nanotechnology (micro) in Materials Engineering atomic-sized (very small)[8].Potential in nanotechnology and advance may open the way for the production of solar cells is slightly cheaper and more effective. The solar cell is inexpensive also help in provide electricity to rural areas or Third World countries. Solar cell industry has grown rapidly in recent years due to the by strong interest in the field of renewable energy, and the problem of global climate change. Nanotechnology has already shown significant breakthroughs in the field of solar energy. Nanotechnology may be able to increase the efficiency of solar cells, but this most promising application of nanotechnology is to reduce the manufacturing cost. The use of Nano technology in solar cells inexpensive help to preserve the environment.

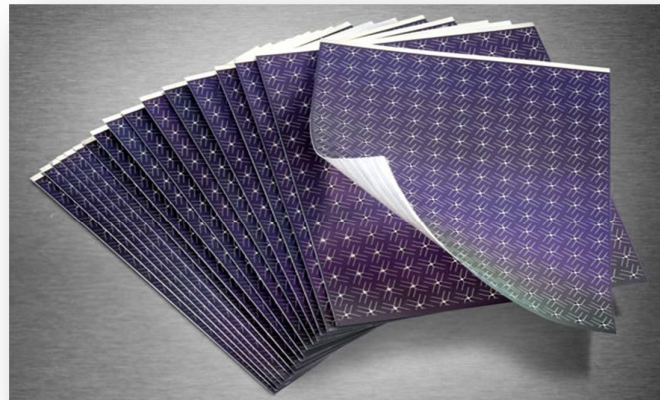


Figure 3-2: Nano solar

Nano structured layers in the solar cell film offers three important advantages.

First: due to multiple reflections, effective optical path is much larger than the thickness of the absorption of the actual film.

Secondly: the light generated electrons and holes need to go through a much shorter path and thus reduce recombination losses to a large extent. As a result, the absorption layer thickness in Nano-structured solar cells can be thin up to 150 nm instead of several micrometers in conventional solar cells, thin.

Third: the energy gap of the various classes can be tailored to the desired value of the design by changing the size of the Nano-particles.

Chapter Four

Manufacturing of Nano Solar cells

4.1 Introduction

Nanotechnology is the engineering functional systems at the molecular level. This includes both the current work and concepts that are the most advanced. The original sense, 'nanotechnology' refers to the projected ability to build elements from the bottom to up, using tools and techniques that are being developed today to make complete, and high-performance products

The Nanotechnology is a unit of metric measurement so that one nanometer is equal to one molecule of billionths of a meter (or a millionth of a millimeter), and at reducing the materials to the Nano scale size, material properties greatly vary from physical terms (for example: gold color becomes red when Nano scale particle diameter of 10 nm gold). It is a chemical hand interaction of nanoparticles dramatically increased rate compared to the bulk or large materials, and nanomaterial's famous use in the manufacture of solar cells is known as quantum points, lead sulfide, which is the most famous quantum dots for excellence absorbs infrared radiation energy[9].

4.2 Forms of Nanomaterial's

Nano materials take several forms for each installation and the characteristics of the measure of the diameter and length, and each of them uses of distinctive; too, it can be classified as nanomaterial's shape to

First: quantum dots: These are the installation of a Nano quasi-three dimensional conductive several ranges between 2 and 10 nanometers.

Second: The installation of a nan Fluorine strange carbon is a molecule consisting of 60 carbon atoms, and molecules Fluorine spherical

resemblance of a soccer ball. The Buckyball ratio has been named to the inventor architect (Buckminster Fuller).

4.3 Types of Nanomaterials

1-Nanoparticles balls: the most important carbon nanoparticles balls that belong to the fluorinated category, which differs slightly in structure where its multiple layers as it is an empty space.

2- Nanoparticles: particles that the word modern use of nanoparticles, but the particles were found in nature, or of manufactured goods since ancient times and could nanoparticles as an atomic or molecular grouping microscopic definition ranging in size from a few atoms to one million atoms.

3- Nanotubes: These are segments of folds are cylindrical and are often open end of the pipe and the other sealed a semi-circle, made the tubes from organic materials or inorganic enjoy this pipeline strength and solidity and electrical conductivity [10].

4.4 Fiber nanoparticles

Characterized fiber nanoparticles that surface area to a large scale as the number of large surface atoms for the total number, and take several forms as the six-party fiber and spiral fiber-like grains of wheat compounds nanoparticles: These are substances added to it nanoparticles during the manufacture of those materials.

It has been identified classification of Nano material's into several sub-categories, according to the identity and similarity of their properties and their applications in diverse fields and can be summarized as follows:

- metals and metallic liquid
- ceramic material

- Polymers
- Overlapped materials

4.5 Fluorine

Fluorine is one of the four types of naturally occurring forms of carbon, first discovered in 1980 carbon molecules composed entirely and takes the form of a hollow sphere or tube. They are similar in structure of graphite, which includes carbon paper hexagonal rings, but they contain pentagonal rings or Seven, which enable the three-dimensional structures to be formed. Fluorine is produced in small quantities naturally in the fire, but it was noted for the first time in the soot caused by ablation of graphite with a laser.

4.6 Nanotubes [8]

Carbon nanotubes (CNT) is the particular form of the fullerene form, which is similar in structure to the carbon, but to form an elongated tubular structures, 1-2 nm in diameter. It can be produced in its simplest form, with very large proportions and can be 0.1 mm in length. In its simplest form, including nanotubes and a single layer of carbon atoms arranged in a cylinder, known as the single wall Carbon nanotubes as they can be, as several concentric tubes formed center (multi-wall carbon nanotubes) with diameters of up to 20 nm, and the length of 0.1 mm. Carbon nanotubes have a great tensile strength, and is considered to be 100 times stronger than steel, while being just one-sixth of its weight, making them potentially more powerful and smaller fibers known. And they also show a high conductivity, high space, a unique kind of electronic properties of molecular absorption and potentially high capacity. Applications that are currently being investigated include polymer compounds (conductive and structural filler), electromagnetic shielding, electron field emitters (flat panel displays), super capacitors, batteries, hydrogen storage

materials and structural composite. A major focus of current research on nanotubes on the cobalt production rates even kilogram (or more) amounts because many applications require large quantities. As has been nanotubes of other materials, including the production of silicon and germanium.

4.7 Quantum Dots

Considered quantum dots one of the forms of the most famous of nanomaterial's, so named because the electrons which are enclosed in three dimensions (length, width and height), i.e., that quantum dots are Nanoscale nanomaterial's (hundreds of atoms only) enclosed materials have energy gap higher (and we mean here the energy needed by an electron gap card in order to be liberated from corn), this quantitative limitation of electrons in the three-dimensional earn these quantum dotsUnique property in dealing with light effectively making it a perfect candidate to form a solar cell. The picture below micrograph point's quantum dotsshow atoms scattered on both sides of the quantum dots[9].

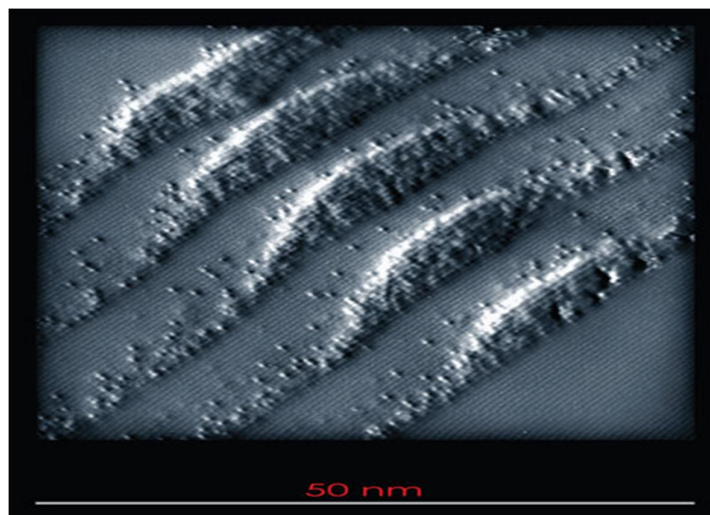


Figure 4-1:Quantum dots

The Nano materials at the quantum dots possess high efficiency in converting light into electricity due to quantitative limitation for electrons and referred to earlier, which means that the photon and one could cause the release of more than electrons and therefore gives higher efficiency solar cell and figure below represents what is happening in the solar cell containing the amount of points

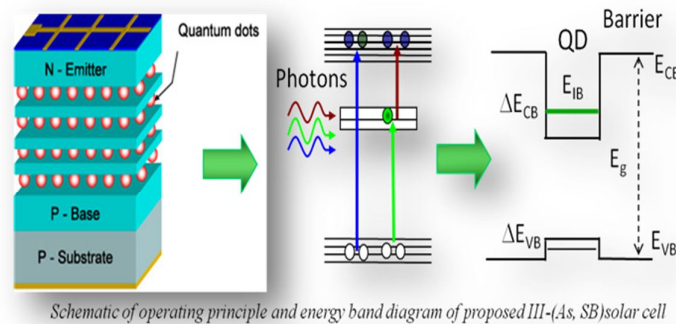


Figure4-2: Band diagram of proposed (As,Sb)solar cell

was established method for the installation of quantum dots, semi-free impurity material, which caused discharge power is not useful, but rounded quantum dots treats the surface of quantum materials from impurity iodized materials, which lead to the reduction of the proportion of dopant materials, which allow the production of electrons larger even It is coopted, beside the material lead sulfide. While zinc oxide particles which ranges molecule diameter between 15-20 nm is responsible for the transfer of electrons and polarized to the outer electrons so that the outer electrons connected to an electrical circuit to generate electrical power in[9].When points absorbs a quantum of light from the sun, are issued electrons contain energy, to attract the electrons out of quantum dots to the circuit, which is the generation of energy, and that is not attracting the electrons, the electrons give energy to the ocean or the neighboring in thermal energy is useful, because the transfer of electrons from the quantum dots through the zinc oxide particles, and must be carefully installed zinc oxide particles so that there will not be impurity

materials Working on electrons leaking .Improving the efficiency of solar cells using semiconductor quantum dots (QD) and one from the starting point to increase the efficiency of the conversion of the solar cells is the use of semiconductor quantum dots (QD). Using quantum dots, the band gaps can be adjusted specifically for the conversion of light is also the longest wave, thus increasing the efficiency of solar cells. These solar cells are so-called quantum point is, at the present time are still subject to basic research. As physical systems for solar cells QD, semiconductors and other materials such as Si / Ge or C / T / C combinations were considered. The potential for these solar cells Si / Ge QD advantages are:

- 1- Higher absorption of light, particularly in the area spectral infrared,
- 2- Compatibility with standard silicon solar cell production (in contrast to the third / V semiconductor)

- 3- Increase the current image at higher temperatures.

- 4- Improve the radiation hardness compared to conventional solar cells.

In versions of nanotechnology in the long term it should cost bellow, and the use of quantum dots, and should be able to reach higher levels of efficiency that traditional.

Coat Nanoparticles with quantum dots semiconductor crystals small connectors. Unlike traditional materials which one photon generates only one electron, quantum dots have the ability to high energy conversion. Quantum dots work the same way, but they produce three electrons for every photon from the sun's rays that strike points. Moving electrons from the valence band to the conduction band between the points also attract more of the spectra of sunlight waves, thus increasing conversion efficiency of up to 65 percent. The other area of quantum dots can be used is a creation of the so-called hot carrier cells. Usually additional power provided by photon loss in the form of heat, but with a hot energy carrier excess cells of photons leads to electrons higher energy, which in turn leads to a higher voltage and the transfer of electrons through the network of the particles is a major problem in higher efficiency to achieve convert the image in the pole nanostructured.

Solar cells manufactured of quantum dots only includes simple existent devices in most laboratories in the world, so there is hope that this article nanoparticles tops in the field of solar energy and contribute to reducing our use of substances harmful to the environment, nanotechnology may be able to increase the efficiency of solar cells, but the application the most promise of Nanotechnology is to reduce the manufacturing cost. Find out where chemists at the University of California, way to produce cheap plastic solar cells that can be painted on virtually any surface, events generated by these solar cells, the new plastic is only about 1.7%, These solar cells new plastic benefit from the tiny Nano rods are dispersed within a polymer, behave bars nanoparticles aswires because when the light-absorbing specific wavelength is generated by electrons long, flowing electrons through the bars of nanotechnology until it reaches an electrode made of aluminum which combine to form a stream and used as electricity , this type of cells with a manufacturing cost less than conventional cells for two main reasons; The first is that these plastic cells are not made of silicon, which can be expensive. Second, the manufacturing of these cells does not require expensive equipment such as chambers clean and vacuum chambers traditional silicon solar cells. Another possible advantage of these solar cells is that the Nano-rods can be adjusted or twelve tuned to absorb a variety of wavelengths of light, this can significantly increase the efficiency of the solar cell because it can be utilized more of the incident light There is research going on in order to put an end to the conflict existing between achieving high efficiency and low cost solar cells, where they are using colloidal quantum dots. They semiconductor particles in diameter does not exceed a few nanometers, these particles can be sprayed as a commentator on large flexible substrates. And quantum dots represent a material system can be tuned with a high degree, where you can determine the band gap not only by selecting semiconductor material, but also by the particle size ,Any solar system seeks to achieve returns converting very high energy, it is necessary to collect from the sun efficiently large energy photons (blue) high-energy, and that is absorbed as well as photons (infrared) with a low-power,

and through the solar devices composed of cells multi surfaces, any layers of light-electric cells have a Gaps different range and placed on top of each other, and will combine the capacity of each layer within the device or through an external circuit [5].Enable developing a solar-efficient cells, where it was put very thin membrane of nanoparticles silicon single nanometer size directly in the solar cell silicon, he found that it increases the production of electrical energy efficiency by 60% when the work of the cell in the in UV range of the solar spectrum. As possible to improve productivity in the range of visible light spectrum by 10%, using nanoparticles the size of 2nm.

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

Nanotechnology is the second industrial revolution, social, economic and environmental benefits, and applications in the field of energy, particularly solar energy. After the rapid expansion of research and technological development, research is still in its early stages, the solar modules nanoparticles in the future may provide the benefits such as the flexibility reduce costs, generate clean energy and efficiency of 65%, compared to about 20 to 25% for the first generation, crystalline silicon PV cells based P managed to provide many and promising solutions, and we conclude from this study, the following results:

1. There is now an increasing interest and compete seriously about investing in the development of programs and of alternative energy technologies, particularly solar energy and embrace this green technology to become the main source of energy, particularly the Middle East and Central and North Africa.
2. Cost is an important factor in the success of solar technology.
3. Efficiency is a measure of the ability of a certain area of the solar cell (by be square meter) coming from the sun and convert it into electrical energy absorption of energy, and there are several types of efficiencies with different features of solar cells.
4. Properties of materials differ greatly when reduced to Nano scale size of the physical and chemical locality.
5. The advances potential in nanotechnology could open the door to the production of cheaper and more efficient solar cells, which helps in providing rural electricity or Third World regions.

6. Nanotechnology may be able to increase the efficiency of solar cells, but the most promising application of nanotechnology is to reduce the manufacturing cost.
7. Possibility of nanotechnology improve performance of solar cells dependent on semiconductors to become dependences and suitable for the generation of electrical energy from the sun's rays with high efficiency conversion.
8. Replacement of Nano-materials technology semiconductor solar cells from organic materials are cheap and with the highest efficiency.
9. Nano-materials energy saves about 220 Watt, the highest value of conventional solar cells.
10. Solar cell hybrids (combination of materials / polymer organic, blended with semiconducting inorganic materials) one of the alternative technologies to harness of solar energy into electrical energy to overcome the high cost of conventional solar cells.
11. Application of nanotechnology in solar cell hybrids has opened the door for the manufacture of a new class of high-performance devices.
12. adjustments could be made to the structure of the solar cell is also improvement of radiation rigidity, low mass, and improve the structural flexibilities for future devices, this nanotechnology could lead to the development of conformal, efficiency to more than 30%.
13. The Nano-rods could be synthesized or tuned to absorb a variety of wavelengths of light, this can significantly increases the efficiency of the solar cell because it can be taken advantage more of the incident light.

5.2 Recommendations

- Material and moral support and revitalize the search traffic in the areas of solar energy.
 - Reload uses of solar energy in the Arab world and the limitation studies and evaluate what existing ones.
- Making-out projects and large and a somewhat useful another source of energy and the training of cadres in addition to not repeat them, but diversifying in the Arab countries to make use of all solar energy applications
- Activate scientific exchange scientific advice between the Arab countries in the development of solar cell industry and developed using the nanotechnology ways, by holding seminars and periodical meetings.
- Application of all the ways of rationalizing energy conservation and study the best its roads in addition to support of which use of solar energy in their homes citizens.
- Encourage cooperation with developed countries in the use of nanotechnology and to benefit from their expertise to be built on the basis of equality and mutual benefit.
- Forming scientific committee is working on the study and follow up the developments of what has been reached in the field of nana-technologies and their effectiveness in increasing the efficiency of solar cells reduce the cost of manufacture.
- Necessity with aid of decision-makers by experts in nanotechnology in local universities and international research centers to get the recommendations of everything related to the use of nanotechnology in reducing the cost of solar cell manufacturing.
- Conducting research with a view to put an end to the opposed existing between achieving high efficiency and low cost solar cells using, for example. Semiconductor particles not exceeding a few Nanometers in diameter.

References:

- [1] Ying Guoi, Alan L. Portrait, Lu, January 2017, Nanotechnology-Enhanced Thin-Film Solar Cells Analysis of Global Research Activities with Future Prospects
- [2] AL mantasPivrikas, Helmut Neugebauer, (October 2012), Influence of processing additives to Nano-morphology and efficiency of bulk-hetero junction solar cells à comparative review.
- [3] Lorena Macro, Roberto Gómez, (July 2009), Improving the performance of colloidal quantum-dot-sensitized solar cells.
- [4] Minatorivola and Jan haulm, (September 2009), Nanostructured dye solar cells on flexible.
- [5] Shengs, li semiconductor physical electric's, plenum press – New York 1993.
- [6] System pricing trends – historical, recent and photovoltaic. 22 September 2014.
- [7] Theodore, L. and Kunz, R. Nano technology, Environmental Implications and Solutions. John Wiley. New Jersey (2005).
- [8] Brazil, M. R.; Still man, G. E. (1996). Properties of gallium arsenide. IEEE In spec. ISBN 0-85296-885-X.
- [9] Cetinkunt S (2008) Mechanical engineering. Personal Communication University of Illinois, Chicago (done by Seagull & Theist (2010).
- [10] WWW.PHOTON-MAGAZINE. COM.
- [11] <http://ar.wikipedia.org/wiki>
- [12] محمد عمار , الطاقة , مكتبة النهضة المصرية – القاهرة , اغسطس 1998 م.
- [13] د. بشير هاشم , مبادئ الطاقة الشمسية , الطبعة الثانية – الكويت 1994 م.
- [14] احمد خوجلي , الطاقة الشمسية وإمكانية إستغلالها- الخرطوم , بدون طبعة.
- [15] اجهزة الطاقة الشمسية , إبراهيم محمد القرضاوي . مركز دلتا للطباعة والنشر – الإسكندرية , بدون طبعة.
- [16] مارتن أوكوين , الخلايا الشمسية مبادئ العمل والتقنية , ترجمة يوسف مولود حسن - الموصل 1989 م, بدون طبعة.
- [17] احمد خوجلي , فيزياء الجوامد , الطبعة الثانية – الخرطوم 2000 م.