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Nanostructure in Solar Cell

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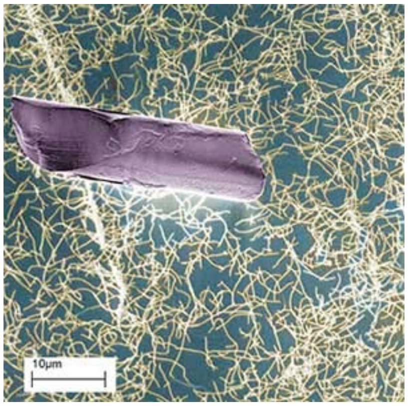
Abstract—*The purpose of proposal of this paper is to consume power and give abundant power generation of the future technology. As we know that the nano structure or a particle is very small in dimention , So by using this property we can implement a nano structure in solar cell for abundant power generation. The main purpose of using solar energy is it is renewable resource, so there is continues production of energy. So we have combined both the nanotechnology and solar energy for future technology.*

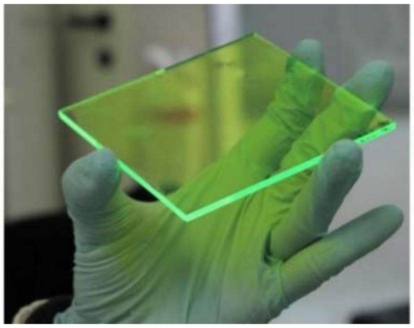
1. INTRODUCTION TO NANOTECHNOLOGY

“The value of nanotechnology is almost everywhere. The challenge is to ensure that we use nanotechnology to become the architects of a better life, not the architects of our own destruction.” “Nanotechnology gives an opportunity to South Africa to be the best in the world in multiple fields of research”

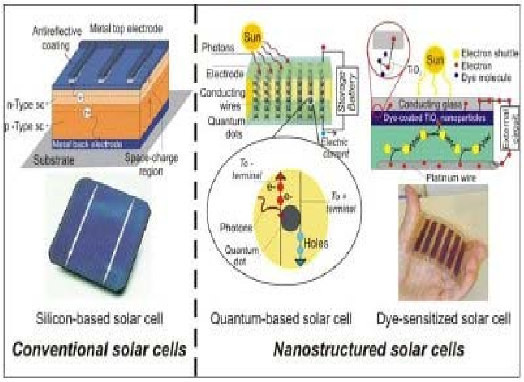
The design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/superior characteristic or property.



Human hair fragment and a network of single-walled carbon nanotubes It seems that a size limitation of nanotechnology to the 1-100 nm range, the area where size-dependant quantum effects come to bear, would exclude numerous materials and devices, especially in the pharamaceutical area, and some experts caution against a rigid definition based on a sub-100 nm size. Another important criterion for the definition is the requirement that the nano-structure is man-made. Otherwise you would have to include every naturally formed biomolecule and material particle, in effect redefining much of chemistry and molecular biology as 'nanotechnology.' The most important requirement for the nanotechnology definition is that the nano-structure has special properties that are exclusively due to its nanoscale proportions. Nanostructured materials are used in the development of a new generation of efficient solar cells, but challenges in the characterization and fabrication of these cells delay commercial adoption.



The success of photovoltaics as a renewable energy technology arguably rests on two numbers: the efficiency of conversion of solar energy into electricity and the cost per watt of produced power. Silicon solar cells, which command the largest market share, reach a power-conversion efficiency of 25.6%[1]; this value is reduced in commercial products, and cannot exceed 29%.



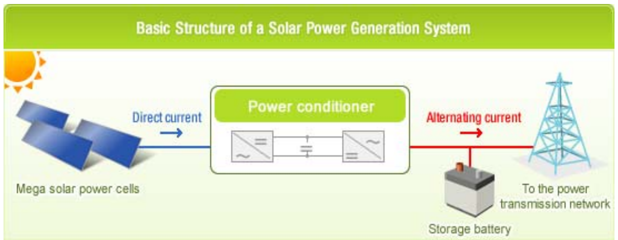
Indeed, a fundamental limit introduced by Shockley and Queisser caps the efficiency of any solar cell based on a single p–n junction (a junction between positively and negatively charged volumes) to about 33% or less, depending on the bandgap of the material and on the illumination conditions[2]. Furthermore, silicon solar cells are expensive because of the raw materials used (monocrystalline silicon wafers) and the installation required. These cells are also rigid and relatively heavy. As a result, new materials and device architectures are actively sought.

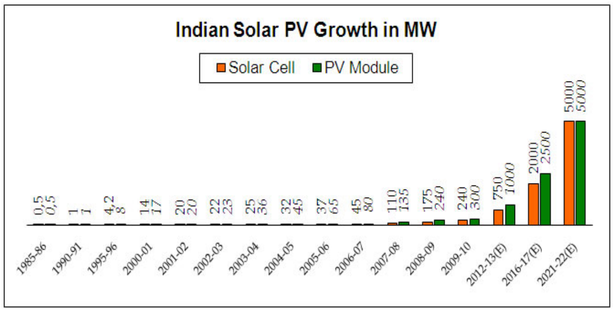
2. SOLAR CELL POWER GENERATING SYSTEM:

A **solar cell**, or **photovoltaic cell**, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels. Solar cells are described as being photovoltaic irrespective of whether the source is sunlight or an artificial light. They are used as a photodetector (for example infrared detectors), detecting light or other electromagnetic radiation near the visible range, or measuring light intensity.

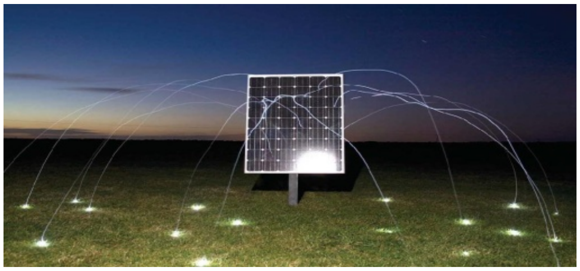
The operation of a photovoltaic (PV) cell requires 3 basic attributes: The absorption of light, generating either electron-hole pairs or excitons.The separation of charge carriers of opposite types.The separate extraction of those carriers to an external circuit.

Efficiency may be the first parameter you think of when you hear the word *photovoltaics*. However, a less-talked-about factor can have a big impact, too—how thin a solar cell is. Researchers have recently come up with new ways of slimming down cells using structures smaller than the wavelengths of visible light.





3. NANO STRUCTURE TO CATCH LIGHT



"The main aim is to use as little material as possible to absorb sunlight," associate professor of electrical engineering at Stanford. High-efficiency materials, such as III-V semiconductors and crystalline silicon, are expensive. With other materials such as amorphous silicon, cost is less of an issue, but the electrons and holes that carry charge travel only short distances before being lost as heat. "The thinner the cell gets, the easier it is to get the carrier out," Fan explains. However, the thinner a solar cell is, the more likely that photons will pass right through it before they can be absorbed.

Commercial crystalline silicon cells can be 180 micrometers thick, Fan says. But some companies are pushing to get down to 50 µm, while his lab and other researchers are aiming for designs that are only a micrometer or two thick. In theory, techniques such as adding random nanoscale texturing to the surface of cells could enhance light absorption by as much as 50-fold, Fan says, by changing the angles at which photons travel through the cells, but nanophotonics can improve that by another factor of 10.

One approach is called plasmonics. Photons striking small, metallic structures can create Plasmon, which are oscillations of electron density in the metal. The effect can increase the scattering of light within the solar cell, giving it more of an opportunity to absorb the photons. Vivian Ferry, a postdoctoral researcher at Caltech, says her team is creating plasmons using hemispheric bumps on the contacts of a 90-µm-thick solar cell made of hydrogenated amorphous silicon. Ferry says the nanostructured device produces 15 percent more current than a commercially produced, randomly textured solar cell.

Another nanophotonics trick in the works is using photonic crystals to construct reflectors. Photonic crystals are periodic structures with features smaller than the wavelength of the light they are designed to deal with. Miro Zeman, who heads the photonics materials and devices group at Delft University of Technology, in the Netherlands, says his lab has built photonic crystal reflectors at both the back of the cell and in the middle. The reflectors force light to bounce around inside the silicon, increasing the chances that it will be turned into electricity.

Another photonic crystal scheme would use the structures in a 1-µm-thick layer of crystalline silicon. According to Ounsi El

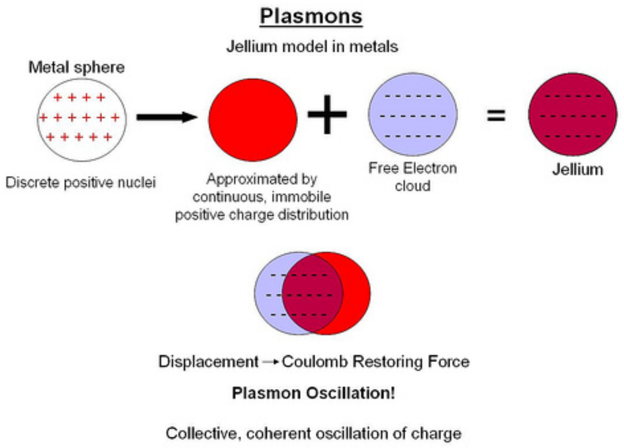
Daif, a researcher at Imec in Leuven, Belgium, the photonic crystal layer can then be joined to an amorphous silicon layer. Because the film is so thin, "traditional texturing techniques cannot really work in this case," El Daif says. Theoretically, he says, such a photonic crystal could increase photon absorption by 37 percent.

These technologies are still years from being commercial products, Fan says. But they might be worth the wait.

4. PLASMONIC OSCILLATION

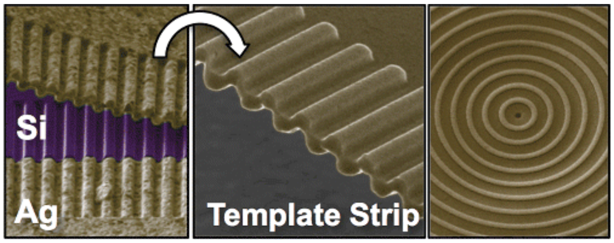
Plasma oscillations, also known as "**Langmuir waves**" (after Irving Langmuir), are rapid oscillations of the electron density in conducting media such as plasmas or metals. The oscillations can be described as instability in the dielectric function of a free electron gas. The frequency only depends weakly on the wavelength of the oscillation. Thequasiparticle resulting from the quantization of these oscillations is the plasmon.

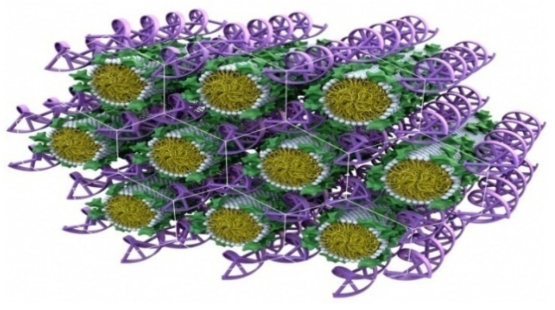
Langmuir waves were discovered by American physicists Irving Langmuir and Lewi Tonks in the 1920s. They are parallel in form to Jeans instability waves, which are caused by gravitational instabilities in a static medium.



5. BUMPING PLASMONS

Plasmons using hemispheric bumps on the contacts of a 90-μm-thick solar cell made of hydrogenated amorphous silicon. The nanostructured device produces 15 percent more current than a commercially produced, randomly textured solar cell.





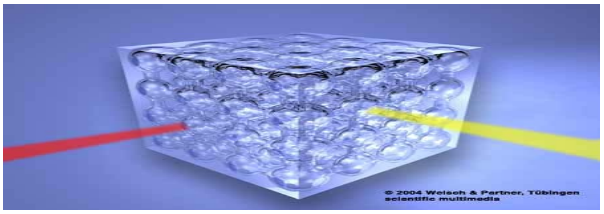
6. PHOTONIC CRYSTALS

Another nano photonics trick in the works is using photonic crystals to construct reflectors. Photonic crystals are periodic structures with features smaller than the wavelength of the light they are designed to deal with. Micro Zemen, built photonic crystal reflectors at both the back of the cell and in the middle. The reflectors force light to bounce around inside the silicon, increasing the chances that it will be turned into electricity. Theoretically, he says, such a photonic crystal could increase photon absorption by 37 percent.

Photonic crystals are nanostructures that affect the motion of photons in much the same way that ionic lattices affect electrons in solids. Photonic crystals occur in nature in the form of structural coloration and promise to be useful in different forms in a range of applications.

Photonic crystals can be fabricated for one, two, or three dimensions. One-dimensional photonic crystals can be made of layers deposited or stuck together; two-dimensional ones can be made by photolithography, or drilling holes in a suitable substrate. Fabrication methods of three-dimensional ones include drilling under different angles, stacking multiple 2-D layers on top of each other, direct laser writing, or, for example, self-assembly of spheres in a matrix and dissolving the spheres.

Photonic crystals can in principle find uses wherever light must be manipulated. Existing applications include thin-film optics with coatings for lenses. Two-dimensional photonic-crystal fibers are used in nonlinear devices and to guide exotic wavelengths. Three-dimensional crystals may one day be used in optical computers.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7. PROPOSED SYSTEM

When a Nanostructure setup can produce a increased range of current when compared to the normal solar cells Plasmonic Cell = 37% + (Solar cell) Hence if we introduce A VOLTAGE

D+OUBLER it can rise the output and this energy can be utilized to run not only the low watt appliances but also the higher , even a machine.

Note: This is the first innovation were the solar energy can be used to run a machine even.

8. ADVANTAGES OF THIS PAPER

Here are a few of the advantages that Nanosolar's technology has over other types of photovoltaics.

Instead of using glass as a substrate, like First Solar and other thin film manufacturers do, Nanosolar uses aluminum foil. This has three advantages: One, foil is much cheaper (one or two cents per square foot and mil thickness). Two, it enables them to make the cells in a "roll-to-roll" process, turning a roll of foil into a roll of 50,000 cells in one continuous loop. (Check out their video to see their process in action.) Three, the end result is very lightweight and adaptable to many applications.

Nanosolar may be able to produce its modules more cheaply than any other manufacturer.

Until now, First Solar's module manufacturing cost has been the lowest in the industry, at about 87 cents per watt. Nanosolar has not yet announced its manufacturing cost or module pricing because it is only targeting utility-scale projects where the price is customarily undisclosed. (At this time, the company does not have a product for the retail market, but reports that one is in development.) But in an e-mail response to my inquiry, Nanosolar CEO Martin Roscheisen stated that his company is "planning to demonstrate that our capital efficiency is three times as good as First Solar's."

"Capital efficiency" is a broader metric than cost per watt, including the cost of building a fabrication plant and other costs. As recently as last year, Nanosolar believed it could potentially deliver product to the market at 1/10th the cost of traditional silicon, and build physical plants with roughly 1/10th the capital. I did not receive a direct answer on whether this is still their claimed. But it does seem plausible that +Nanosolar will be the cheapest manufacturer in the industry.

The efficiency of Nanosolar's cells is now the highest in the thin-film industry. The National Renewable Energy Laboratory has independently verified that Nanosolar's cells can convert a maximum of 16.4% of the solar energy hitting them into electricity. When the cells are sorted and matched and turned into modules, Nanosolar's median efficiency is higher than 11%, just edging out First Solar's average efficiency of 10.9%. By comparison, traditional silicon modules are about 16% efficient, and hybrid modules like those from SunPower (NASDAQ:SPWRA), are 19.3% efficient — but both types cost more than twice as much as thin-film modules.

Nanosolar has incorporated several important innovations in the design of their Nanosolar Utility Panel^{TM} modules. With their solar foil hermetically sealed between two sheets of tempered glass, their modules are mechanically stronger, more durable, and more lightweight than other thin-film modules, so they can be made in larger sizes and eliminate the need for bulky aluminum frames. They claim their modules are able to span 1.7 times the distance between rails that First Solar's modules can, reducing the need for mounting rails by 41% and significantly reducing the installation labor. Their thin profile also allows the company to ship more than three times as many kilowatts-worth in a shipping container as First Solar can, reducing shipping costs.

Nanosolar's panels can carry six to seven Amps of current, compared with one Amp for First Solar's panels, which minimizes resistive losses and puts them on par with silicon modules. Consequently, the panels can be strung together in much longer strings before hitting the inverter's voltage input limit. This can reduce the need for cables running back to the inverter — a significant part of the balance-of-system costs — by as much as 73%, and allows arrays as long as 64 meters (versus a 12-meter maximum for First Solar), further reducing installation and cabling costs. The panels are also designed and certified to handle a system voltage of 1500V — 50% higher than the industry standard.

Finally, the modules have an electrical connector on the edge of the module, rather than inside the back of the module, so only a short cable between modules is needed to make the electrical strings. This reduces the labor cost of interconnection by 85%, according to independent third-party testing. Having personally spent many an hour crawling around under arrays fiddling with the wires (and occasionally making costly mistakes in the process), I can tell you this is a terrific innovation.

In total, Nanosolar believes the advantages of its module design will bring the balance-of-system costs for their installations in line with that of traditional high-efficiency silicon modules.

9. SUMMARY

At present the solar cell are use for domestic purposes. By introducing the Nanotechnology in solar cells the efficiency of the current is increased. Bumped Nanostructure increases the output upto 15%.And plasmotic crystal increases the current upto 37%, Finally the future world may depend upon the mixture of Solar and Nanotechnology.

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