SCIENCE BEHIND THE NANO SOLAR CELL

Kshitij Yograj Patil [1] , Dr. Vishali P.Sonawane [2] , Yograj Gorakh Patil [3]

1. Student in First year Engineering , Sapkal Knowledge Hub , Anjneri (NASIK).

2. Asstent prof in Engineering Chemistry ,Brahama Valley,Engg.College,Anjneri –(NASIK)

3.Siniour Executive Officer in Glenmark

ABSTRACT

The Global Warming is today's major problem of the world. Nano-technology has to come as boon in the energy sources in the form of solar –cell. It is eco-friendly device Nanotechnology, with its unprecedented control over the structure of materials, can provide us with superior materials that will unlock tremendous potential of many energy technologies currently at the discovery phase. The quest for more sustainable energy technologies is not only a scientific endeavor that can inspire a whole generation of scientists, but the best way to establish a new economy based on innovation, better paid jobs, and care for the environment

I. INTRODUCTION

As we know that Sun shines approximately 1000 watts of energy per square kilometer of Earth. If all this energy is to be converted into usable forms then it can light up our homes for many centuries that also free of cost. So this energy was collected in the form of panels called as **solar panels**. **Solar panels** are effective way to channelize sunlight and use it for electricity. An array of **solar panels** are also used to convert solar energy into electrical energy.

solar cell were of larger size and having efficiency of 67.4% but changing the panel by silicon nano rods made it possible to capture 96.7% of light. It is also proven safe and does not emit hazardous waste. The use of nano-composite could reduce by 1.5 billion of fuel compensation and reduce CO_2 by 5 billion kg. The coating on panel by using catalyst's reduces pollutants. Silicon panels are efficient and durable. It provides renewable and recyclable energy resources.

Lastly, solar panel is best eco-friendly device as it does not use oil or gas and does not produce waste so with the advent of nano-technology based solar panels. We can effectively and efficiently use solar power as a natural resource.

With the evident effects of environmental neglect, energy all over the world is becoming more and more depleted. There are several sources of energy, and some of them are even natural resources such as wind, solar, and hydro. But even if the sources of energy are natural resources and should be delivered to the people at a lower cost, still, power costs are high due to expenses incurred while generating electricity.

Catalysis is one of the largest area where nanoparticles can be used for reducing pollutants, considerable end products and it is expected that the nanoparticles worth $ 30 billion will be used by the industry annually. Solar power is one of the most renewable sources of energy

II. SCIENCE BEHIND THE SOLAR CELL

Converting sunlight in to electricity

Photovoltaic modules, commonly called solar modules, are the key components used to convert sunlight into electricity. Solar modules are made of semiconductors that are very similar to those used to create integrated circuits for electronic equipment. The most common type of semiconductor currently in use is made of silicon crystal. Silicon crystals are laminated into n-type and p-type layers, stacked on top of each other. Light striking the crystals induces the "photovoltaic effect," which generates electricity. The electricity produced is called direct current (DC) and can be used immediately or stored in a battery.

Solar Cell (multi crystalline silicon)

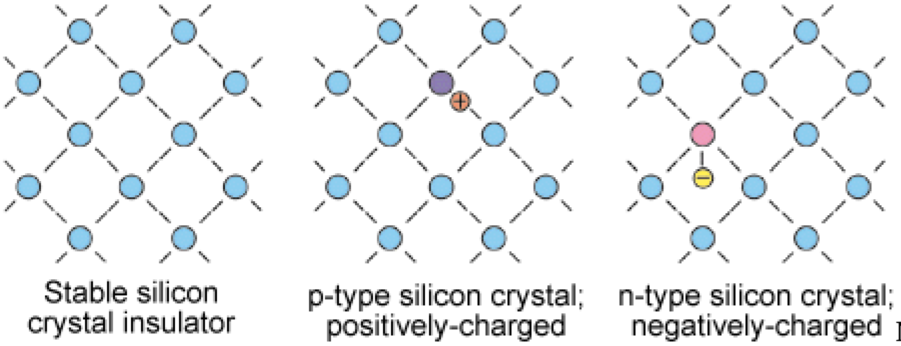
III. POWER GENERATION USING P-N GATE

High purity silicon crystals are used to manufacture solar cells. The crystals are processed into solar cells using the melt and cast method. The cube-shaped casting is then cut into ingots, and then sliced into very thin wafers

IV. PROCESSING WAFERS

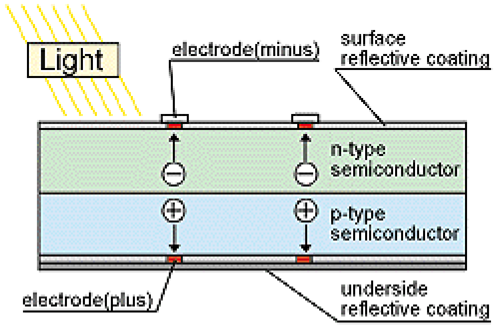
Silicon atoms have four "arms." Under stable conditions, they become perfect insulators. By combining a small number of five-armed atoms (with a surplus electron), a negative charge will occur when sunlight (photons) hits the surplus electron. The electron is then discharged from the arm to move around freely. Silicon with these characteristics conducts electricity. This is called an n-type (negative) semiconductor, and is usually caused by having the silicon 'doped' with a boron film.

In contrast, combining three-armed atoms that lack one electron results in a hole with an electron missing. The semiconductor will then carry a positive charge. This is called a p-type (positive) semiconductor, and is usually obtained when phosphorous is doped into the silicon.



P- N

A p-n junction is formed by placing p-type and n-type semiconductors next to one another. The p-type, with one less electron, attracts the surplus electron from the n-type to stabilize itself. Thus the electricity is displaced and generates a flow of electrons, otherwise known as electricity.



When sunlight hits the semiconductor, an electron springs up and is attracted toward the n-type semiconductor. This causes more negatives in the n-type semiconductors and more positives in the p-type, thus generating a higher flow of electricity. This is the photovoltaic effect.

Direct solar power is a solar thermal collector. It has a dark surface that absorbs sunlight. This causes the surface to get warm. This heat is converted into energy and used in a fluid circuit advantages but to the whole of mankind.

V. ADVANCED NANOMATERIALS FOR FAST AND EFFICIENT ENERGY STORAGE

Solar cells are also being effected by nanotechnology. Not only can they be protective with the coatings mentioned above, but scientists have engineered ways to make lightweight and more efficient photovoltaic cells using nanotechnology to react to sunlight more quickly, channel power with less energy loss, and give solar panels new flexibility..So solar cell is made in the form of nanorods.

This potential feature of these solar cells is that the these rods could be 'tuned' to absorb various wavelengths of light. This could significantly increase the efficiency of the solar cell because more of the incident light could be utilized.ie In most solar cells, the extra energy in blue and ultraviolet light is wasted as heat. But the small size of nanoscale crystals, also called quantum dots, leads to novel quantum-mechanical effects that convert this energy into electrons instead solar cells made of silicon nanocrystals could theoretically convert more than 40 percent of the energy in light into electrical power, Nanocrystal quantum dots (NQDs)[5] are nanometer-scale single crystalline particles of semiconductors. Due to the quantum confinement effect, their light absorption and emission wavelengths can be controlled by tailoring the size of NQDs **Nanocrystal solar cells** are solar cells based on a substrate with a coating of nanocrystals. The nanocrystals are typically based on silicon, CdTe or CIGS and the substrates are generally silicon or various organic conductors.

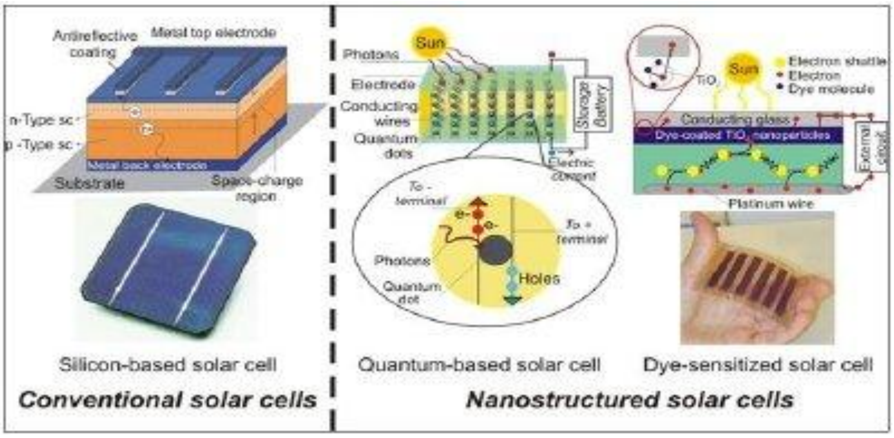


Figure 1. Evolution of PV technology: from conventional (silicon-based solar cells) to nanostructured solar cells (quantum-based and dye-sensitized solar cells)[1]

Concentrating sunlight with mirrors or lenses could raise that figure to about 40 percent, but the same approach could boost the efficiency of a silicon-nanocrystal solar cell to well over 60 percent,.

Nanocrystalline silicon (**nc-Si**), sometimes also known as **microcrystalline silicon** (**μc-Si**), is a form of porous silicon.[1] It is an allotropic form of silicon with paracrystalline structure—is similar to amorphous silicon (a-Si), in that it has an amorphous phase. Where they differ, however, is that nc-Si has small grains of crystalline silicon within the amorphous phase. This is in contrast to polycrystalline silicon (poly-Si) which consists solely of crystalline silicon grains, separated by grain boundaries. The difference comes solely from the grain size of the crystalline grains. Most materials with grains in the micrometre range are actually fine-grained polysilicon, so nanocrystalline silicon is a better term. The term Nanocrystalline silicon refers to a range of materials around the transition region from amorphous to microcrystalline phase in the silicon thin film. The crystalline volume fraction (as measured from Raman spectroscopy) is another criterion to describe the materials in this transition zone.

nc-Si has many useful advantages over a-Si, one being that if grown properly it can have a higher electron mobility, due to the presence of the silicon crystallites. It also shows increased absorption in the red and infrared wavelengths, which make it an important material for use in a-Si solar cells. One of the most important advantages of nanocrystalline silicon, however, is that it has increased stability over a-Si, one of the reasons being because of its lower hydrogen concentration. Although it currently cannot attain the mobility that poly-Si can, it has the advantage over poly-Si that it is easier to fabricate, as it can be deposited using conventional low temperature a-Si deposition techniques, such as PECVD, as opposed to laser annealing or high temperature CVD processes, in the case of poly-Si.[2]

Solar panels should also be inclined at an angle as close to the area's latitude as possible to absorb the maximum amount of energy year-round. A different orientation and/or inclination could be used if you want to maximize energy production for the morning or afternoon, and/or the summer or winter. So the nanorods used in solar cell is multi-layer funnels designed to capture e light incident. The first layer absorbs the light that hits the panel at wide outer angles and turns it to a slightly narrower angle. The succeeding layers become narrower, like they are passing the light to the next layer even further as it funnels the light till it reaches the active region of the panel at a 90° angle. This process makes the solar panel securely capture the sun's energy without having to rotate with the sun.

VI. CONCLUSION

Silicon is by far the most common material in solar cells today, and it's attractive as the basis for broader deployment of photovoltaics in the future. Even though the future is likely to see the thin solar panel film become the market's leader, the traditional crystalline silicon cells are likely to rule the market for at least a few more years, since they are still more efficient than thin film solar materials.

Solar power can be used to get wireless broadband internet to remote areas. The stations that can reach these areas are solar powered because they are too far away from conventional electricity.

REFERENCES

[1] Singh R.S., Rangari V.K., Sanagapalli S., Jayaraman V., Mahendra S., Singh V.P., "Nano-structured CdTe, CdS and TiO2 for thin film solar cell applications" Sol. Energy Sol. Cells 82, 315-33, 2004.
[2] Aldous, Scott. "How Solar Cells Work." How Stuff Works. 22 May 2005.
[3] <http://science.howstuffworks.com/solar-cell1.htm>.
[4] Choi, Charles. "Nanotech Improving Energy Options." Space Daily. New York: May
[5] 27, 2004. <http://www.spacedaily.com/news/nanotech-04zj.html>.
[6] "Power Plastic." Engineer Magazine. March 8, 2005.
[7] <http://www.konarkatech.com/news_and_events/konarka_articles/2005/3_march/the_engineer/
[8] power_plastics_mar8.php>.
[9] Paul Preuss. "An unexpected discovery could yield a full spectrum solar cell."
[10] Research News. Berkeley Lab. 18 November 2002. <http://www.lbl.gov/Science-
[11] Articles/Archive/MSD-full-spectrum-solar-cell.html>.
[12] Sanders, Bob. "Cheap, Plastic Solar Cells May Be On The Horizon." UC Berkeley
[13] Campus News. 28 March 2002.
[14] <http://www.berkeley.edu/news/media/releases/2002/03/28_solar.html>.
[15] "Societal Implications of Nanoscience and Nanotechnology." National ScienceHowStuffWorks article: Toothman, Jessika, and Scott Aldous. "How Solar Cells Work" 01 April 2000. By Paul Holister, Author & Consultant | February 26, 2007
[16] D.G. Rickerby and M. Morrison (2007) "Nanotechnology and the environment: A European perspective", Science andTechnology of Advanced Materials 8(1-2): 19-24.
[17] Ineke Malsch for Nanoforum
[18] Nature material paper "Enhanced absorption and carrier collection and carrier collection in Si wires array for photovoltaic applications" by Atwater, lewis etal.
[19] J. Garcia Martinez, Ed. "Nanotechnology for the Energy Challenge", Wiley-VCH, Weinheim, 2010.

[20] Serrano E., Rus G., Garcia-Martinez J. "Nanotechnology for sustainable energy", Renew. Sust. Energy Rev., 13(9), 2373-84, 2009.

[21] "Renewables in global energy supply: an IEA facts sheet", IEA/OECD. 2007.

[22] World Energy Outlook 2006, OECD/IEA 2006.

[23] Stockman M., "Light-emitting devices: From nano-optics to street lights" Nature Mater. 3 (7), 423-4, 2004.

[24] Singh R.S., Rangari V.K., Sanagapalli S., Jayaraman V., Mahendra S., Singh V.P., "Nano-structured CdTe, CdS and TiO2 for thin film solar cell applications" Sol. Energy Sol. Cells 82, 315-33, 2004.

[25] O'Regan B., Grätzel M., "A low-cost, high-efficiency solar cell based on dye-sensitized colloidal TiO2 films" Nature 353, 737-40, 1991.