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Solar cells And Nanotechnology

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Abstract: *Current solar power technology has little chance to compete with fossil fuels or large electric grids. Today's solar cells are simply not efficient enough and are currently too expensive to manufacture for large-scale electricity generation. However, potential advancements in nanotechnology may open the door to the production of cheaper and slightly more efficient solar cells. Nanotechnology might be able to increase the efficiency of solar cells, but the most promising application of nanotechnology is the reduction of manufacturing cost. The basic concept is that Plastic is made using nanoscale titanium particles coated in photovoltaic dyes, which generate electricity when they absorb light. These new plastic solar cells utilize tiny nanorods dispersed with in a polymer. The nanorods behave as wires because when they absorb light of a specific wavelength they generate electrons. These electrons flow through the nanorods until they reach the aluminum electrode where they are combined to form a current and are used as electricity. Another potential feature of these solar cells is that the nanorods 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.*

Keywords: solar nanotechnology, nanoscale titanium, nanowires, inexpensive, increased efficiency.

I. INTRODUCTION

First, I would like to examine the current solar cell technologies available and then look at their drawbacks. Then I will explore the research field of nano solar cells, and the science behind them. Finally, I will consider the implications that these technologies would have on our society.

II. SOLAR TECHNOLOGY

Before introducing new solar products which use nanotechnology, it is necessary to explain the basic process that a normal solar cell uses. Conventional solar cells are called photovoltaic cells. These cells are made out of semiconducting material, usually silicon. When light hits the cells, they absorb energy though photons. This absorbed energy knocks out electrons in the silicon, allowing them to flow. By adding different impurities to the silicon such as phosphorus or boron, an electric field can be established. This electric field acts as a diode, because it only allows electrons to flow in one direction (Ref. 1). Consequently, the end result is a current of electrons, better known to us as electricity.

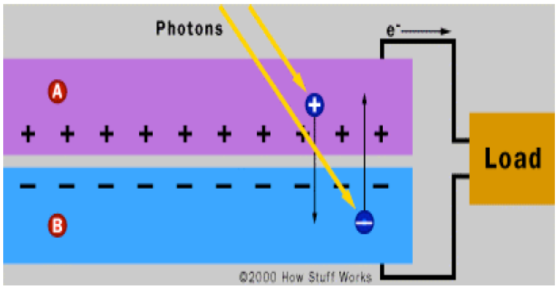

Figure 1: Diagram of a photovoltaic solar cell

III. DRAWBACKS OF CONVENTIONAL SOLAR TECHNOLOGY

Conventional solar cells have two main drawbacks: They can only achieve efficiencies around ten percent and they are expensive to manufacture. The first drawback, inefficiency, is almost unavoidable with silicon cells. This is because the incoming photons. Must have the right energy. If the photon has less energy than the band gap energy then it will pass through. If it has more energy than the band gap extra energy will be wasted. Loss of around 70 percent of the radiation energy incident on the cell"(Ref. 1) Consequently, according to the Lawrence Berkeley National Laboratory, the maximum efficiency achieved today is only around 20 percent (Ref 4). Mass-produced solar cells are much less efficient than this, and usually achieve only ten percent efficiency.

IV. SOLAR NANOTECHNOLOGY

Nanotechnology might be able to increase the efficiency of solar cells.

***A.* Plastic:** Plastic, a thin, flexible, solar panel made up of nanoscale Titanium / dye complex. $TiO2$ nanoparticles absorb, impinging photons with energies equal to or higher than its band gap (>3.0 eV), electrons are excited from the valence band into the unoccupied conduction band, leading to excited electrons in the conduction band and positive holes in the valence band. These charge carriers can recombine, nano radiatively or radiatively (dissipating the input energy as heat), or get trapped and react with electron donors or acceptors adsorbed on the surface of the photo catalyst. The competition between these processes determines the overall efficiency for various applications of TiO2 nanoparticles.

Titanium nanomaterials have been extensively studied in the last two decades. TiO2 can absorb light into the visible light region and convert solar energy into electrical energy for solar cell applications . Due to their versatile properties, nanomaterials have possessed themselves vast applications, including paint, toothpaste, UV protection, photo catalysis, photovoltaic, sensing, electrochromics, as well as photochromics.

This solar technology is effective in indirect lighting situations and enables you to produce power nearly all day long, even on a vertical surface. The Total Energy Collected from Plastic outperforms other solar panels, and delivers solar energy and design freedom to architects, glass manufacturers and others in the building and construction fields.

Plastic comes as both opaque and semi-transparent solar panels. Being thin and flexible, we are able to mold to the curves and contours of your designs. This means you are no longer limited to installing rigid, black, silicon solar panels. Plastic gives you the freedom to create solar powered buildings that embrace the beauty of your creations.

***B.* Nano Wires:** Nano wires are microscopic wires that have a width measured in nanometers. Typically their width ranges from forty to fifty nanometers, but their length is not so limited. Since they can be lengthened by simply attaching more wires end to end or just by growing them longer, they can be as long as desired. They are especially attractive for nanoscience studies as well as for nanotechnology applications.

Nanowires are metal just like other, regular wires. The only real difference in concept is their size. They also vary in complexity and uses. While they can do many of the same things, they have many other capabilities beyond those of regular wire.

Nanowires are simply small wires that will be able to greatly reduce the size of electronic devices while allowing us to increase the efficiency of those devices. The nanowires have diameters and lengths on the order of 10 nm and 10μm, respectively. The sizes of nanowires are typically large enough (> 1 nm in the quantum confined direction) to have local crystal structures closely related to their parent materials. The smaller and smaller length scales now being used in the semiconductor, opto-electronics, and magnetic industries.

***C.* Nanotechnology Solar cell:**

These new plastic solar cells utilize tiny nanorods dispersed *Diagram of a nano solar cell (Ref. 5).* With in a polymer. Because when they absorb light of a specific wavelength they generate electrons. These electrons flow through the nanorods until they reach the aluminum electrode where they are combined to form a current and are used as electricity (Ref. 5). This type of cell is cheaper to manufacture than conventional ones for two main reasons. First, these nanotechnology solar cells are not made from silicon, . Second, manufacturing of these cells does not require expensive equipment.

Another potential feature of these solar cells is that the nanorods could be ‘tuned’ to absorb light. This could significantly increase the efficiency of the solar cell because more of the incident light could be utilized.

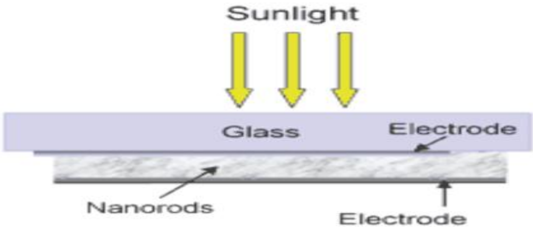

Figure 2: Diagram of a nano solar cell ref (5).

Nanotechnology solar cell which absorbs both sunlight and indoor light and converts it into electricity. The basic concept is that Plastic is made using nanoscale titanium particles coated in photovoltaic dyes, which generate electricity when they absorb light. According to Engineer Magazine, Konarka has already, "built fully functional solar cells that have achieved efficiencies of around 8 %"(Ref. 3). In addition to that tuning the nanorods to absorb light in order to exploit a greater range of the color spectrum.

Improvements such as this could make it possible to manufacture inexpensive solar cells with the same or more efficiency as current technology. Since the manufacturing cost of conventional solar cells is one of the biggest drawbacks, this new technology could have some impressive effects on our daily lives. Although this new technology is only capable of supplying low power devices with sufficient energy, its implications on society would still be tremendous. It would help preserve the environment, decrease soldiers carrying loads, provide electricity for rural areas, and have a wide array of commercial applications due to its wireless capabilities. Now I will examine each of these implications in further detail.

Inexpensive solar cells, which would utilize nanotechnology, would help preserve the environment. According to Engineer Magazine, Konarka Technologies is already proposing, "coating existing roofing materials with its plastic photovoltaic cells" (Ref. 3). If it were inexpensive enough to cover a home's entire roof with solar cells, then enough energy could be captured to power almost the entire house. If many houses did this then our dependence on the electric grid (fossil fuels) would decrease and help reduce pollution. Some people have even proposed covering cars with solar cells or making solar cell windows. Even though their efficiency is not very great, if solar cells were inexpensive, then enough of them could be used to generate sufficient electricity.

New technology in solar cells would also have military implications. The U.S. Army has already hired Konarka Technologies to help design a better way to power their soldiers' electrical devices. According to Daniel McGahn, Konarka's executive vice president, "A regular field soldier carries 1.5 pounds of batteries now. A special operations soldier has a longer time out, has to carry 140 pounds of equipment, 60 to 70 pounds of which are batteries (Ref. 2)." If nanotechnology could be used to create inexpensive and reasonably efficient solar cells, it would greatly improve soldiers' mobility.

Inexpensive solar cells would also help provide electricity for rural areas or third world countries. Since the electricity demand in these areas is not high, and the areas are so distantly spaced out, it is not practical to connect them to an electrical grid. However, this is an ideal situation for solar energy. If it were inexpensive enough, it could be used for lighting, hot water, medical devices, and even cooking (Ref. 2). It would greatly improve the standard of living for millions, possibly even billions of people!

Finally, inexpensive solar cells could also revolutionize the electronics industry. Solar cells could be embedded into clothing and be 'programmed' to work for both indoor light and sunlight. For the first time, our electronics would be truly wireless, and we wouldn't have to plug them into an outlet at night to recharge them.

V. ADVANTAGES OF NANOTECHNOLOGY SOLAR CELL

- Lower manufacturing costs and more flexibility in manufacturing.
- Easy to manufacture and it does not require special arrangements.
- As the properties of light absorption and stability, titanium has been developed in making solar cell cheaper.
- In this nano wires has been tuned for absorbing the photons, so that it can be used even in indoor lighting and maximum energy can be used.

VI. CONCLUSION

The effects that a low cost, reasonably efficient (low power) solar cell would have on society are tremendous. It would help preserve the environment, protect soldiers, provide rural areas with electricity, and transform the electronics industry. These dramatic effects, which would all be a result of nanotechnology, would greatly change and even improve society.

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