Nanotechnology in Solar Cells
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Today, the generation of electricity using solar cells is not a viable large scale power replacement or simply can't compete with other electrical power generators such as large electric grids. One of the main reasons is that it is simply too expensive to manufacture for large scale electricity generation. Another factor that makes solar cells unappealing is the lack of efficiency. Currently the efficiency of a silicon solar cell is somewhere around 15 percent (but varies a lot) (howstuffworks.com). Solar cells are too expensive and not efficient but there are new technologies that could change both the price and/or the efficiency. The main technology that could impact solar cells is nanotechnology. For the purpose of this writing I will be discussing the use of nanotechnology in solar cells and potential advancements being put forth.

A simple explanation of solar cells and how they work is that photons (which are particles or light) hit the solar cell and those photons are absorbed by some kind of semiconducting materials (for example silicon). Then the electrons are basically drawn out of their atoms which in turn creates electricity (electron flow). The direction only flows in one direction, where this is due to the composition of the solar cells (Wikipedia.org)

Solar cells can be classified into three different generations. The first generation cells consist of large-area, high quality and single junction devices. First Generation technologies involve high energy and labor inputs which prevent any sort of progress in the reduction of production costs. Single junction silicon devices are approaching the theoretical limiting efficiency of thirty-three percent and achieve cost parity with fossil fuel energy generation after a payback period of 5-7 years. They are not likely to get lower than US$1/W (Wikipedia.org).

Second generation materials have been developed to address energy requirements and also production costs of solar cells. Alternative manufacturing techniques such as vapor deposition and electroplating are advantageous as they will reduce high temperature processing in a meaningful basis. It is commonly accepted that as manufacturing techniques evolve production costs will be dominated by basic material requirements, whether it's a silicon substrate, or glass cover (Wikipedia.org).

Third generation technologies aim to enhance poor electrical performance of second generation (such as thin-film technologies) while maintaining very low production costs. Current research is targeting conversion efficiencies of 30-60% while retaining low cost materials and manufacturing techniques (Wikipedia.org).

One way to capture more of the solar energy is to incorporate or put in a nanomaterial into semiconductor films where in turn it will prove to be more cost-effective when compared to traditional technologies. Specifically, this technology involves:

> "…hybrid nanocomposites, incorporating inorganic nanorods into organic semiconductor films. The elements can be mass-produced under ambient conditions without complicated or expensive steps. These crystals, more properly known as nanocrystals because they are a nanometer or billionth of a meter in size, are chemically pure clusters of 100 to 100,000 atoms, about 75,000 times smaller than the diameter of a human hair (http://www.pathnet.org)."

It's amazing how a particle that small can be produced and in turn make solar cell more efficient:

> "Conventional single junction semiconductor solar cells have a maximum thermodynamic conversion efficiency of ~31%. One major factor efficiency limiting factor is the one-to-one relationship between absorbed photon and generated electron hole pair. Nanocrystal based solar cells have the potential of breaking this limit due to the recent discovery of multiple exciton generation which is a quantum confinement enhanced process wherein a single photon can generate up to seven electron-hole pairs. This discovery, combined with the availability of a diverse set of tunable nanocrystal building blocks would confront us with the intriguing challenge to develop material systems capable of exploiting multiple exciton generation in photovoltaic devices (www.cheme.cornell.edu)". (figure 1 depicts this process)

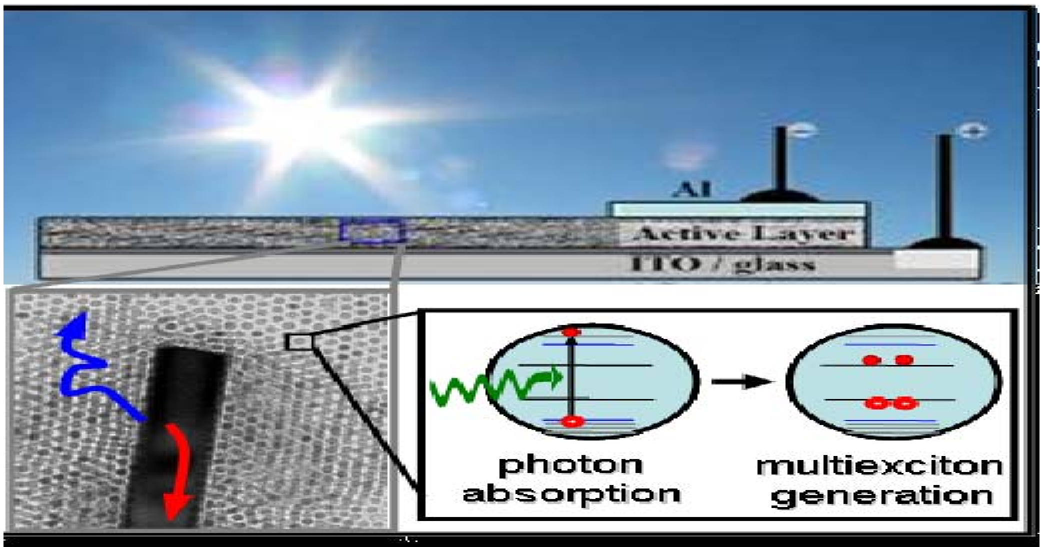

Figure 1

There are many technologies being developed with respect to solar cells, one of them is being researched and could have the potential to even convert solar energy into electrical energy in the night time. The product or technology being researched is that of plastic solar cells where basically the composite can be sprayed onto other materials and used as portable electricity, sort of like paint. The plastic material uses nanotechnology and also contains the first solar cells able to harness the sun's invisible infrared rays. Existing materials are only able to capture the sun's visible light. While half of the sun's power lies in the visible spectrum, the other half lies in the infrared spectrum. So, this new material is the first plastic composite that is able to harness the infrared. How this technology is being done is that researchers are combining specially designed nano particles called quantum dots with a polymer to make the plastic that can detect energy in the infrared portion (http://news.nationalgeographic.com).

A main issue with solar cells is cost-effectiveness: "At a current cost of 25 to 50 cents per kilowatt-hour, solar power is significantly more expensive than conventional electrical power for residences. Average U.S. residential power prices are less than ten cents per kilowatt-hour, according to experts", but all this could change as stated in this next quote: "Flexible, roller-processed solar cells have the potential to turn the sun's power into a clean, green, convenient source of energy..." and "This technology could one day become five times more efficient than current solar cell technology (http://news.nationalgeographic.com)". Another important detail is that this solar cell plastic could potentially "…allow up to 30 percent of the sun's radiant energy to be harnessed".

Figure 1 (below) depicts the "… analytical technique that uses infrared spectroscopy to study light-sensitive organic materials (that) could lead to the development of cheaper, more efficient solar cells. Using infrared (IR) spectroscopy to study the vibrations of atoms within the material, the technique provides information about the movement of electrons within a film of carbon-based materials (www.science.psu.edu)".

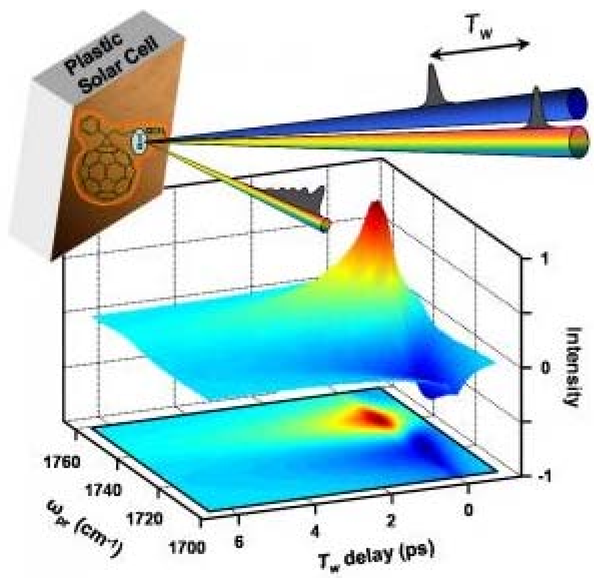

Figure 2

There are many applications to this technology involving plastic solar cells. One of the potential applications could include energy-saving plastic sheeting that could be put onto a rooftop to supply heating needs, or also having solar cell window coating that could let in enough infrared light to power home appliances. Another application could be a hydrogen-powered car painted with the film and could potentially convert enough energy into current or electricity to continually recharge the car's battery. In a large scale "…researchers envision that one day "solar farms" consisting of the plastic material could be rolled across deserts to generate enough clean energy to supply the entire planet's power needs (http://news.nationalgeographic.com)".

There are many other technologies and applications that come within the range of nanotechnology in solar cells and that is one of the reasons that this is a very interesting field of study. With further research, study and understanding there will be more breakthroughs involving the use of nanotechnology in solar cells. Where, ultimately it has the potential to surpass any type of electricity-producing devices, products, and even large scale power generators.

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