Solar Cells and Nanotechnology

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Agenda:

-Explore current technology

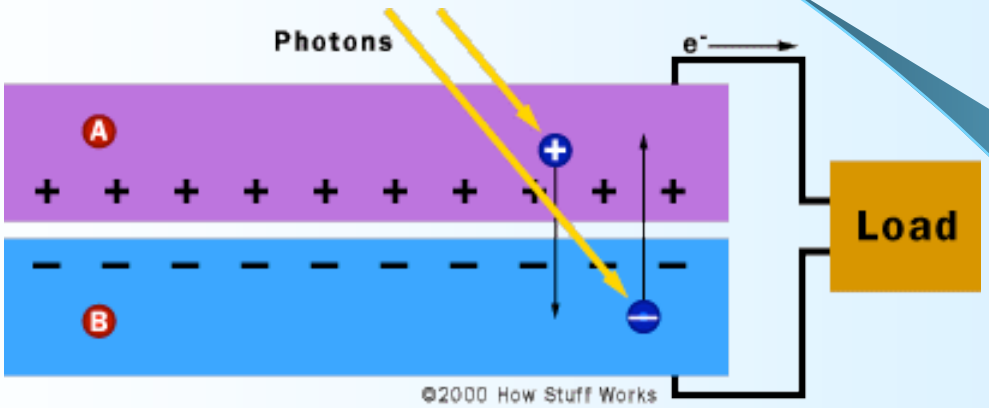
-Discuss drawbacks of current technology

-Explain where nanotechnology enters the picture

-Discuss the science behind nano solar cells

-Explore the societal impact

Current Technology: Photovoltaic Cells



Short Version: Light in, electricity out.

College Version: If the energy of the incident photons equals or exceeds the band gap energy of the material, then the valence electrons will get excited, and enter the conduction band. Here, they are susceptible to an electric field and form electricity.

(Reference 1)

Drawbacks:

-‘Inescapable inefficiency’

-For material with a higher band gap, fewer photons have enough energy to excite the electrons into the conduction band.

-So then, why not just choose a material with a lower band gap?

-Because the band gap also determines the voltage of the cell.

-Consequently the optimal band gap which balances these effects is around 1.4 ev.

-These effects result in a loss of 70% of the energy incident on the cell.

-As a result the maximum efficiency of any photovoltaic cell is only around 30%, and in practice actual efficiencies of only 10% are achieved.

(Reference 1)

Drawbacks:

-Manufacturing Cost

-Since photovoltaic solar cells are made out of silicon, they are very expensive to manufacture.

-Manufacturing procedures are complicated by clean rooms and vacuum chambers due to the required purity of the silicon.

(Reference 1)

Nanotechnology To The Rescue!

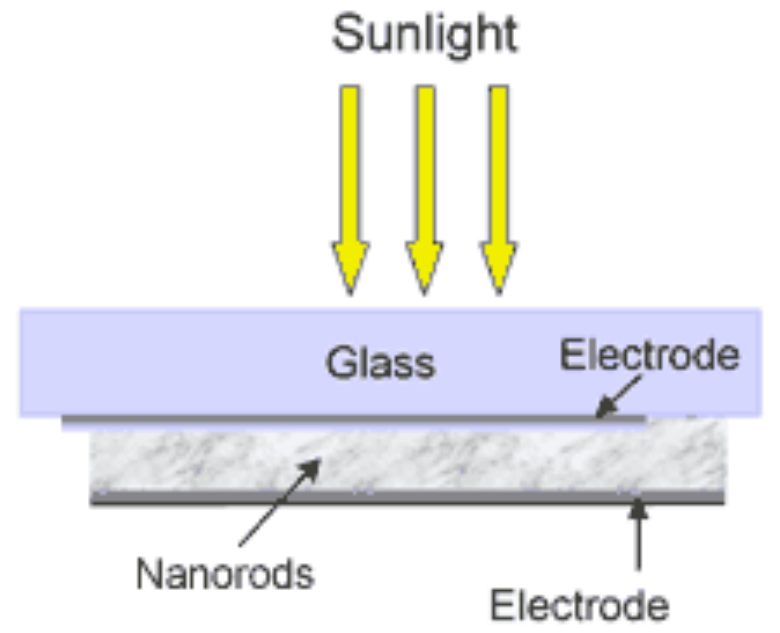
- Chemists at the University of California, Berkeley, have designed a 'plastic' solar cell which utilizes tiny nanorods to convert light into electricity.

"A panel of eight plastic solar cells based on inorganic nanorods and semiconducting polymers."

(Reference 3)

- These solar cells consist of a layer of tiny nanorods only 200 nanometers thick, dispersed within a polymer.
- So far these cells can produce only 0.7 volts, so they are only appropriate for low-power devices.
- These cells could be mass produced because the nanorod layers could simply be applied in separate coats.

(Reference 3)



- 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.

(Reference 3)

-This type of cell is cheaper to manufacture than conventional ones for two main reasons.

-First, these plastic cells are not made from silicon, which can be very expensive.

-Second, manufacturing of these cells does not require expensive equipment like conventional silicon based solar cells.

-These solar cells only achieve efficiencies of about 1.7%, so they are not yet competitive with silicon solar cells.

-A. Paul Alivisatos, professor of chemistry at UC Berkeley states, “For this to really find widespread use, we will have to get up to around 10 percent efficiency, but we think it's very doable."

(Reference 3)

Societal Implications

- Although this new technology is only capable of supplying low power devices with sufficient energy, its implications on society would still be tremendous.
- It could 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.

Houses

-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 fossil fuels would decrease and help reduce pollution.

- Even though their efficiency is not very great, if solar cells were inexpensive, then enough of them could be used to generate sufficient electricity.

(Reference 2)

- Since these nano solar cells are flexible and polymer based, they could be easily applied, possibly even painted, onto surfaces like roofs.
- This would be far superior to current solar cells which are bulky and not aesthetic.

(Reference 4)

Military

(Reference 4)

-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 special operations soldier has to carry 140 pounds of equipment, 60 to 70 pounds of which are batteries."

-If nanotechnology could be used to create inexpensive and reasonably efficient solar cells, it would greatly improve soldiers' mobility.

Rural Areas/ Developing Countries

-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. It would greatly improve the standard of living for millions of people.

(Reference 4)

Conclusions

- Nanotechnology could be used to create a cheaper solar cell.
- It may not achieve a much better efficiency, but the reduced manufacturing cost could lead to many new uses for solar energy.
- The potential effects of this new technology could help soldiers, the environment, and rural communities.

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