ABSTRACT:

After few decades, the fossil fuel present on the earth will be not sufficiently available for all the population present on this earth. The main source of energy will be dependent on the non-conventional source of energy. The world is addicted to electric power, and with emerging economies, electrified transport, and electrical devices everywhere, demand for that power is ever increasing. Currently, most electricity is produced unsustainably, with enormous risks for the environment, health, and supply security. The main source of energy available will be dependent on solar energy which is the free gift of nature. To trap the solar energy we have developed the technology i.e. solar cell or plate but the efficiency of these plates are very low and the overall cost of the energy conversion is too high. These costs are difficult to reduce significantly by mass production, but they do scale with the efficiency of the solar cells.

The large-scale use of photovoltaic devices for electricity generation is prohibitively expensive at present; generation from existing commercial devices costs about ten times more than conventional methods. Here we describe a photovoltaic cell, created from low-to-medium purity materials through low-cost processes, which exhibits commercially realistic energy-conversion efficiency. The device is based on a 10µm-thick, optically transparent film of titanium dioxide particles a few nanometres in size, coated with a monolayer of a charge-transfer dye to sensitize the film for light harvesting. Because of the high surface area of the semiconductor film and the ideal spectral characteristics of the dye, the device harvests a high proportion of the incident solar energy flux (46%) and shows exceptionally high efficiencies for the conversion of incident photons to electrical current (more than 80%). The overall light-to-electric energy conversion yield is 7.1-7.9% in simulated solar light and 12% in diffuse daylight. The large current densities (greater than 12 mA cm^-2) and exceptional stability (sustaining at least five million turnovers without decomposition), as well as the low cost, make practical applications feasible.

Keywords: Solar cell, Efficiency, Photovoltaic cell, Energy conversion, Electric current.

[1] INTRODUCTION
Solar cells have seen remarkable improvements since the first issue of the journal Solar Energy Materials in 1979. The photovoltaic (PV) field has given rise to a global industry capable of producing many gigawatts (GW) of additional installed capacity per year. The problems with energy supply and use are related not only to global warming but also to such environmental concerns as air pollution, acid precipitation, ozone depletion, forest destruction, and radioactive substance emissions.

To prevent these effects, some potential solutions have evolved including energy conservation through improved energy efficiency, a reduction in fossil fuel use and an increase in environmentally friendly energy supplies. Among them, the power generation with solar cells system has received great attention in research because it appears to be one of the possible solutions to the environmental problem.

One type of renewable energy source is the photovoltaic (PV) cell, which converts sunlight to electrical current, without any form for mechanical or thermal interlink. PV cells are usually connected together to make PV modules, consisting of 72 PV cells, which generates a DC voltage between 23 Volt to 45 Volt and a typical maximum power of 160 Watt, depending on temperature and solar irradiation. Solar panel efficiency depends on various factor such as solar intensity (brighter the sunlight, the more there is for the solar cell to convert), temperature, dust which decreases the efficiency of panel etc.

In this paper we will discuss various methods and techniques to improve the efficiency of solar panel. The various techniques discussed in this paper will help to improve the efficiency of rate of energy conversion.

[2] TECHNIQUES FOR IMPROVING THE EFFICIENCY OF SOLAR CELL AND COST REDUCTION

(a) Improvement of Efficiency and Cost Reduction by Nanotechnology

Making solar cells ultra-thin reduces their material costs, but often at the expense of their efficiency. These ‘thin film PVs’ (tPVs) use silicon films that are between nanometres and tens of micrometres thick, whereas typical solar cells use silicon wafers around 200 micrometres thick. Silicon represents 10–20% of the cost of a solar cell, so a 100–fold reduction in silicon could significantly improve the cost-efficiency of such systems.

Most common PV systems are based on a high quality silicon crystal. When photons of light collide with electrons in the silicon, they are knocked loose, which generates an electric current. Commercial versions of such systems are currently around 22% efficient at converting sunlight into electricity.
However, tfPV systems are currently 7–13% less efficient than traditional systems. This is partly because, when PV cells become thinner, light interacts differently with their surface texture and collisions between photons and electrons are reduced (this is not an issue with thicker PVs).

The study reviews current attempts to improve ‘light management’ in tfPVs using nanostructures. It summarises some of the different ways that researchers are using nanostructures to boost the number of collisions between photons and electrons.

For instance, nanostructures can increase the amount of light entering a PV by reducing reflections from its surface. A polished silicon wafer reflects more than 30% of the light that it receives. Densely packed nanostructures can be used to create thin anti-reflective coatings, which work across a wide range of wavelengths and angles of light.

Varying the shape, height or width of nanostructures can alter a property called ‘optical resonance’. Such structures can capture and guide light to the PV surface, or bounce light around inside the tfPV cell. This keeps light in the cell for longer, which increases the chances of colliding with an electron.

The review also explores how nanostructures can be used to ‘trap light’ depending on their location in a tfPV. Nanostructures on the front of the PV can guide light into the absorbing layer, or reduce reflection. Nanostructures on the back of a PV could be used as high-performance reflectors, bouncing otherwise lost light back into the PV. The light-absorbing layer itself can benefit from a sculpted nanostructure, which could change its ability to absorb light of different wavelengths, for instance. This would allow the cells to extract energy from a wider range of light wavelengths than traditional PV cells.

TfPVs also offer additional advantages, besides lower material costs. For example, they are flexible because they only use very thin silicon, whereas current non-thin-film PVs are rigid. This could make tfPVs easier to install; like paper, they could be spooled off a roll.

(b) Quantum techniques to enhance solar cell efficiency

In a standard solar cell, an incident photon can generate one electron. The voltage of the solar cell determines how much energy that electron can deliver to the power grid, independent of the energy that was initially carried by the photon. This means that a large fraction of the energy of very energetic photons (such as the green and blue photons) is wasted as heat. However, if that photon is absorbed in a material that is capable of singlet fission, the solar cell can convert it into two electrons.

The trick is to split the initial excited state inside the singlet fission material into two lower-energy states that we call triplet excitons. This conversion can be very efficient, and under the right conditions the triplet states can be extracted as electrons.
To achieve efficiencies higher than those for conventional solar cells, we need to take one extra step. The singlet fission material only absorbs the very energetic part of the spectrum, so that all the low-energy photons remain unused.

Efforts in this field have therefore focused on combining the singlet fission material with a solar cell material with a low band gap, which absorbs those low-energy photons. Then, both can work simultaneously to generate one electron per photon from the low-energy light, and two electrons per photon from the high-energy light.

To demonstrate such a solar cell, we used pentane (a small organic molecule) as the material for singlet fission, and lead-sulfide quantum dots as the low-band gap material. We chose quantum dots as the combination materials because their high degree of tenability enables relatively easy realization of the desired properties for electron extraction. However, for a technologically relevant application, singlet fission needs to be combined with solar cell materials closer to applications, such as silicon, copper indium gallium selenite, or perovskite.

In a recent application with silicon, the electrons from the singlet fission material were collected separately from the electrons generated in silicon. While this works and could improve the efficiency in principle, it adds unnecessary losses and complexity, for example, from additional transparent contacts that are required. A more elegant alternative would be a direct electron transfer between the two materials, or even transfer of the triplet exaction energy. The latter could allow conversion of the energy from the triplet states into a low-energy photon, which could then be absorbed by any low-bandgap solar cell. Both electron transfer and energy transfer have been demonstrated experimentally with quantum dot semiconductors, yet more relevant materials remain to be explored.

Singlet fission could be harnessed to improve the efficiency of solar cells. To enhance an established technology such as silicon, we still need to significantly improve our understanding of triplet exaction dynamics, energy and charge transfer from triplet exactions, and singlet fission itself. In the ideal case, singlet fission could raise the efficiency of a conventional solar cell by a quarter.

(c) Cooling Technique

Photovoltaic panels (PV) get overheated due to excessive solar radiation and high ambient temperatures. Overheating reduces the efficiency of the panels. The ideal $P–V$ characteristics of a solar cell for a temperature variation between 0 °C and 75 °C are shown in Fig 1. The $P–V$ characteristic is the relation between the electrical power output $P$ of the solar cell and the output voltage, $V$, while the solar irradiance, $E$, and module temperature, $Tm$, are kept constant. The maximum power output from the solar cells decreases as the cell temperature increases, as can be seen in Fig 1. This indicates that heating of the PV panels can affect the output of the panels significantly.
(d) Antireflective Coating (ARC)

When light strikes the silicon cells, packets of solar energy are absorbed and converted into electricity. Because bare silicon has a high refractive index, more than 35 per cent of incident light is reflected away from the panel's surface before it can be converted into usable energy. The reflection is reduced by texturing and by applying anti-reflection coatings (ARC) to the surface. Antireflection coatings on solar cells are similar to those used on other optical equipment such as camera lenses. They consist of a thin layer of dielectric material, with a specially chosen thickness so that interference effects in the coating cause the wave reflected from the anti-reflection coating top surface to be out of phase with the wave reflected from the semiconductor surfaces. These out-of-phase reflected waves destructively interfere with one another, resulting in zero net reflected energy.

Anti-reflective glass coating from Australian company Brisbane Materials lets solar panels capture more light and therefore boosts their efficiency. The coating decreases light reflection by 75 per cent and increases power output by three per cent, which may seem small, but it's the highest improvement for any anti-reflective coating so far and, over an array of solar panels, this type of improvement can make a big difference. To coat a solar panel, the liquid solution that contains silicon dioxide is applied to the sheet of glass that protects the solar cells, then is heated to room temperature which turns it into a very thin layer of porous, reflection-dulling glass. That room temperature heating instead of a typical high-temperature (around 600 degrees Celsius) heat is what could make this coating far easier and cheaper to implement.

(e) Dye-Sensitized Solar Cells

Dye-sensitized solar cells (DSCs) have been widely investigated as a next-generation solar cell because of their simple structure and low manufacturing cost. In general, a DSC comprises a Nano crystalline titanium dioxide (TiO2) electrode modified with a dye fabricated on a transparent conducting oxide (TCO), a platinum (Pt) counter electrode, and an electrolyte solution with a dissolved iodide ion/triiodide ion redox couple between the electrodes. Although certified conversion efficiency using black dye has been reported to be 10.4% by the Swiss Federal Institute of Technology in Lausanne, efficiency of over 10% has rarely been achieved due to insufficient understanding of
the mechanism of DSCs, which is different from that of conventional solar cells.

In order to further improve the efficiency, we then considered ways of elevating the other factors such as short circuit current density (JSC). There are two approaches to improving JSC. One is to develop a new dye which can absorb incident light of longer wavelengths, and the other is to increase the extent of light trapping within the TiO2 electrodes.

[3] CONCLUSION

The reasonable and effective utilization of solar energy is an important path which can deal with the global energy crisis at present. Photovoltaic (PV) cell, which converts sunlight to electrical current, without any form for mechanical or thermal interlink. So the study on improving the efficiency of solar panel is very necessary. We have proposed several methods (using cooling technique of panel, using anti-reflecting coating etc..) to improve the efficiency of solar panel. Practice has proved that the use of these methods can effectively improve the efficiency of solar power generation.

Photovoltaic conversion has become one of the most promising alternatives to the electric power production due to its clean nature, low maintenance costs and long term stability. Despite all that, the manufacturing and installation of solar cells is still very expensive. Therefore, the price of solar power is still pretty high.

Actually ,this paper suggest various techniques regarding improvement of solar cell or panel that can increase its efficiency with reduction in its overall cost.

REFERENCES

