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Global Research Activities for Harvesting Solar Energy (A Review)

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Abstract: The increasing importance of environmental concern, fuel savings and unavailability of power has led to the renewal of interest in renewable energies. This paper examines global research patterns to assess development prospects. The various new and advanced methods to harness solar energy and also the methods to increase the efficiency of the existing techniques are discussed.

Keywords: microcontroller, nano-objects, nanotechnology, photovoltaic, renewable, sensitised.

INTRODUCTION

The energy received by the earth from the sun(with a rate of 174PW in the upper atmosphere) is by far larger than current world energy consumption. In view of the present crises of the dominant energy resources solar power emerges as a concrete alternative for a sustainable world energy supply. The rapid depletion of conventional fossil fuels and environmental concerns have resulted in extensive use of renewable sources of energy for electrical power generation. Energy is the convertible currency of technology. Without energy the whole fabric of society would crumble. Renewable energy is increasingly viewed as critically important globally. Solar radiation is a direct source for generating heat, cold and power. Indirectly, it is possible to use solar energy through hydropower, wind energy, energy of sea waves, heat energy of environs and energy of biomass. Thanks to photoelectric effect in semiconductors, we can transform the solar energy in solar cells to power energy. Transformation of solar energy to power energy has wide utilization. The use of new and efficient photovoltaic cells has emerged as an alternate measure of renewable green power and energy conservation.

A FEW SOLAR ENERGY HARVESTING TECHNIQUES

(a): Nanotechnology Enhanced Thin-Film Solar Cells

In theory all parts of visible spectrum from infrared to ultraviolet can be harnessed. The mainstay at present is the silicon solar cell which accounted for 90% of the market in 2004. However these are costly to manufacture and have limited efficiency (around 14% in most production modules, and up to 25% in the lab). The cost per unit of power is at least several fold higher using silicon solar cells than that derived from fossil fuel combustion (The Institute of Nanotechnology, 2006).Thin film is a more cost-effective solution and uses a cheap support onto which the active component is applied as a thin coating. As a result much less material is required (as low as1% compared with wafers) and costs are decreased.
Nanotechnology (“nano”) incorporation into the films shows special promise to both enhance efficiency and lower total cost. Many nano-structured materials are now being investigated for their potential applications in photovoltaic[2]
Nano-structured layers in thin film solar cells offer three important advantages.
First, due to multiple reflections, the effective optical path for absorption is much larger than the actual film thickness.
Second, light generated electrons and holes need to travel over a much shorter path and thus recombination losses are greatly reduced. As a result, the absorber layer thickness in nano-structured solar cells can be as thin as 150 nm instead of several micrometers in the traditional thin film solar cells.
Third, the energy band gap of various layers can be tailored to the desired design value by varying the size of nano-particles. This allows for more design flexibility in the absorber and window layers in the solar cells.

(b): Effective Battery Charging System by Solar Energy Using C Programming and Microcontroller

A simple, reliable and effective solar panel charging system has been introduced consisting of a solar panel of desired size and shape.
This solar panel is integrated with an embedded system (which contains three modules i.e. dc to ac converter, microcontroller/compiler module and charging output and a battery system).This embedded system regulates the electricity produced(after being converted to ac from dc) between the storage battery and charging output with the help of

microcontroller which is programmed to combat the situations in presence and in absence of input supply and able to supply stored energy at night or in unavailability of solar source.

PV generators are neither constant voltage sources nor current sources but can be approximated as current generators with dependent voltage sources [1]. During darkness, the solar cell is not an active device. It produces neither a current nor a voltage. However, if it is connected to an external supply (large voltage) it generates a current ID, called diode current or dark current. The diode determines the i-v characteristics of the cell. There are three different models of PV cells generally available.

A small effective system comprising of four modules, first the stepping down the dc voltage from Xv to Yv(say) for the microcontroller process to take place, secondly inverting the dc to ac, followed by the relay action of switching and finally passing it to the microcontroller module where it is governed as per the situation of the battery of the module as well as of the system.

The designed system will solve several of the situations where the solar panel is shown incapable and not worthy for the work. The general information describing the overall system, we get the supply from the solar panel system which is step down as per the requirement and inverted if needed which sends us to the next level of relay where the switching takes place as per the command of microcontroller[3].

Considering the three situations in when solar panel is connected:

a) Firstly when the output is connected, in this case the current flows directly to the output, once the output requirements are fulfilled, it automatically switches to the next mode with the help of a zener diode being regulated by microcontroller and commanded to relay, fixed to a certain level and glowing the led for the same.

b) Secondly the switched mode transferred to the charging of the battery placed inside the system for emergency usage, follows the same function of charging and when fully charged to the level of Zener diode given it switches the current to the initial stage.

c) Thirdly the initial stage current not entering the system when both the stages are fulfilled prevent the further depletion of batteries which can be caused if extra current runs through them and increasing the life of the system.

The proposed system is be very effective for solving several situations where the solar panel is incapable and not worthy for the work. The proposed effective charging system can be extended to any level, any set-up, which only involves the small embedded kit with the three essential modules empowering the renewable energy.

(C): Dye Sensitised Solar Cells

New pigment deposition process increases efficiency of solid-state dye-sensitised solar cells [4]
Dye-sensitised solar cells, first introduced in 1988 are low-cost solar cells belonging to the group of thin film solar cells. The technology, sometimes described as ‘artificial photosynthesis’, uses a layer of nano-titania (a pigment used in white paints and tooth paste) and light harvester deposited on glass, metal or polymer substrates.
One of the advantages DSC technology offers over traditional silicon solar panels is the consistent energy output in low-light, dawn, dusk, cloudy, indoor/artificial, and shaded or indirect-light conditions. This means that the cumulative seasonal energy output from DSC over the course of a cloudy autumn, dreary winter, and whole year is much greater.
The two-step deposition process could be easily implemented commercially as it is relatively cheap and convenient for production in mass quantities.
Such technology could virtually turn buildings into active power generators, supplying either the building’s inhabitants or the national grids.

(D): Solar Cells on Paper

Using abundant, inexpensive organic elements like carbon, oxygen, and copper in a vacuum chamber layers are “printed” through a process called vapor deposition, similar to frost forming on a window[9]. At less than 120 degrees Celsius, the method is gentler and cooler than that normally used to manufacture photovoltaic materials, allowing it to be used on delicate paper, cloth, or plastic.

Silvery blue solar cells seem to magically generate electricity from sunlight. The cost of manufacturing crystalline and thin-film solar cells with silicon, glass, and rare earth materials like tellurium and indium is high. A prototype solar cell (a sheet of paper embossed with a pinstripe and chain-link design) folded into a paper airplane as a power source for an LCD clock.

(E): Increasing Efficiency of Solar Panels

Recent research from the Imperial College, London (ICL), has demonstrated one way to increase the electrical current produced by devices in the lab by 22 per cent. By studding the light-receiving surface of gallium-arsenide (Ga-As) devices with aluminium nanocylinders, like the ridges on Lego blocks, the researchers were able to promote the scattering of light in the visible part of the spectrum, which dominates the energy in sunlight.

The scattered light then travels a longer path inside the semiconductor, meaning that more photons can be absorbed and converted into current. It is important that the metal nanocylinders do not absorb the light themselves, as that would prevent it from reaching the panel.

The advantage of aluminium structures is that their absorption occurs in the ultraviolet part of the spectrum. That means that the absorption losses are limited to the ultraviolet and scattering from the aluminium particle dominates in both the visible and near infrared.

The significance of this method work lies in demonstrating aluminum's better performance over silver and gold nanostructures. For one, aluminium is more abundant and less costly than silver and gold. For another, the 22 per cent spike that aluminium provides, as their paper notes, makes thinner-film solar panels technically feasible without compromising power conversion efficiencies, thus reducing material consumption.
Higher efficiency devices could play a significant role in realizing energy goals even in India, making them more cost-effective.

(F): Future Cells Could Be Made of Wood Fibres

The one downside to solar technologies is what materials are used to make them. From rare earth metals to plastics, solar cells can be made from a host of not so environmentally-friendly items. In the future though, solar cells may be green energy producers and greenly produced.

Researchers from University of Maryland, the South China University of Technology, and the University of Nebraska-Lincoln have developed a new type of paper made from wood fibers that is 96 percent transparent and could ultimately replace the plastic substrates that solar cells are made on. Not only would that mean that solar cells would be more environmentally friendly, but they'd be cheaper to make and even perform better.

As the researchers explain, solar cell performance benefits when materials possess both a high optical transparency (to allow for good light transmission) and a high optical haze (to increase the scattering and therefore the absorption of the transmitted light within the material).

The new wood-based paper has an ultrahigh transparency of 96% and ultrahigh optical haze of 60%, which is the highest optical haze value reported among transparent substrates.

(G): Increased Charge Carrier Mobility of the Nanostructures Materials for Solar Energy Applications

The effect of both the fullerenes C60 and C70, as well as the carbon nanotubes on the mobility of charge carriers in conjugated organic systems based on polyimide (PI), on 2- cyclooctylamino-5-nitropyridine (COANP), on other nitro replaced aromatic compounds has been studied. It has been established that the carrier mobility in photoconductive nano objects-containing conjugated organic thin films exhibits a tenfold increase as compared to the nano objects-free organic films. The charge transfer complex (CTC) formation between donor part of the organic matrix and carbon-based acceptor has been revealed as the main mechanism responsible for the increased charge carrier mobility [10].

CONCLUSION

As discussed in the paper these proposed systems will be very effective for solving several situations where the solar panel is incapable and not worthy for the work.

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