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Nanotechnology in Solar & Fuel Cells

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ABSTRACT: The discussion of this paper is implementing nanotechnology in renewable energy sources.since these are non-depleting as well as eco –friendly, but the materials we use to capture energy are costly as well as they prove to be in-sufficient.Using nanotechnology we can smartly tackle problems over a wider range such that it can be used in many applications.

KEYWORDS*:* dye sensitized solar cells, Coaxial electro spinning, nano rods.

1. INTRODUCTION

The very foundation of modern civilization lies on the abundant supply of electrical energy.For the last two centuries,most of our electricity needs have been fulfilled by fossil fuel sources such as coal,natural gas and petroleum. However, the global electricity demand is continuously increasing.The continuous increase in energy demand is forcing our society to search for environmentally clean,sustainable and renewable energy sources. Probably nuclear energy could be an answer. But decomposition &radiations are huge drawbacks. The cheap source of developing energy is sun and in technical view fuel cells could be the second hand. Developing nanotechnology can lend its applications for sufficiently for a long period minimising the need for huge demands.

1.1 Solar Energy

Solar energyis the non-polluting&non-depletingsource of energy we get from the sun. On an average earth receives about $3.6*10^{28}$ joules of energy from sun. we know about conventional solar that they are made crystalline silicon &trap photons such that recombination of electrons & holes takes place to emit light. But they have two main drawbacks:

1. They are expensive.
2. They are in-efficient because the incoming photons or light. Must have the right energy,called the band gap energy,to knock out an electron. If the photons has less energy than the band gap energy then it will pass-through. If it has more energy than the band gap,then that extra energy will be wasted as heat.

Nanotechnology might able to increase the efficiency of solar cells, but the most promising application of nanotechnology is the reduction of manufacturing cost. The new solar cells are called as “plastic cells”. 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 aluminium electrode where they are combined to form a current and are used as electricity. This type of cell is manufacture than conventional ones for two main reasons .[1]

1. First, these plastic cells are not made from silicon, which can be very expensive.
2. Second, manufacturing of these cells does not require expensive equipment such as clean rooms or vaccum chambers like conventional silicon based solar cells. Instead, these plastic cells can be manufactured in a beaker.

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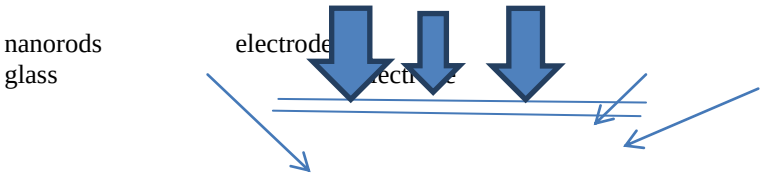
Another potential feature of these solar cells is that the nanorods could be 'tuned' to absorb various wavelengths of light. This could significantly increase the efficiency of the solar cell because more of the incident light could be utilized.

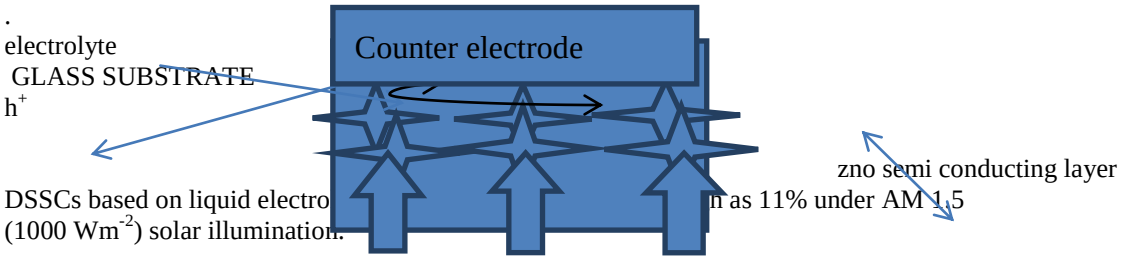


A well-known company named konarka technologies is also pursuing the use of nanotechnology to Improve solar energy. In fact, they are already manufacturing a product called, "power plastic" which absorbs both sunlight and indoor light and converts it into electricity. For patent reasons, their technology is kept secret, but the basic concept is that power plastic is made using nanoscale titanium dioxide particles coated in photovoltaic dyes,which generate electricity when they absorb light.[4]

1.2 DYE SENSITIZED SOLAR CELLS:

In recent years, dye-sensitized solar cells(DSSCs) have received considerable attention as a cost-effective alternative to conventional solar cells.DSSCs operate on a process that is similar in many respects to photosynthesis. The process by which green plants generate chemical energy from sun light. Central to these cells is a thick semiconductor nanoparticle film (electrode) that provides a large surface area for the adsorbtion of light harvesting organic dye molecules. Dye molecules absorb light in the visible region of the electromagnetic spectrum and then "inject" electrons into the dye from an electron donor mediator supplied by an electrolyte, Resetting cycle.

Because of the low cost of production, DSSCs have potential to revolutionize the solar cell industry. However, until recently the most common DSSC systems under investigation were based on electrodes consisting of sintered semiconducting nanoparticles (mostly Tio_2 or zno). These nanoparticle based DSSCs rely on trap-limited diffusion through the semiconductor nanoparticles for the electron transport. [3]



1.3FUEL CELLS:

A fuel cell combines hydrogen and oxygen to product electricity,heat, and water. Fuel cells are often compared to batteries.both convert the energy produced by a chemical reaction into usable electric power. However, the fuel cell will produce electricity as long as fuel (hydrogen) is supplied,never losing its charge.

Fuel cells are a promising technology for use as a source of heat and electricity for buildings, and as an electrical power source for electric motors propelling vehicles. Fuel cells operate best on pure hydrogen. But fuels like natural gas, methanol, or even can be reformed to produce the hydrogen required for fuel cells. Some fuel cells even can be fuelled directly with methanol, without using a reformer. In the future, hydrogen could also join electricity as an important energy carrier. An energy carrier moves and delivers energy in a usable form to consumers. Renewable energy sources, like the sun and wind, can't produce energy and hydrogen, which can be stored until it's needed. Hydrogen can also be transported (like electricity) to locations where it is needed.

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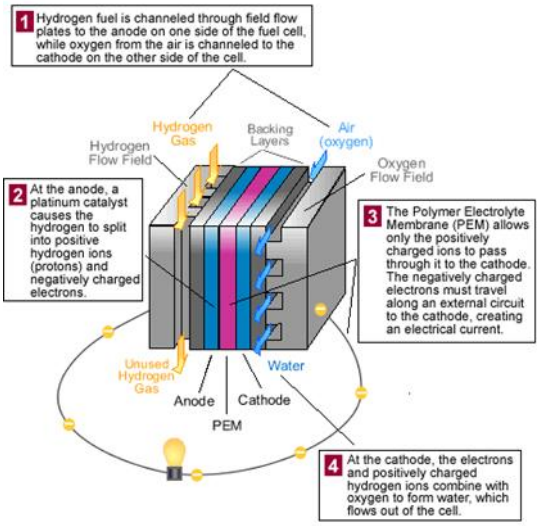
II. INTERESTING FACTS THAT RECOMMENDS HYDROGEN TO BE USED AS A FUEL

1. Hydrogen is the most abundant element in the universe.
2. Hydrogen is the only element that can exist without neutrons. Hydrogen's most abundant isotopic has no neutrons.
3. Solid, crystalline hydrogen has the lowest density of any crystalline solid.
4. We owe most of the energy on our planet to hydrogen. The sun's nuclear fires convert hydrogen to helium releasing a large amount of energy.



Nanotechnology provides more efficient membranes such that leakage of hydrogen is impossible. Since platinum is needed for the production of hydrogen. Using nanoparticles of platinum production cost & increases its efficiency. We can use these fuel cell bundles in automobiles, industries, laptops etc….

III. HYDROGEN POWERED VECHICLES

Ford Motor Company recently introduced the P2000, a new car with a hydrogen internal combustion engine (ICE) that "could help bridge the gap between gasoline vehicles and the fuel cell vehicles of the future." [1] The engine is not much different from an ordinary gasoline engine. The use of hydrogen greatly reduces emissions although nitrous oxides are still a problem. Engine efficiency about equals a diesel, about 35%. The hydrogen is stored in a tank that is rated at 240 atmospheres (240 bars). The range is only 62 miles. Ford does not give the price of the P2000, but it should be inexpensive given that all of the components are rather ordinary.Honda has introduced the FCX, a car utilizing a fuel cell instead of an ICE. [3] This gives an overall efficiency of 45%. A fuel cell turns hydrogen into electricity which drives the wheels through electric motors. The hydrogen is stored in carbon fibre tanks at 333 bars.The engineers at Honda have also provided a solar powered hydrogen source. On sunny days in California it produces 16 litres per day. The tanks of the FCX holds 156 litres. The solar powered hydrogen source can move one FCX 16 miles each day.[5]

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Modern18 wheel semi-trucks are a formidable piece of engineering. The durable diesel engines can develop 500 horsepower continuously, and they achieve 35% efficiency. They can haul 80,000 pound loads at high speeds over mountains. Carbon fibre and aluminium are used to reduce weight. Designing a hydrogen powered replacement would be a very difficult project. Trucks need a lot of power all the time while cars need a lot of power only during short bursts of acceleration. Most of the time, cars need only a low power engine. The Honda FCX exploits that fact.
The diesel engine could be replaced by a hydrogen internal combustion engine. At 35% efficiency, there would no gain in fuel economy.

A fuel cell capable of developing the equivalent 500 horsepower of electrical power would cost millions of dollars. Improving overall efficiency from 35% to 45% hardly seems worth it.

This is an artist's rendering of a hydrogen powered version of the A310 Airbus. [2]It is also called the "Cryoplane" because of the very visible cryogenic hydrogen tank located above the passengers. Cryogenic hydrogen is the only possibility for aircraft as high pressure tanks would be too heavy. The physical properties of liquid hydrogen determine the appearance of the Cryoplane. Liquid hydrogen occupies 4.2 times the volume of jet fuel for the same energy which means that the tanks have to be huge. Jet fuel weighs 2.9 times more than liquid hydrogen for the same energy. The reduced weight partly compensates for the increased aerodynamic drag of the tanks. The Cryoplane would have less range and speed than the A310 Airbus. Whatever energy source is used, 30% will be lost in hydrogen liquefaction.

The second stage of the Saturn 5 rocket that took 3 men to the moon used liquid hydrogen. A vehicle that can go directly to orbit has always been the dream of space travel. The X-33, now cancelled, was designed to do that. Liquid hydrogen is the only fuel light enough and energetic enough to do the job. The X-33 had liquid hydrogen tanks with very little insulation resulting in rapid hydrogen loss. This is only a small problem because the tanks can be topped off just before launch. Travel time from earth to orbit is only a few minutes and so high hydrogen losses are tolerable. Hydrogen gas stored in plastic micro beads could make fuel cell vehicles safer to use.

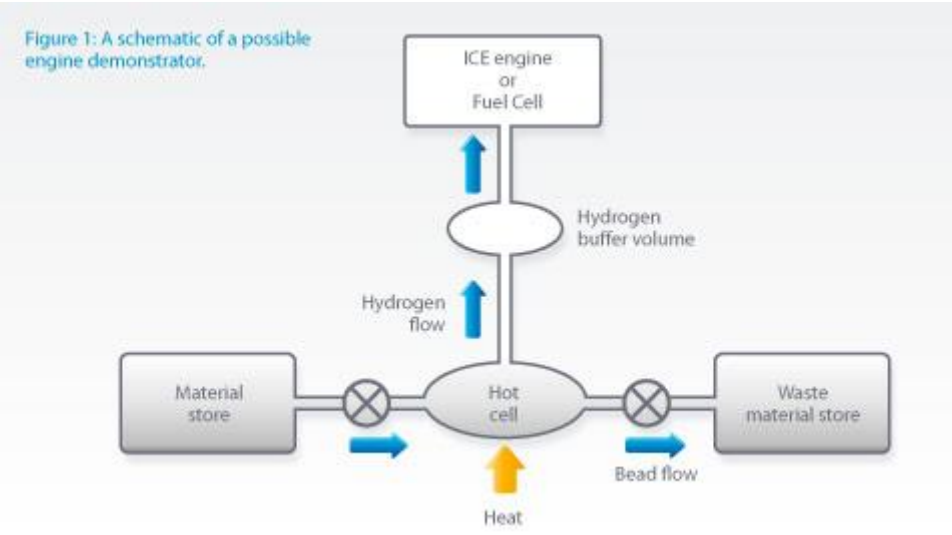

Figure 1: A schematic of a possible engine demonstrator.

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Coaxial electro spinning is a new technology developed by cell energy, a spin off from britain's Rutherford Appleton laboratory. Also called electrospraying, the process absorbs and encapsulates hydrogen gas in a microscopic sponge formed by nano-fibre hybrids.

The plastic beads storing the chemical hybrid are 30 times smaller than a human hair,making the micro the micro beads flow like liquid through a vehicle's fueling system. The beads can safely be exposed to air and require less heat to drive off the encapsulated hydrogen that is used to propel the vehicle. Spent beads are stored in a separate waste tank and get recycled when drivers refuel their vehicles.

For consumers, this breakthrough means they can refuel fuel cell vehicles quickly and safely without fear of the pump bursting in flames.

Most fuel cell vehicles store compressed hydrogen gas in either 5,000 0r 10,000 psi tanks. And although all fuel is combustible, fuel cell detractors often warn that hydrogen gas posses a safety threat to drivers.

V. CONCLUSION AND SCOPE

1. Goal is to decrease our dependence on fossil fuels.
2. Most viable for niche market.
3. Most economical for all people to use.
4. A greener earth for our living.

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