



# Nanotechnology and Energy

P.Raj Shekhar Phaneendra  
Associate Professor  
Department of Physics

Pragati Engineering College, Surampalem, Andhra Pradesh, India

### Abstract:

This paper basically deals with the key necessity of Nanotechnology as an alternative energy source for the current growing energy requirements of the world. This emphasises the multidirectional research in the field of Nanotechnology to serve this purpose.

### INTRODUCTION

In a short span of time research and development has experienced a tremendous growth in nanotechnology. Nanotechnology is the engineering of tiny machines that have projected ability to builds things from bottom up inside nanofactories by making use of techniques and tools developed to prepare or manufacture highly advanced products. It holds the answer to the extent there are answers to most of our most pressing material needs.

At the nanoscale materials exhibits various properties. Changed properties include greater material strength, enhanced reactivity better catalytic function & higher conductivity currently nanotechnology is described as revolutionary discipline in terms of its possible impact on industrial applications. Nanotechnology offers potential solutions to many problems using emerging nanotechniques.

In respect of narrowing fossil energy resources and potential side effects of climate warming carbon

dioxide emissions it becomes obvious that for a sustained long term economical prosperity a fundamental renewal of the energy sector will be necessary. Nanotechnology as a cross section and key technology has the potential to significantly contribute to technological breakthroughs in the energy sector. This includes short term incremental steps for a more efficient exploitation, handling and usage of conventional as well as regenerative energies and in the long term completely new approaches for energy generation such as imitating natural processes like photosynthesis. The paper will summarize the results of a recent study on the technological and economical potential of nanotechnologies in the energy sector and give an overview on technological developments and recent market trends.

Depending on the strong inter-disciplinary character of nanotechnology there are many research fields and several potential applications that involve nanotechnology. Let us discuss in this section role of nanotechnology for future energy requirements.

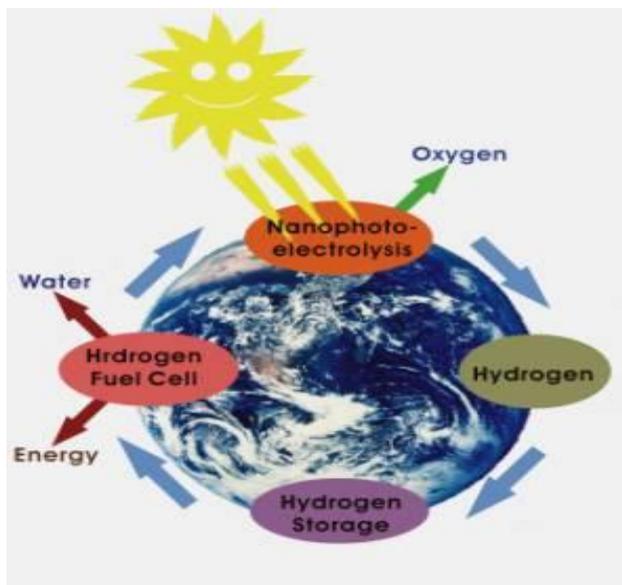


Fig.1

Diagram represents the splitting of water into hydrogen and oxygen

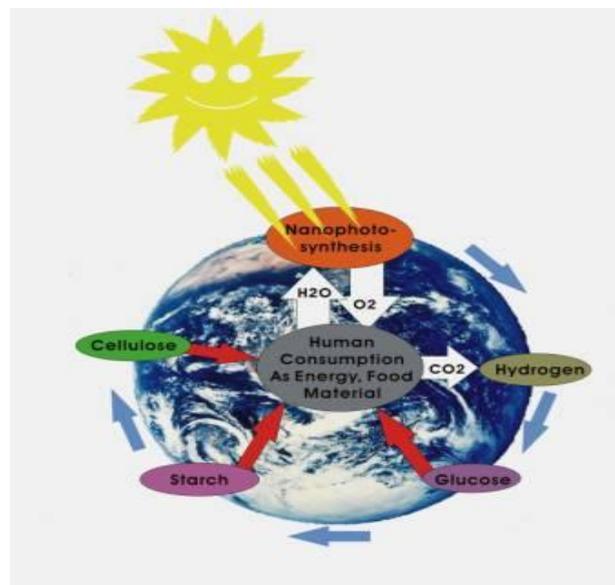


Fig.2

Diagram represents the Nanophotosynthesis in nature

### NANOTECHNOLOGY MEETING OUR NEEDS

<sup>[1][4]</sup> Researchers at the Energy and Environmental Technology Application Center at the University at

Albany's College of nanoscale science and Engineering(CNSE) are researching and developing nanoscale technologies that is capable of producing greater

yields at low cost across a range of conventional, as well as renewable alternative power generation technologies.

### “More power, less emission from conventional Electrical systems”.

According to Professor Pradeep Haldar, nanoscale engineering and director at CSNE “One of the keys to addressing this challenge is innovation and some of the most promising solutions are occurring at the smallest scale—the nanoscale”. The potential of new nanoscale technology to improve power efficiency and life span of equipment used in power generation, transportation and distribution is already and increasingly evident for both existing conventional and new alternative systems.

The latest generation of fossil fuel plants, including coal fired ones, requires components able to withstand high temperatures and pressures in order to raise efficiency, lower maintenance costs and decrease emission levels.

New ceramic “Nano Coatings” are being used on raw water and pretreatment systems, fire protection systems, condensers cooling towers, de-aerators, steam turbines, electric generators, air-heaters, protecting metallic components and extending their life while increasing output and reducing energy consumptions emissions.

### ALTERNATIVE ENERGY TECHNOLOGY FOR MODERN WORLD

<sup>[4]</sup>Nanotechnology’s most exciting and valuable contributions in the energy sector are likely to be seen in the renewable, alternative energy sector.

Halwar states “Today, the renewable industry represents the fastest growing energy market in the world and nanoscale science and Engineering are playing an increasingly critical role”.

Nanoscale processes, materials and devices are already part of the process through which silicon based Photovoltaic Solar Cells 95% of markets today produce electricity. Focus is on research and development of a new generation of solar power technology that includes ultra thin amorphous Silicon, organic and inorganic Solar cells derived from nano crystals that convert sunlight into electricity. These solar Nano cells are so small and pliable

that they can be painted on to physical structures so that the walls of a building may one day soon be able to produce energy.

### SOLAR ENERGY AND HYDROGEN PRODUCTION

One way of producing environment friendly hydrogen is by electrolysis with the electricity generated via solar cells. A research is on its way on using nanotechnology to produce solar electricity at greater efficiency and with cheaper components. Another method is PhotoelectroChemical hydrogen production cells.

### BULBS

<sup>[2]</sup>Lighting is a part of life and in its absence seems to put all of us in darkness. A tube light or an incandescent bulb consumes nearly around 10% of supplied energy to produce light, and remaining is emitted as heat energy. Now a day’s Compact Fluorescent and LED bulbs already increasing efficiency of lighting but lighting based on quantum dots is expected close to 100% efficiency.

### DISPLAYS AND MONITORS

Air conditioners and Heaters are the largest users of energy within the home and after that come house hold appliances and entertainment. Appliances are not working regularly but television and computer screens are on for hours at a time. Number of methods are being processed for the next generation flat panel display screens and greatly all of these methods are based on nanotechnology in the form of carbon nano tubes or other components. Manufacturers who are developing these screens suppose that it will reduce the energy consumption.

### INSULATION FILMS

As we know that Thermal insulation materials are bulky and the way they trap a layer of air to provide their insulating properties. In an application a thick insulating layer is not suitable and so efficiency is lost. It has now been used to synthesise an insulating material that can be coated on to a surface as a thin film. The insulating effect of this material exceeds most traditional insulating materials. Transparent films are available for window coatings. These nanotechnology enabled solar control films reduce energy consumption by filtering solar heat and insulating windows.

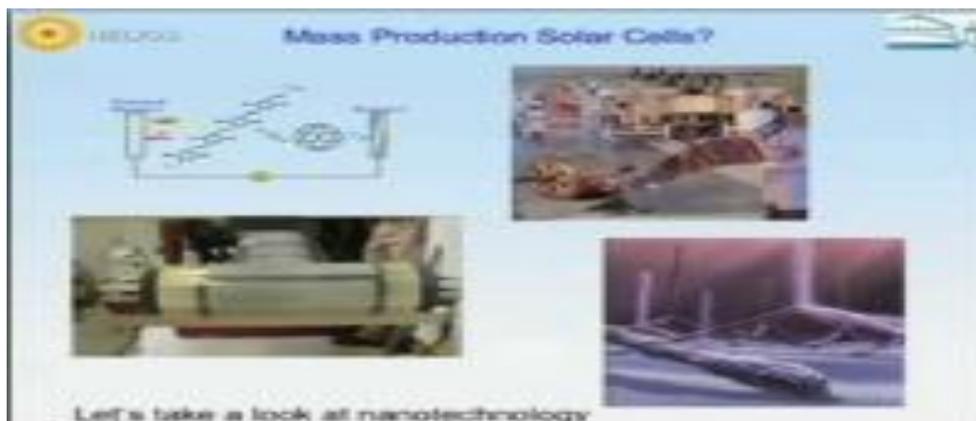


Fig.3.Nano solar 1GW Solar Power Film Coater

### NANOTECHNOLOGY BOOSTS EFFICIENCY OF CONVERTING SOLAR ENERGY INTO HYDROGEN IN FUEL CELLS

[3] Researchers find great promise in a process that could use solar energy to use hydrogen, the third most abundant element on earth's surface, as the ultimate alternative to fossil fuels. This process increase dramatically the efficiency of titanic photo anodes used to convert solar energy into hydrogen in fuel cells. Solar energy has the

power to reduce greenhouse gases and provide increased energy efficiency, Hydrogen, the third most abundant element on earth's surface, has long been recognized as the ultimate alternative to fossil fuels as an energy carrier. Automobiles using hydrogen directly or in fuel cells have already been developed, but the biggest challenge has been how to produce hydrogen using renewable sources of energy.

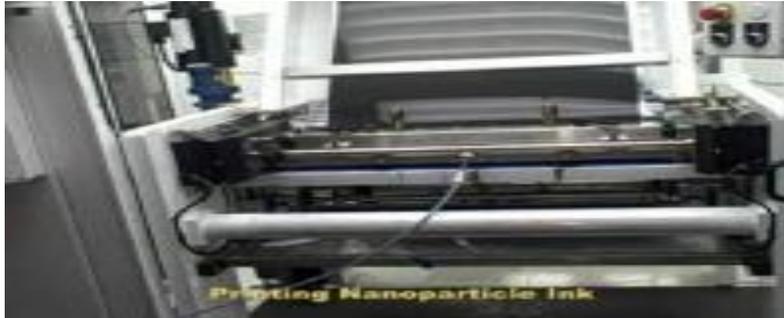


Fig.4

World's first 1GW solar production tool. Breakthrough in the production of solar electricity cells: Simply printed (using ink with semiconductor nanoparticles).

### NANOTECHNOLOGY BREAKTHROUGH- INVENTION OF PAPER BATTERY

How exciting if a piece of paper supplies power to your cell phone or CD player! That's the latest growing technology that researchers at RPI, New York have come up with. The new battery, that looks like a piece of paper called paper battery could one day provide a lightweight power source for electronics and other devices. The prototype square battery would be printed like a newspaper.



Fig 5

Diagram showing Paper battery

### PRODUCTION OF SINGLE AND MULTI WALLED CARBON NANOTUBES



Fig 6

This picture shows how multi walled and single walled Carbon Nanotubes appear . Example applications are usage

of aligned nanotubes in flat screen displays, hydrogen storage for automobiles and the potential for nanotube switching in microelectronics

### Heat From The Sun To Electricity Converted By Silicon Ink Technology

Solar energy manufacturing is being redefined by Innovalight. Innovalight is using High precision inkjet manufacturing to replace many of the costly manufacturing steps required to make solar modules today. The by product is a high efficiency, low-cost and highly reliable silicon based solar module which will bring solar energy to the masses.



Fig 7

### Turning Sunlight Into Liquid Fuels



Fig 8

Researchers with the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) have now taken a critical step towards this goal with the discovery that nano-sized crystals of cobalt oxide can effectively carry out the critical photosynthetic reaction of splitting water molecules.

### **ENERGY GENERATION**

It's highly essential to discuss the possible measures to generate energy for the future generations. Nanotechnology's premier importance to the present world is the development of cheap yet highly efficient solar cells for the generation of electricity. Primary developments are being made in this field with solar cells being developed that are made from cheap, low toxicity materials through to electricity generating films that can be painted onto almost any surface.

#### **[5] Enabling Nanotech Revolutions**

1. Photovoltaics -- a revolution to drop cost by 10 to 100 fold.
2. H<sub>2</sub> storage -- a revolution in light weight materials for pressure tanks, and/or a new light weight, easily reversible hydrogen chemisorption system
3. Fuel cells -- a revolution to drop the cost by nearly 10 to 100 fold
4. Batteries and super capacitors -- revolution to improve by 10-100x for automotive and distributed generation applications.
5. Photocatalytic reduction of CO<sub>2</sub> to produce a liquid fuel such as methanol.
6. Direct photoconversion of light + water to produce H<sub>2</sub>
7. Super-strong, light weight materials to drop cost to LEO, GEO, and later the moon by > 100 x, to enable huge but low cost light harvesting structures in space; and to improve efficiency of cars, planes, etc.
8. Nanoelectronics to revolutionize computers, sensors and devices.
9. High current cables (superconductors, or quantum conductors) with which to rewire the electrical transmission grid, and enable continental, and even worldwide electrical energy transport; and also to replace aluminum and copper wires essentially everywhere -- particularly in the windings of electric motors (especially good if we can eliminate eddy current losses).
10. Thermochemical catalysts to generate H<sub>2</sub> from water that work efficiently at temperatures lower than 900 C.
11. CO<sub>2</sub> mineralization schemes that can work on a vast scale, hopefully starting from basalt and having no waste streams.

12. Nanoelectronics based Robotics with AI to enable construction maintenance of solar structures in space and on the moon; and to enable nuclear reactor maintenance and fuel reprocessing.
13. NanoMaterials/ coatings that will enable vastly lower the cost of deep drilling, to enable HDR (hot dry rock) geothermal heat mining.
14. Nanotech lighting to replace incandescent and fluorescent lights

### **CONCLUSION**

<sup>[6]</sup>In the field of Nanotechnology our growing area of research is to provide sufficient energy to the world by protecting our environment in the coming next 50-60 years. By neglecting this we are endangering the future generations with regard to energy sources. Nanotechnology will play a pivotal role in this area of research.

In connection with the demand and supply of world energy requirement Nanotechnology will change our economic structure and lives over the next generation. Nanotechnology and Energy are connected together. The production of Oil Wells can be increased by using the Nanotechnology. Keeping in view the consensus that projects the future demand for the worldwide oil supplies increases 1.5 to 2 years in developed and Third world countries. Increasing oil well yield is one of the most productive research activities because producers know the need of it.

We should not forget that the energy issues that nanotechnology is trying to find solutions in global scale, especially with environmental pollution in the developing countries. It has to be scalable to global dimensions so that adopted solutions can have few negative consequences.

It's more inspiring that your energy related nanotechnology investment is increasing day by day. In wide view, the world currently consumes only 14 terawatts of electrical power that it generates with large inefficiency and losses. By next century, we need to generate above 30 terawatts to satisfy the minimum modern worldwide standards. Nanotech based efficient electrical transmission lines seem to have a bright future this century.

#### **References:**

- [1] <http://www.enn.com/energy/article/27770>
- [2] [www.azonano.com/article](http://www.azonano.com/article)
- [3] <https://energyconsulting.wordpress.com/2009/03/23/nano-technology-boosts-efficiency-in-converting-solar-energy-into-hydrogen-in-fuel-cells..>
- [4] Handbook on Nanoscience, Engineering and Technology, 2nd Ed., Taylor and Francis, 2007.
- [5] National Nanotechnology Initiative. <http://www.nano.gov>
- [6] Centre Responsible For Nanotechnology, <http://www.crnano.org/whatis.html>