Energy Application in Nanotechnology

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Abstract— This study is define on the nanotechnology with energy application. In this technology explain the energy conversion, generation, storage and transportation.it is in unique technique, capacity, great potential to fabricate new structure at atomic scale has produced novel material and devices. Its technique have great potential applications with wide fields.to required large no. of energy in the world.in present available energy is not sufficient for comparison on world requirement energy. That's vision of fulfillment the required no. of energy by through this new technique.in hence present advance of the nanotechnology to suitable useful energy generation, production, storage and use. The main function and aim of this technology working from different fields, areas and points, to find out the better solutions. Which is the great challenge of our life?

Key words: Fuel cells, Nanotechnology, Super capacitors

I. INTRODUCTION

Nanotechnology a is a new approach to understanding and modifying the properties of materials at the nano scale: 1nm $=10^{-9}$m is a length of very small molecules. [1]

The application of nanotechnologies to energy transmission has a large potential significant to transmission technology with the need for additional development. Nanotechnology is being used and considered for more efficient energy supplies and uses. These applications may not be affected energy transmission directly, because it has a large potential to reduce need for the fuels, electricity or nature gas for energy transmission. [2].

The world energy requirement is satisfied by the combustion of fossil fuels. Par day 210million barrels of oil used in total worldwide, in about 85 million from oil,23% from coal,17% from gas, 17% from biomass,5% from some fission,6% from little hydroelectric and almost none from renewable resources.[3].

In future that by 2050 will be need twice amount of the energy because we are the amount of natural fuel burning and consuming today ,about 14 TW.(terawatts). That's main reason continuously increasing the population of the world.

The nano energy is very efficient and economically viable option. Its excellent example-solar energy, in earth every day is hit by165, 000 TW of solar power. The main objective is solar energy collection, conversion, storage and distribution. Which is efficient and cost effective? The current efficiencies of solar panels have about 25%energy conversion. But it is very expensive. Therefore we needs to suitable storage. Another alternative energy source is hydrogen. This fuel cell to be used life time and that is not very expensive.it is a solution of future Energy challenges. [3].

II. ENERGY APPLICATION

The general energy applications in nanotechnology is used many application targeted to provide more efficient energy supplied and uses. It's have a large potential to reduce the need for the fuel, electricity or natural gas. The energy related technologies in which nanotechnology may be play role involve:

- Lighting
- Heating
- Transportation
- Renewable energy
- Energy storage
- Fuel cells
- Hydrogen generation and storage
- Power chips

The nanotechnology is to traditional energy source in a more efficient, safe and by environmentally combined manner. Its have some general suitable energy sources as like biomass, wind energy, geothermal energy and solar power.it is reduced the energy loss of the power transmission and manage the power grade. [2-5]

III. ENERGY CONVERSION

The nanotechnology is provide optimization to all standard fuel cell system, namely regarding electrodes, membranes, electrolytes or even catalysts in the electrodes as well as for hydrogen production.

A membrane fuel cells, mainly polymer membrane fuel. The suitability of the temperature which shall be improved, inter alia, through the application of inorganic-organic nano composites. Here, polymers are used to modify with in organic nanoparticles in sol-gel processes. The high efficiency is achieved through higher operating temperature, and carbon monoxide arising from the reforming process therefore hydrogen produce from methanol. The highest efficiencies are possible in electrochemical hydrogen/oxygen. Hence the hydrogen produces by the conversion of natural gas or methanol. Many energy sources as like wind and solar energy is power generated through the nanoparticles or environmental kinetic motions & radiations. In other hand "the environmental changes are we can use power generation technique. That method in storing the nano partials are used with conversion to a suitable energy. Nanotechnology is make great energy stores, including in electrical and chemical store such as batteries and hydrogen. Hydrogen has a high energy density by weight, but its storage has a low energy density by volume that is a major challenge. [4-5].

We can take a process of hydrogen production for understanding the energy conversion system in nanotechnology or advance technique. With the help of Nano structuring increase the efficiency of precious metal

catalysts in the electrolytic decomposing of water. The optimizing the high temperature electrolysis of water at about 1000^0C and high efficiency 90% over are achieved in energy conversion, now here ceramic materials are used as oxygen-conducting solid electrolytes, the photo electrolytic water decomposition provides a promising approach. The photochemical decomposition of water in the photocell through observation of light at photo electrodes lead. Therefore oxidizing of the oxygen in the anode and cathode point hydrogen being reduced to elemental hydrogen.

Oxidizing of oxygen in semiconductor electrode metal. [4]

$$H_2O + 2h^+ \rightarrow 1/2\ O_2 + 2H^+$$

Reduction of hydrogen in semiconductor electrode metal

$$2H^+ + 2e^- \rightarrow H_2$$

We know that hydrogen is a smallest element, its can escape easily from tanks and nanotubes. Then it is a conventional fuel. They are two ways of storing the hydrogen. One ways observation and another is store in container. [2]

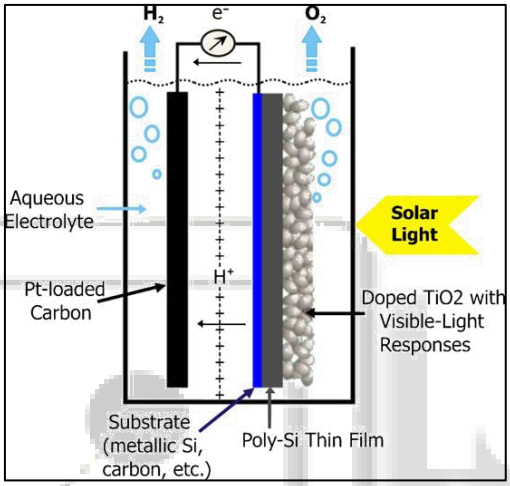

Fig. 3: schematic sketch of photo electrolytic hydrogen production. [6]

Hydrogen can be used both in engines and fuel cells. In engine hydrogen can be burn in the same manner as gasoline or natural gas, the fuel cell are electrochemical device that transform the chemical energy of hydrogen into electricity.in a hydrogen fuel cell, hydrogen combined with oxygen without combustion in an electrochemical reaction and produce direct current electricity.[6]

Fuel cell type	Anode reaction	Cathode reaction	Operating temperature
Alkaline FC	$H_2 + 2OH^- \rightarrow 2H_2O + 2e$	$½\ O_2 + H_2O + 2e^- \rightarrow 2OH^-$	75^0 C
Polymer electrolyte member	$H_2 \rightarrow 2H^+ + 2e^-$	$½\ O_2 + 2H^+ + 2e^- \rightarrow H_2O$	80^0 C
Phosphoric acid	$H_2 \rightarrow 2H^+ + 2e^-$	$½\ O_2 + 2H^+ + 2e^- \rightarrow H_2O$	200^0 C
Molten carbonate	$H_2 + co_3^{2-} \rightarrow H_2O + co_2 + 2e^-$	$½\ O_2 + co_2 + 2e^- \rightarrow co_3^{2-}$	650^0 C
Solid oxide	$H_2 + o^{2-} \rightarrow H_2O + 2e^-$	$½\ O_2 + 2e^- \rightarrow o^{2-}$	500-1000^0 C

Table 3.1 hydrogen fuel cells are different types;

IV. ENERGY TRANSPORTATION

Nano technology may be more efficient transportation via catalysts in fuels; stronger materials; lighter and stronger material and more efficient batteries. Stronger material transportation resulting by the use of high strength, low weight material. Nanotechnology may be reducing the need for transportation fuels. A grid cable capable of the desired power transmission across to very longest distance. It's have a very useful. Its power transmission in the small rate of energy loss or negligible energy loss for transmission. The 100miles power transmission in only 5% loss on copper based electric grids. The insulation system in only 7% of energy loss during power transmission. A special type carbon tubes are called nanotube or armchair nanotubes. The dielectric based nano composites polymers have insulation properties which is improve the erosion and tracking resistance it is making the interesting conditions for high voltage outdoor insulation applications. [2-5]

Low-loss power supply through nanomaterial's. In power transmission grid cable length of over lengths of overs 600m could already be realized. Its transmission has low energy loss. The semiconductor will be play growing role in energy transmission for low loss wired power supply [4].

V. ENERGY STORAGE

The energy storage technology do not represent energy source, they improve stability, power quality, and reliability of supply. Battery technologies have improved & challenge of practical electric vehicles and utility application. The energy storage through flywheel technologies are used now advance and nonpolluting with power supply .the visible energy storage more technologies include as like ultra-capacitors, superconducting devices, batteries, flywheels etc., are using for energy storage systems. In electrical energy, it can be stored by converting the ac electrically and storing it electromagnetically, kinetically, or as potential energy. The two system of energy storage technology. Frist the energy can be stored by the application of device and second the energy can be transferred into or out of storage device. This is mainly depending into peak power rating. [10].

The power storage or energy storage system in characterized different devices and storage system. That may be explained below.

A. Batteries

In present most active research in this field is currently focused on rechargeable lithium batteries. As compared with the batteries, the Li-ion chemistry leads to an increase of 100-150% on storage capacity of energy per unit weight and volume. The research in Nano batteries points out the use of

nanomaterial's for both the electrode and the non-aqueous electrolyte.[6] the Nano structuration of the anode for rechargeable lithium batteries involved the substitution of LiC_6 electrode, with storage capacities of 340mAh/g, by graphite nanoparticles and carbon nanotubes. These has been further replaced by Nano sized mental oxides (i.e. titanium, aluminium, vanadium, cobalt, tin as well as silicon oxides) send mostly used nanotubes and nanowires. In hence to present approaches include the use of Nano scale metal alloy composites to increase the life cycle of nano composites through the reduction of volume changed during the formation of the alloy. As like, Li_4Si has the highest gravimetric energy density, 4200mAh/g, of all lithium alloys, volume change during alloy formation and are around 400%.

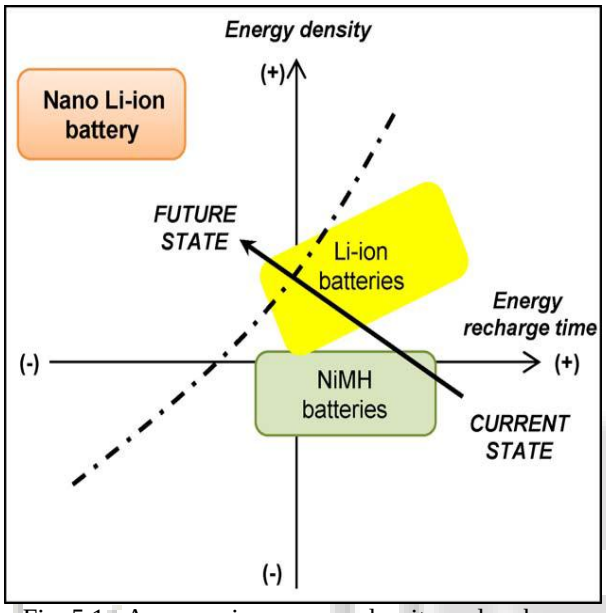

Fig. 5.1: A comparison energy density and recharge between conventional and a new batteries.[6].

The lithium-ion technology is regarded to high cell voltages and excellent energy and power density. The capacity and safety of lithium-ion batteries, in particular through optimized electrode materials and electrolytes. Here, development goal are anodes and cathode with higher loading/ discharge capacity, i.e., nonporous carbon materials(carbon aerogels, carbon nanotubes) higher energy densities can also be achieved through higher cell voltage, e.g. cathodes of mixed oxide of the category LiMPO4 with (M = Co, Ni, MN).[4]

It has a cost effective energy storage device. In this system energy stored by electrochemically. A battery system is made up of a set of low-voltage/power battery modules are connected in parallel and series. Batteries are charged when they undergo an internal chemical reaction under a potential applied to the terminals. They deliver the absorbed energy, or discharge, when they reverse the chemical reaction. The main application of batteries: high energy density, high energy capability, round trip efficiency, cycling capability, life span, and initial cost. Under consideration in this technology to the batteries large scale energy storage. [10].

B. Super capacitors

It has electrochemical double- layer capacitors characterized by high energy and power density. They are consist of two electrodes an electrolyte and separated by a separator. The super capacitor will be achieved through Nano structuring and the associated surface extension.

The carbon aerogels as nonporous material they are suitable as graphitic electrode materials in super capacitors. Due to this material, super capacitors with power density more then 10 kW/kg. Should be possible. [4].

C. Fuel cells

A fuel cell is a device used for electricity generation that is composed of electrodes that convert the energy of a chemical reaction directly into electrical energy, heat, and water. It is produced electricity from an external supply of fuel and oxygen, the limited internal energy storage capacity of the battery. Fuel cell provides useful power in remote location such as spacecraft and weather stations. Fuel cells will be used to power everything from electronic device to cars, building, and utility power plants. [2].

D. Advanced capacitors

Capacitors are devices which are used the electric energy stored by accumulating positive and negative charge separated by an insulating dielectric. The capacitance, *C*, and stored charge *q*, and voltage of plates, *V*, the capacitance depends on the permittivity of the dielectric, ε, the area of plates, *A*, and the distance between the plates, *d*,. Therefore, the energy stored on the capacitor depends on the capacitance and on the square of the voltage.

$q=CV$

$C=\varepsilon\ A/D$

$E= ½\ CV^2$

$dV=i*(dt/Ctot)+i*R_{tot}$

The capacitor is used in many ac and dc application in power systems. DC storage capacitors can be used for energy storage for power applications. [10].

E. Energy storage in flywheel

Flywheels can be used to store energy for power system. When flywheel is coupled any electric machine. The stored energy depends on the moment of inertia of the flywheel. The moment of inertia (*I*) depends on the radius, mass, and height (length) of the rotor, energy is transferred to the flywheel when the machine operates as a motor (the flywheel is accelerates), charging the energy storage device. The flywheel is discharged when the electric machine regenerates through the drive.

$E=1/2\ Iw^2$

$I=r^2mh/2$

We can improve the capability of the flywheels by increasing the moment of inertia of the flywheel and by turning at higher rotational velocities, or both. [10]

F. Energy harvesting

It may be define as the abstaining power from source that are available or used for other purposes or energy scavenging is known as power harvesting. Here now some devices being developed for energy harvesting in industry – the waste heat from nuclear plants and steel mills can be used, but cannot be used for aerospace application. This technology such as: power from source such as waste engine heat, warm soil or liquids, kinetic motion, and piezoelectric materials. These large energy source can be improve the local power of the efficiency, or even provide to NASA's

equipment only where other power source could not operate or would be too large inefficient. The studies should be done to identify all promising energy source such as kinetic momentum/energy, solar, nuclear, (radioisotope/fission/fusion), in-space fuel recovery, or local radiation and various energy conversion method need to this analysis. Application of this power system should be identified, e.g., enabling power for remote sensors and controls in air crafts engines, spacecraft engines. And other locations where power was not available. The energy harvesting system is to prove that there is enough power to be gained or this is an enabling technology to produce power for a novel application. The energy conversion technology development can enable energy harvesting. [11]

VI. SOLAR ENERGY

The renewable source of energy, solar energy holds a great potential, but the development of this device that's efficient and cost effective conversion into electric current. The solar energy conversion is doing using photovoltaic effects/solar photovoltaic cells; it has made semiconductors that generate an electric current. The efficiency of solar system is on the type of semiconductors it is made of, and its absorbing capacity. Presently, maximum energy conversion efficiency (around 25%) in a PV cells is obtained when this is made of crystalline silicon's (Si). this is excellent conduction materials, but it has very expansive to this products. Generally, such as TiO_2, can

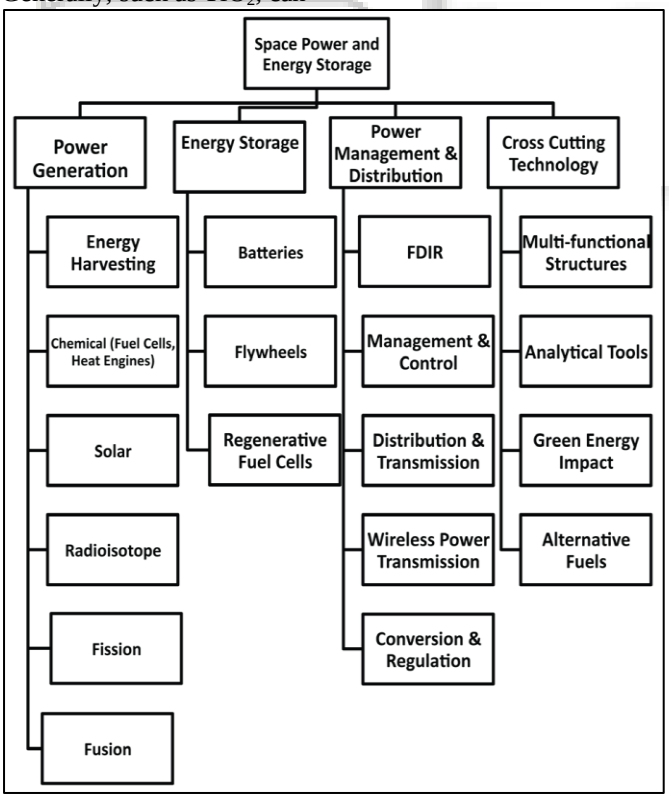

Fig. 5: Energy Storage System. [11].

Be used in PV technology; this material is less conductive, so it leads to cheaper PVs, hence, lower energy conversion efficiencies. Nanotechnology can be used to introduce alternative materials and fabrication methods to produce cells with tailored adsorption characteristics, in this technology conversion efficiency (10-15%) and reduced cost. e.g., crystalline solids with a controlled conductivity band gap to optimize energy absorption and highly ordered to thin film. Thin film semiconductor with band gaps of different energies, and "sensitized semiconductors". [3]

A. Solar cell

the storing of solar energy in these technology. Nanotechnologies is regarded as a factor for photovoltaic to achieve broad economic acceptance through considerable cost savings and increases in efficiency with the added on new materials based and solar cells, with types of the production processes. That can be possible with the help of nanostructures, such as quantum dots.it is possible to optimally adjust band gap of semiconductors to the incident radiation spectrum or to emit several charge carriers per photon thus improve the conversion efficiencies. The nanotechnology is giving the different types efficient and cost saving solar cells.

- Thin-layer solar cells.
- Titanium dioxide nanoparticles in solar cells.
- Fullerene derivate as electron acceptors in polymer solar cells.
- Nano layer in stack cells.
- Quantum dots for solar cells.

Fig. 6.0: Utilization of Solar Energy In Automobile. [7].

B. Different solar and renewable energy

1) Home solar

The utilization of PV energy generation and storages in private households, called home solar, it is already possible in days. Increasing energy rates and reduced governmental subsidies for feeding the solar energy.

2) Energy storage in grides

The storage of can become economical if countries, regions, areas or places with a need for energy are isolated from each other and balancing is not feasible. That's used the energy storage and energy distribution by grids. It has less power loss in transmission of power.

3) Renewable energy source

Electricity integration on an industrial scale with connection with renewable energy source and energy storage technologies is accepted in the sort medium term, e.g. around 2015-2020 on the distribution grid level. In future 2030 the share of RES and demand for energy storage could have increased sufficiently that, with reduced system prices. [9].

VII. GENERATION OF NANOTECHNOLOGY

A. Frist generation 2001: passive nanostructures.

Nano structuring coating, nanoparticles, nanostructured metals, polymers, ceramics, catalysts, composites, displays.

B. Second generation now: active nanostructures.

Transistors, amplifiers, targeted drugs and chemical, actuators, adaptive structures, sensors, diagnostic alloys, fuel cells, solar cells, high performance Nano composites, ceramics, metals.

C. Third generation 2010: 3-D Nano system and system of Nano systems.

Various assembly techniques, networking at the Nano scale and new architectures, biomimetic materials, novel therapeutics/ targeted drug delivery

D. Fourth generation 2015: molecular Nano systems.

Molecular device "by design", atomic design, emerging functions. [8]

REFERENCE

[1] European commission directorate general for research information and communication unit B-1049, Brussels.
[2] By Deborah elcock environment science division Argonne national laboratory (nov-2007), pg. ANL/EVS/TM/08-3 report at on, at http://www.osti.gov/bridge.
[3] Luisa fillipponi &Duncan Sutherland interdisciplinary Nano science center (iNANO) university of Aarhus, Denmark, report on, at http://www.nanocap.eu.
[4] Hessian ministry of economy, transport, urban and regional development, at report on , at http://www.hessen-nanotech.de
[5] Nano connect Scandinavia, at report on, at http://www.nano-connent.org. Chalmers university, DTU, halmstad university, imago Lund university, university of Gothenburg.
[6] A paper- nanotechnology for sustainable energy, at writer- Elena serrano[1],Guillermo rus[2], Javier Garcia-martinez[3].,moleculer nanotechnology laboratory, university of Alicante, carretera Alicante-san Vicente s/n, e-03690 Alicante, Spain.
[7] A book at advance technology and alternative fuel vehicles. DEO/GO-102001-1142, FS143, august 2001.
[8] U.S. Environmental Protection Agency Nanotechnology White Paper EPA 100/B-07/001/February 2007. http://www.epa.gov/osa.
[9] A source from Nanotechnology in the sectors of solar energy and energy storage, author- Ralph Seitz, Bjorn p. Moller, axel Thiemann, and reas Sauer, Michael meister, mickael pero, Oliver kleine, Clemens rohde, antje bieewisch meike de vries, Victoria kayser.at report on, at http://www.isi.fraunhofer.de.
[10] A paper of energy storage system for advance power applications, at author – Paulo f. ribeiro, Brian k. Johnson, mariesa l. crow, aysen arsoy. And yilu liu (all senior member IEEE)
[11] A source by national aeronautics and space administration, NASA headquarters Washington, dc 20546 at contact on, http://www.nasa.gov

