Footprints of Nanotechnology over Non-Conventional Energy Technology Options

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Abstract: Nanotechnology has opened the floodgate of future opportunities in enhancement of efficiency of non conventional energy producing technologies. The nanotechnology has touched every facet of entire spectrum of solutions in non conventional energy. The major impact of nanotechnology is in the use of nano materials which range from nano polymer to metal composites these materials can be tailor made to suit the requirements for particular applications such as solar cells and other direct energy converting technologies. The nanopolymers have revolutionised the construction of wind mill turbines and rotor blades.

The low per unit weight and high stress taking capability has been instrumental in creating high efficiency and low energy wasting wind electrical energy generating equipments. The thermal energy conversion ratio gets geometrically amplified in case of solar photovoltaic cell systems as it decisively intensifies the electron release and photon transformation. The paper discusses the options, materials and technologies in direct solar application, indirect heat conversion system, wind energy conversion module modification. It also touches the future of hydro power energy production and its control systems and their modification due to impact of emergence of nearly superconducting metal composites in nano technology field.

Keywords: Nanotechnology, Nanomaterials, Nano Tubes, Nanocomposites, nanopolymers

1. INTRODUCTION

Nanotechnology unbolts many doors which embrace pressing problems associated with social and environmental issues. It provides alternative solutions to many of the problems faced today by us. It assists by manipulating data at the atomic and molecular level and supramolecular level. Breakthrough in nanotechnology unfasten the probability of strolling beyond our current alternative sources for energy supplies by broaching technologies that are more efficient, inexpensive and environmentally sound.

In the original sense nanotechnology refers to the projected ability to construct items from the microscopic to macroscopic level in coherence with the increase in the efficiency. India may contribute to 25% towards the advancement of nanotechnology [Source :economic times].

Nanotechnology boosts the solar efficiency by approximately 80% hence escalating the energy generation, transformation and distribution.

2. SALIENT ASPECTS OF NANOTECHNOLOGY

- Nanomaterials possess unique, beneficial chemical, physical, and mechanical properties, they can be used for a wide variety of applications.
- These applications include, automobiles, ceramics, weapons, weapon platforms, medical sector, protective films, hard cutting tools, airframes
- Nanocoated wear resistant drill probes for example can be utilised for the optimisation of lifespan and efficiency of the systems for the development of oil and natural gas deposits or geothermal energy and thus saving the cost.
- Nanotechnology could contribute to the optimisation of the layer design and the morphology of the organic semiconductor mixtures in the component structures
- High duty nano materials are very much suitable for lighter and more rugged rotor blades of wind and tidal power plants as well as wear and corrosion protection layers for mechanically stressed components

3. TYPES OF NANOMATERIALS

The nano materials are used in various shapes and sizes and they are produced tailor made to suit the requirement.

The main type of materials are

- Carbon black
- Silica fumes
- Clay
- Metal/alloys/composite
- Ceramics
- Polymer Composites;

The above materials are available in the following forms:

Nano Ceramic Powders: These are solid powders which constitute the most important segment of the whole nano structured materials. The powders constitute more than 50% of the total nano structured materials

Nano Tubes: These are the single or multilayered tubes of conductors and semiconductors. They are strong materials and with high thermal and electrical conductivity

Nanocomposites: Generally they are polymer based with nano sized filers used in various applications such as bearing, gear boxes etc

Applications of Nanotechnology in Energy Sector:

Nanomaterials assist in higher volume of energy transmission without significantly adding to the losses and wearing away of the parts of the associated with the energy transmission/distribution system. It also exacerbates the carbon dioxide emissions and hence help provide a cleaner energy production and distribution

The transfiguration of primary energy sources into electrical energy, heat and kinetic energy requires utmost efficiency. Efficiency increases specially in the case of fossil fuels and steam power plants. However the escalated efficiency compels higher operating temperatures and hence heat resistant turbine blade materials when considering the probe of wind energy turbines.

However refinement is plausible if the nano-scale heat and corrosion protection layers are employed for turbine blades in power plants or aircraft engines to enhance the efficiency through elevated operating temperatures or the application of light materials. Nano structured semiconductor materials with optimised boundary layer design contribute to increased efficiency that could pave the way for broad application in the utilisation of waste heat for example in automobiles and human body diffused heat.

The utilisation of nanotechnologies for the enhancement of electrical energy stores like batteries and super capacitors proves to be of the most beneficial use .Due to the high cell voltage and the outstanding power energy density the lithium ion technology is regarded as the most promising venture.

Nanotechnology in the Sector of Solar Energy

Conventional solar cells based on photovoltaic technology have come a long way in recent years, but they're still missing a big chunk of the electromagnetic spectrum. The silicon semiconductors in a solar cell are geared toward taking infrared light and converting it directly to electricity. Meanwhile, the visible spectrum is lost as heat and longer wavelengths pass through unexploited. A new nano-material being developed by a group of researchers spread across the country could act as a "thermal emitter," making solar power significantly more efficient by withdrawing more of that wasted energy. And hence it increases the utility margin of the exhausted heat by a exorbitant exponential curve

The infrared part of light is relatively easy for conventional high-efficiency solar cells to convert to electricity, and the thermal emitter approach works within that framework. A thermal emitter isn't a parallel system for deriving electricity directly from the sun's rays. Instead, this is an application or so-called thermo photo voltaic principals.

Thermo photovoltaic in this context refers to the production of heat from light. The thermal emitter consists of two parts, the first being a tungsten-based absorber that heats up when exposed to light. The emitter component takes that heat energy and uses it to output infrared light, which silicon semiconductor solar cells are already able to absorb. By doing something with all the other wavelengths of light cascading toward solar panels, researchers have estimated a theoretical 80% efficiency rating — much higher than the mid-30s where most silicon-based solar panels are stuck.

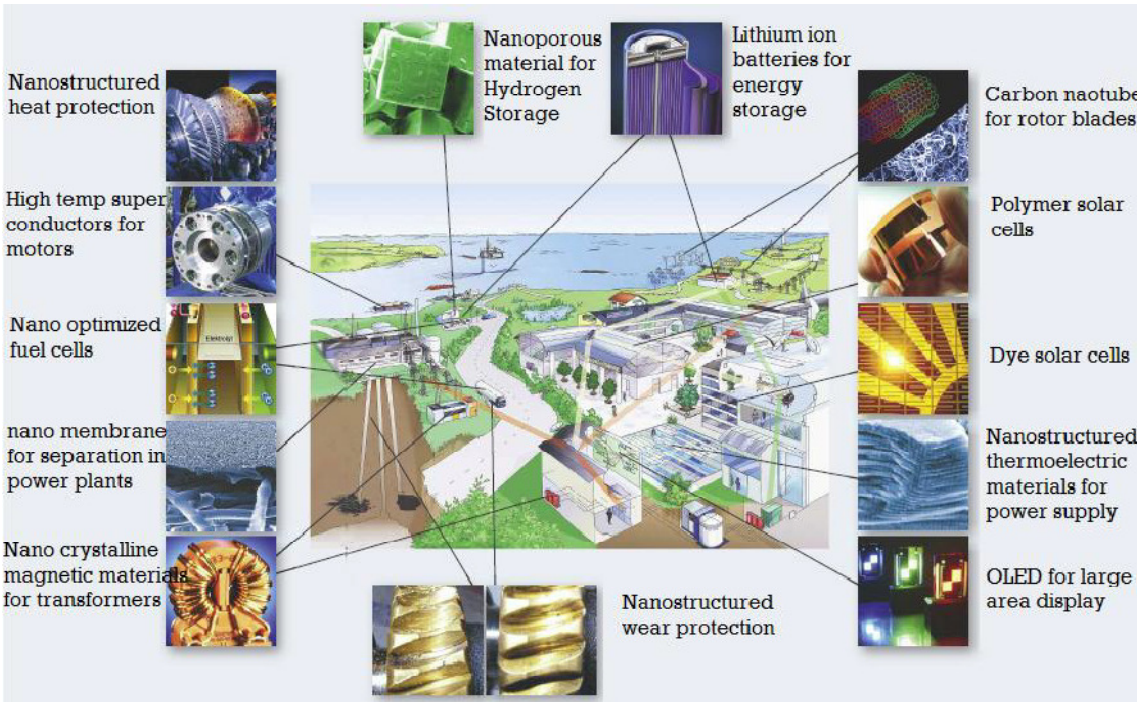

Fig: Applications of Nanotechnology in the Energy Sector

However, past experiments with thermal emitters found that the increase in performance in the real world was a mere 8%, which hardly justifies the increased cost and maintenance. This turns out to be due to the extreme temperatures involved. The delicate 3D structure of thermal emitters have traditionally not held up to temperatures above 1800 degrees Fahrenheit (about 1000 degrees Celsius). When the entire purpose of a material is to get hot, you want it to thrive at high temperatures, not fall apart.

To address this issue a new method has been employed under which tungsten is used as a thermal emitter. The tungsten structures were coated with a nano layer of hafnium dioxide, a ceramic which added significant structural durability at high temperatures. Whereas raw tungsten absorption surfaces would break down at 1800 degrees Fahrenheit, these nano-coated surfaces operate without

issue for 12 hours at that temperature. At 2500 degrees Fahrenheit the material still lasts an hour before breaking down.

This approach to improving solar cells is appealing for a variety of reasons. Both tungsten and hafnium dioxide are extremely plentiful and safe to work with. Thermal emitters also work with existing solar cell technology, making it simple to add them to existing systems.

Pertinence of Nanomaterials in the Field of Wind Power

Out of all the renewable sources of energy the hydropower is the most utilized source and wind power is the next most tapped resource. Conventionally a wind turbine constitutes of the following parts

- High mast/tower
- Turbine blades
- Electrical energy generator
- Power system for stepping up the voltage up to transmission level

The nanotechnology has already created a sizezble footprint in the field of wind energy generation through the usage of advance nanomaterials. The various nanomaterials which are employed as an alternative to the conventional materials are listed below and can be compared to their counterparts:

Parts of the system	**Conventional Material**	**Nanomaterial**	**Advantages over the preceding**
High mast/tower	Steel shell	Metal alloy Composite	(a) Light weight (b) High Strength
Turbine Blade	Aluminum /Tungston alloy	Nanocomposite high strength carbon fibre	(a) Extremely light weight (b) Weather proof (c) Easy modification of aerodynamic profile
Electrical Energy Generator	Copper/Aluminum windings on Silicon core	(a) Nanomagnetic materials (b) Nano Multilayer rods	(a) No eddy current losses (b) Minimum generator losses (c) High efficiency
Power Systems	Copper/Aluminum semiconductors,conductors	Nano-Magnets	(a) High efficiency (b) Heat Resistant (c) Precision Control

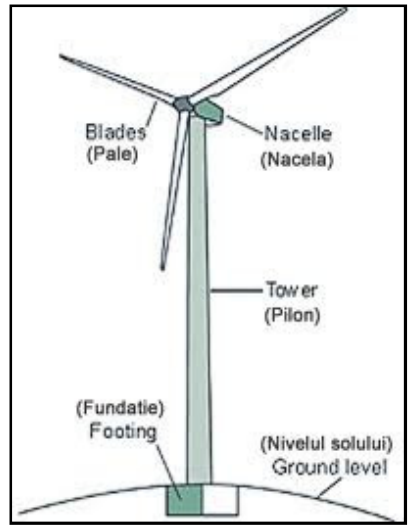

Fig: Wind Energy Power Systems Employing Nanomaterials

Hydropower plants using nanotechnology

Harnessing energy through hydro power using nanomaterials is almost similar to wind energy extraction except the method of harnessing is different.

Inference

Nano technology is an emerging field which is casting it's footprint in all most all facets of life. Renewable sources of energy is one of the most important fields requiring research, for the sustainable growth of mankind. As provisioning of cost effective and perennial source energy will hold the key to future progress. Nano technology is one of such manifest tool to provide the renewable sources of energy to all, at an appropriate cost and in reasonable quantum.

REFERENCE

[1] *Puneet Sharma, Director- Reinste Nano Ventures, Nano technology and energy consortium*
[2] *Dr. Thomas Abraham, Innovative Research and products (iRAP), Inc.*
[3] *Wikipedia*
[4] *www.nanotechnology.com*