Review Article

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Nanotechnologies for the Future

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Abstract
The needs of the world are growing while the sources are decreasing. The existing systems have not been able to cope up this developing situation. It is likely that with the fast increasing population will worsen this situation. All types of sciences, commerce and arts have not been able to provide the solutions to this situation so far. Nanotechnology is the new field which provides us some hope to meet the growing challenges. New wonder nano-materials like carbon nano-tubes, fullerenes, bucky-balls, dendrimers, quantum dots, nano-crystals, titanium dioxide nano-particles, silver nano-particles, silver nano-wire and other such nano-sized particles have brought a change in the materials at a surface level but need now is changing the redundant systems into new workable nanotechnology systems which could provide worthwhile solutions to the ever growing problems. This concept paper aims at delineating the role of Nanotechnology in the new world.

Keywords: Nanotechnologies, Buildings, Energy, Space, Health.

Introduction
The world has grown too big over the years and requires very large scale solutions. The various knowledge-sources provide some solutions but the continuously growing problems are going out of hands. The mushrooming of buildings, factories, automobiles, roads etc., has not only occupied large productive lands but also are spreading uncontrollable pollution. Men want shelter for which they build houses and occupy valuable spaces; they want mobility for which they create cars, buses, trains, aircrafts and even spacecrafts and to run them they build roads, rails, bridges and airports all occupying large spaces and eating into existing resources. Men fall sick by the polluted environment for which they use numerous hospitals and tons of medicines. They need eatables for which they want various food items including vegetables. They need water to irrigate fields, build reservoirs and dams for canals and electricity. These too occupy vast spaces needing vast lands and resources. This way our earth is now occupied much beyond its capacity. The way the population of the world is growing no space will be left for human beings, animals, plants or any other type of life requiring space. This is essentially a set of problem which needs urgent solutions.

Can we spare this space for nature's growth? Can be stop these pollutions? Can we have better treatment or control of diseases? Can we move unhindered in the open space and enjoy the nature's beauty? Can we have better solution for our food chain? These and many more questions need to be answered. For this we have to change the systems which go on increasing the burden on the limited earth space and resources.

Can there be such systems? There can be if the man tries to find, since the God has given the man a brilliant mind to think, plan and act logically. Nanotechnologies have some answers. These can build such light and cut to size materials which can save the space from huge buildings, bridges, roads etc. These can develop internal energies of a man to make him capable of moving at faster speeds or even fly. These can produce such foods which do not need vast lands to grow. These can create such in built systems in a body that the diseases are not allowed to occur and if occur are treated from the resources within. These can thus save the space and resources from industries and numerous machineries as well. We will then have plenty of growth for the nature for us to enjoy and live healthy. If the scientists apply their mind to find solutions for the problems facing the future world this is not difficult. Various solutions which new nanotechnology systems can provide are suggested here for a few fields i.e., (a) space saving (b) energy saving (c) Cheaper and fast space travel (d) in built medical treatments system (e) reproducing machineries. The researchers can build on more such new system .of nanotechnology.

Saving Space
Ever increasing population shall continue to demand more space. The haphazard growth of buildings and now multi-storey buildings has created more risks than safety and comfort. We have no alternative than to provide least space occupying buildings if we have to spare space for natural growth with new materials. The nanotechnology has a very important role to play in construction of the buildings, bridges, roads etc. We can alternate such materials with nano-material coated thin hard plastics. These materials will occupy negligible space and can be safely tried out as new building materials. For making such nano-materials there is no dearth of

atoms and molecules in universe; only their right combination and assembling these atoms with required qualities is needed.

How can the required material be created? Material creation may involve all or some of the following steps: (a) listing out characteristic requirements for the particular material, (b) identifying or planning for innovating materials with the above characteristics, (c) adopting methods and approaches for material preparation, (d) organizing construction process and equipment, (e) construction, testing and try out and modification, (f) bulk production and (g) using the materials for construction. The characteristic requirements for building construction are security, strength, ease and cheap transportability and flexibility, minimum labour and its easy availability at affordable costs. The alternative materials providing these qualities are; diamond & steel that provide security and strength; plastics, silicon, cardboard, paper and ply provide easy transportability and flexibility, cheaper costs and less labour. None of these materials in the world at present meets all the needed qualities. Hence there is a need for innovation of such like materials which contain all or almost all of these qualities. One type of such novel material at the threshold or being developed is through nano-materials from various metals. The Nano-materials are the materials with structured components with at least one dimension less than 100 nm. Overall properties of all materials are determined by their structure at the micro & nano-scale. Novel materials can be created by rearranging atomic structures.

Building New Materials at Nano-scale by Rearranging Atoms

Variations in the arrangement of atoms have distinguished the cheap from the cherished and the light from heavy. Arranged one-way, atoms make up soil, air, and water; arranged another way, they make up ripe grapes. Arranged one way, they make up buildings and fresh air; arranged another way, they make up ash and smoke. Nature which created coal, diamonds, sand and dust is the best guide to provide the suitable alternative materials for construction purposes as well. Nano-materials are prepared from nano-particles taking a queue from the nature.

The bulk approximations of Newtonian physics are revealed for their inaccuracy at the nano-scale giving way to quantum physics. Quantum mechanics plays an exciting and challenging role at the nano-scale. The rules of quantum mechanics are very different from classical physics, which means that the behavior of substances at the nano-scale can sometimes contradict common sense by behaving erratically. The energetic properties of matter change at that scale. The surface area to volume ratios become relevant, and even the inter-atomic distances in a metal lattice change from surface effects. Nano-technology explores and gets benefit from quantum phenomenology in the ultimate limit of miniaturization.

Best materials for buildings are nano-carbon coated hardened plastics or clays. Clays are at present used as construction materials, clay particle based composites-containing plastics. Coating & surfaces are used in catalytically active and chemically functional surfaces. Self cleaning windows are coated in highly activated titanium dioxide as water repellent and anti-bacterial. Breathable, waterproof, scratch & stain resisting hard coatings are used in polymers, in-organics and fabrics. Properties of carbon coated nanostructures are: (a) high tensile strength, (b) physical stability, (c) chemically reactive with free radicals so that (i) derivatives can be framed (ii) more hydrophilic than fullerenes (iii) new organic molecules can be generated. Other atoms can be placed inside its "cage" (doping with alkali metals) for (i) superconducting properties (ii) and optical properties (endohedral fullerenes). Carbon coated plastics provide strength, less costs in long run, transportability and flexibility. Nano-carbon coatings provide strength, security & long life and plastics provide transportability and lower costs. Various approaches used for making these nano-materials are bottom up or top down approaches. Bottom up approach is building up from nano-building blocks and top down approach is cutting, etching etc., from top to bottom.

In the process we must first design a set of nano-building blocks, and then assemble the building blocks by the use of positional control. The building blocks are nano-particles linked together through synthesis process. Positional and orientation control over the building blocks can be converted to three dimensional from the one dimensional (relying on linear structures that spontaneously fold into a particular shape to achieve a degree of control in three dimensions). Relatively rigid bricks can be formed that can be bonded to each other in a stiff three-dimensional framework. Many bricks can be assembled in more conventional environments (solution), and so we can eliminate the need for vacuum. This greatly simplifies the system. Indeed, with brick-based nanotechnology one can relatively easily envision the synthesis of a set of bricks that can, with the addition of positional control, be assembled into a wide range of structures with the stiffness.

Nanosize powder particles (a few nanometers in diameter, also called nano-particles) are potentially important. These are zero dimensional. The characteristics of nano-particles are that they have a much greater surface area per unit mass compared with larger particles. As a particle decreases in size, a greater proportion of atoms are found at the surface compared to those inside, e.g., a particle of size 30 nm has 5% of its atoms on its surface, at 10 nm 20% of its atoms and 3nm 50% of its atoms. Nano-particles have a much greater surface area per unit mass compared with larger particles. These characteristics can change or enhance properties as reactivity and strength.

Scanning probe microscopy is an important technique both for characterization and synthesis of nano-materials. The laboratory work can be done by The Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM). STM images surfaces well enough to show individual atoms, sensing surface contours by monitoring the current jumping the gap between tip and surface. AFM senses surface contours by mechanical contact, drawing a tip over the surface and optically sensing its motion as it passes over single-atom bumps. Atomic Force Microscopes and Scanning Tunneling Microscopes can be used to look at surfaces and to move atoms around. By designing different tips for these microscopes, they can be used for carving out structures on surfaces and to help guide self-assembling structures.

Atoms can be moved around on a surface with scanning probe microscopy techniques, but it is cumbersome, expensive and very time-consuming, and for these reasons it is not feasible to construct nano-scaled devices atom by atom. You don't want to assemble a billion transistors into a microchip by taking an hour to place each transistor, but these techniques can be used by self-assembling systems. These microscopes are thus used now primarily in laboratories for probing. Natural or man-made particles or artifacts often have qualities and capabilities quite different from their macroscopic counterparts. Gold, for example, which is chemically inert at normal scales, can serve as a potent chemical catalyst at nano-scales mass compared with larger particles. Major efforts in nano-particle synthesis can be by (a) Gas Phase Synthesis (b) Sol-Gel Processing (c) Cavitations processing, (d) Micro-emulsion processing, and (e) High-energy ball milling

Nano-particles with diameters ranging from 1 to 10 nm with consistent crystal structure have been processed by both gas-phase and sol-gel techniques. Typical size variances are about 20%; however, for measurable enhancement of the quantum effect, this must be reduced to less than 5%. Initial development of new crystalline materials was based on nano-particles generated by evaporation and condensation in a sub-atmospheric inert-gas environment. Various aerosol processing techniques have been reported to improve the production yield of nano-particles. These include synthesis by combustion flame; chemical vapor condensation; electro-spray; and plasma spray. Sol-gel processing is a wet chemical synthesis approach that can be used to generate nano-particles by gelation, precipitation, and hydrothermal treatment. In sono-chemistry, an acoustic cavitations process can generate a transient localized hot zone with extremely high temperature gradient and pressure. Such sudden changes in temperature and pressure assist the destruction of the organo-metallic solution and the formation of nano-particles. The technique can be used to produce a large volume of material for building applications.

In hydrodynamic cavitations, nano-particles are generated through creation and release of gas bubbles inside the sol-gel solution. By rapidly pressurizing in a supercritical drying chamber and exposing to cavitational disturbance and high temperature heating, the sol-gel solution is mixed. The erupted hydrodynamic bubbles are responsible for nucleation, growth, and quenching of the nano-particles. Particle size can be controlled by adjusting the pressure and the solution retention time in the cavitations chamber.

Micro-emulsions have been used for synthesis of metallic, semiconductor, silica, barium sulfate, magnetic, and superconductor nano-particles. By controlling the very low interfacial tension (~10-3 mN/m) through the addition of a co-surfactant, these micro-emulsions are produced spontaneously without the need for significant mechanical agitation. The technique is useful for large-scale production of nano-particles using relatively simple and inexpensive hardware. The only top-down approach for nano-particle synthesis has been used for the generation of structural nano-particles. Already a commercial technique, it has been considered dirty because of contamination problems from ball-milling processes. However, the availability of tungsten carbide components and the use of inert atmosphere and/or high vacuum processes have reduced impurities to acceptable levels for many building applications. Common drawbacks include the low surface area, the highly poly-disperse size distributions, and the partially amorphous state of the as-prepared powders.

To build a house of size 10' x 12' you will require 2400 strips of size 6" x 6" x 0.25" weighing about one kg which can be safely carried by even a child. Assembling with practice may take at the most 2 to 3 minutes. Strength of these strips will be enough to withstand the impact of an atom bomb. The materials used may be nano-carbon coated plastic materials. Advantages of nano-carbon coated plastic materials are that these are hard & strong, easy to construct, transportable, less time to construct, no extra labor to construct, cheaper in the long run, occupy least space/ no permanent space, hermetically sealed hence safe from all round pollution. Disadvantages of carbon coated plastics are that these are still at conceptual stage, require heavy costs of research, heavy initial construction costs and time factor for initial induction. The concept needs to be put into research and the result is certainly expected to be positive. To save space we must find items, other than the nature, now covering major space of the earth. We have producing units (factories and fields) buildings (dwelling and storing units) and communicating units (roads, airports, rails and bridges) as the major space occupying units. If we do away or reduce the sizes of these major units from the earth, we shall be provided pollution free sufficient space on earth to easily survive. More details are available on Grewal (2014).

Settlements in other planets

As an alternative, other planets can be explored for transporting population load on earth. For this these planets have to be made inhabitable and transportation systems between two planets should be made lesser time consuming, cheaper and risk less. Nanotechnology has a potential to create such conditions. Travelling in space may become as easy and cheaper as going to any other town in a tram. The multi-ton spacecraft of today can be replaced by child-wagon toy weighing just 2kg-5kg, yet matching all the capabilities of today's behemoths. Launching equipment into space is an expensive business: it costs $10,000 (£6,300) to lift every 0.45kg (1lb) of stuff into orbit. Making things smaller and lighter is, therefore, a natural route to reducing the cost of launching a spacecraft. Through nanotechnology the mass and size of spacecraft and payloads can be reduced to negligible one.

The cheaper spacecrafts will help increased traffic to outer planets and establishment of colonies in other world thereby taking the load of the earth. Using nanotechnology sensors of the size of a postage stamp and can detect toxins in the air even in alien atmosphere. The sensor could also be modified to sample liquids.

Astronauts' blood and urine samples can be checked for diseases, infections and general health by the sensor set in the spacecraft or astronauts dress itself. Nano-based sensors on board the spacecraft could provide instantaneous analyses and diagnoses.

Nano-engineering could produce surfaces that regulate spacecraft temperatures more efficiently than the materials used today. It could also generate more efficient solar cells, rendering large panels redundant. A lightweight space suit can be more flexible than current garments and would consist of three or more layers and be suitable for spending long periods of time exploring the planets. These can repair themselves using self-assembling nano-units held inside the suit's layers based upon proteins and free to move along the suit layers. In the event of a breach, they would spill out, attaching to one another and building bridges across the damage. They could even carry emergency drugs to immediately treat any wound the astronaut may have suffered.

A web of hairline tubes could be deployed across large tracts of a planet's surface having nano-tubes with an army of nano-sensors that could measure the surface temperature and its composition. Each web would span a dozen kilo-meters and be capable of sensing a planetary environment in great detail. In space missions instead of general purpose spacecraft, hundreds or even thousands of identical microchip-sized spacecraft clusters could be deployed to perform highly specific tasks. These clusters could even measure the earth's magnetic field and gauge its response to solar storms.

Nanotechnology is providing new concepts for multipurpose shields against the triple threats of Aero-heating during atmospheric entry, Radiation (Solar and Galactic Cosmic Rays) and Micrometeoroid/Orbital Debris (MMOD) strikes. The TRIPS concept has direct relevance to the Crew Exploration Vehicle (CEV) planned in the Exploration vision. TRIPS can be upgraded for increasingly more severe aero-thermal entry environments.

Nanosats:

In space, large numbers of smaller, nanotechnology-based spacecraft, known as "nanosats", could do a more detailed job by "carpeting" a much wider volume of space to provide continual monitoring of magnetic behaviour with high sensitivity. Such nano-sats would be so small that any gravitational attraction to the earth would easily be overwhelmed by other forces, such as the pressure of sunlight and the minuscule drag of the earth's highest atmosphere. This means that a nanosat would find it much easier to escape earth's gravitational pull altogether, opening up new possibilities for propulsion. Such nanosats could settle into the natural pathways in space. Once identified, they could be exploited for future missions, allowing the tiny spacecraft to drift through the solar system.

Nanosats could find the natural pathways where they could settle into. Once identified, they could be exploited for future missions allowing the tiny spacecraft to drift like through the solar system.

Saving and improving Health with Inbuilt Treatment System

Nanotechnology may have its biggest impact on the medical industry. Patients will drink fluids containing nanorobots programmed to attack and reconstruct the molecular structure of cancer cells and viruses. There's even speculation that nano-robots could slow or reverse the aging process, and life expectancy could increase significantly. Nano-robots could also be programmed to perform delicate surgeries -- such nano-surgeons could work at a level a thousand times more precise than the sharpest scalpel [source: International Journal of Surgery]. By working on such a small scale, a nano-robot could operate without leaving the scars that conventional surgery does. Additionally, nano-robots could change your physical appearance. They could be programmed to perform cosmetic surgery, rearranging your atoms to change your ears, nose, eye color or any other physical feature you wish to alter.

Eric Drexler's idea of medical nanobots can steer autonomously through your blood stream making repairs and guarding against infection. Swarms of nanobots swimming through your veins, repairing cells or attacking viruses should not be just imagination

Miniaturization of critical technology, including nano-materials delivering targeted, preventative medicines to diseased areas of the body though nanotechnology has a great scope. Using nanotechnology in the body pre-dosed with medicines to predict health risks and automatically administer appropriate medicines will enable to lead healthy, productive lives for longer durations. Creating long-lasting preventative and treatment therapies utilizing nanotechnology will bring a great change in maintenance of health systems. Nanotechnology can be effectively used to bridge the gaps between medicine-biology, materials science, computer technology and public policy. This New clinical approaches can save lives through better diagnosis, treatment and prevention of illnesses. Use of nano-tubes to identify diseased areas of the body and can diagnose the disease far better than the present methods.

The Gene sequencing can create disease resisting better beings. Solid-state Nanopores can be used for Gene Sequencing by sequencing single molecules of nucleic acid, DNA or RNA, at a rate of a million bases per second by electrophoresis of the charged polymers through a solid-state nanopore channel of molecular dimensions. Nanoscale Mass Transport and Carbon Nanotube Based Membranes known as bucky-paper may be used as filter media for analytical mission instruments or implantable device support for health monitoring. A standardized plasma diagnostic reactor, known as the "GEC Cell" can be equipped with a wide range of diagnostics for measuring and understanding plasma physics and chemistry for a variety of low temperature plasmas.

Nano-spectra Biosciences and molecular imaging, applications include injecting nano-materials into the body to identify and treat diseased areas. Current radiation and chemotherapy spreads damage throughout the body. Nearly one in 10,000 molecules actually makes it to the site of the cancer, so in many cases more damage is done by the toxic chemotherapy than the cancer itself. Gold nano-shells can be used to treat cancer. When administered into the body and heated with an external light; the nano-shells can kill the tumor through this directed thermal ablation targets.

Nanospectra's nano-shell technology is in pre-clinical validation now, and initial results already have shown it to be successful in live mice.

Nanotechnology is already moving from being used in passive structures to active structures, through more targeted drug therapies or "smart drugs." These new drug therapies have already been shown to cause fewer side effects and be more effective than traditional therapies. In the future, nanotechnology will also aid in the formation of molecular systems that may be strikingly similar to living systems. These molecular structures could be the basis for the regeneration or replacement of body parts that are currently lost to infection, accident, or disease. These predictions for the future have great significance not only in encouraging nanotechnology research and development but also in determining a means of oversight. Nanotechnology drugs, delivery systems, diagnostic tests and devices when developed will change the medical systems as such.

Nanotechnology can help provide Thermal, Radiation and Impact Protective Shields for multipurpose shields against the triple threats of Aero-heating during atmospheric entry, Radiation (Solar and Galactic Cosmic Rays) and Micrometeoroid/Orbital Debris (MMOD) strikes during space travel.

Better and quick manufacturing through Replicators, nanoscopic machines, called Assemblers

Eric Drexler believed that assemblers could first replicate themselves, building other assemblers. Each generation would build another, resulting in exponential growth until there are enough assemblers to produce objects [source: Ray Kurzweil]. Assemblers might have moving parts like the nanogears. Trillions of assemblers and replicators could fill an area smaller than a cubic millimeter, and could still be too small for us to see with the naked eye. Assemblers and replicators could work together to automatically construct products, and could eventually replace all traditional labor methods. This could vastly decrease manufacturing costs, thereby making consumer goods plentiful, cheaper and stronger. Eventually, we could be able to replicate anything, including diamonds, water and food. Famine could be eradicated by machines that fabricate foods to feed the hungry.

Energy Saving

Nanotechnologies provide the potential to enhance energy efficiency across all branches of industry and to economically leverage renewable energy production through new technological solutions and optimized production technologies. Nanotechnology innovations could impact each part of the value-added chain in the energy sector. Nanotechnologies provide essential improvement potentials for the development of both conventional energy sources (fossil and nuclear fuels) and renewable energy sources like geothermal energy, sun, wind, water, tides or biomass. Nanotechnologies provide the potential to enhance energy efficiency across all branches of industry and to economically leverage renewable energy production through new technological solutions and optimized production technologies. Nanotechnology innovations could impact each part of the value-added chain in the energy sector. Nano-optimized membranes can extend the scope of possibilities for separation and climate-neutral storage of carbon dioxide for power generation in coal-fired power plants, in order to render this important method of power generation environmentally friendlier in the long run. The energy yield from the conversion of chemical energy through fuel cells can be stepped up by nano-structured electrodes, catalysts and membranes, which results in economic application possibilities in automobiles, buildings and the operation of mobile electronics. Nano-structured semiconductors with optimized boundary layer design contribute to increases in efficiency that could pave the way for a broad application in the utilization of waste heat, for example in automobiles, or even of human body heat for portable electronics in textiles.

The losses in energy are mounting. Considerable energy savings are realizable through tribological layers for mechanical components in plants and machines. Nano-porous thermal insulation material suitably applicable in the energetic rehabilitation of old buildings may stop energy loss. Nano-structured materials such as nanofoams can act as improved isolation materials to save energy. The extraordinary electric conductivity of nano-materials like carbon nano-tubes can be utilized for application in electric cables and power lines. Nano-technological approaches for the optimization of superconductive materials for lossless current conduction. Options are given for wireless energy transport, e.g. through laser, microwaves or electromagnetic resonance. Future power distribution will require power systems providing dynamic load and failure management, demand-driven energy supply with flexible price mechanisms as well as the possibility of feeding through a number of decentralized renewable energy sources.

Various nano-materials, inter alia based on nano-porous metal-organic compounds, provide economically realizable development potentials, with regard to the operation of fuel cells in portable electronic devices. Nano-sensory devices and electronical-power components are able to cope with the extremely complex control and monitoring of such grids.

Another important field is thermal energy storage. The energy demand in buildings may be significantly reduced by using phase change materials such as latent heat stores. Adsorption stores based on nanoporous materials like zeolites could be applied as heat stores in district heating grids or in industry. The adsorption of water in zeolite allows the reversible storage and release of heat.

Approaches to Energy Saving and Efficiency

To improve efficiency of energy use; to avoid unnecessary energy consumption; to achieve sustainable energy supply and optimized development of available energy sources, Nanotechnologies provide a multitude of approaches to energy saving e.g., the reduction of fuel consumption in automobiles through lightweight construction materials on the basis of nano-composites, the optimization in fuel combustion through wear-resistant, lighter engine components and nano-particular fuel additives or even nano-particles for optimized tires with low rolling resistance.

In general, the control of light and heat flux by nano-technological components, as for example switchable glasses, is a promising approach to reducing energy consumption in buildings

Nano-fluids can improve the efficiency of a cooling system by transferring the heat away more efficiently; the same enhanced heat transfer performance can be used to deliver the heat generated in a gas-fired boiler to the radiators that maintain living and working spaces at a comfortable temperature. This may appear to defy the conventional rules of thermodynamics as it is possible to reduce gas consumption by 20-30% just by changing the composition of the fluid in the system

Nonvolatile Molecular Memory may help approaching the limits in miniaturization for ultra-high density, low power consumption media. This capability may enable orders of magnitude increases in on-board data storage capabilities that are compatible with space exploration system resource limitations of mass, power and volume.

Nanoelectronics can help increase Logic and Memory. Nanowire-based electronic devices can implement future integrated nanoelectronic systems for both on-board computing and information storage.

To integrate vertically aligned carbon nanotubes (CNTs) into nanoscale vertical interconnects through a bottom-up approach can conduct much higher currents and enable more layers for Si-based integrated circuit (IC) chips thus Carbon Nanotubes can act as vertical interconnects. A nanosensor technology can be used to fabricate nanostructures Carbon Nanotube Sensors for Gas Detection with single walled carbon nanotubes (SWNTs), combined with a silicon-based micro-fabrication and micromachining process.

Electrode-device contact systematically can help extracting a signal from radiation resistant devices at nanoscale. Nanoelectronics and MEMS devices can help develop nano and Micro Fabrication Process Modeling for advanced computing and sensing applications presents significant challenges.

Nanotechnology is already in the process of manufacture of smaller, faster, and more efficient lasers, detectors, and sensors through first-principle design, nanoscale engineering, and prototyping for space communications, computing, lidar ranging, and spectroscopic profiling applications.

Transferring Heat Energy to industrial Use

A lot of energy is applied in industrial production. This energy can be produced on site for instance by combined heat and power installations, or using the industrial waste as fuel. Industrial production can also contribute to energy saving by using less energy or materials for the same number of products. By making the products like automobiles lighter, more energy efficiency can be achieved.

Hydrogen Fuel for Transportation

Hydrogen can be stored in different kinds of materials, in gaseous, liquid or more recently in solid form. Gaseous hydrogen can be transported through natural gas pipelines, mixed into the natural gas, or stored in gas tanks. Liquid hydrogen is stored in metal vessels at high pressures. In solid form, hydrogen is stored in metal hydrides. August 2001, a new developer of metal hydride Hydrogen storage systems, Hera spun off from Shell Hydrogen, Hydrogen Quebec and GFE in Germany. Headquarters and R&D are in Montreal, and a subsidiary in Nuremberg, Germany. Hera can provide Hydrogen storage materials, tanks and tank systems based on metal hydrides. Robert Schulz, Chief scientist and director of R&D of Hera gave a historic overview of the developments of solid hydrogen storage technologies, in July 2002. In the 1960s and 70s the leading technology was conventional hydride materials. In the 1980s, the focus shifted to amorphous hydrides such as NiZr, and from 1990 the focus is on nano-structured hydrides including carbon nano-tubes, nano-magnesium based hydrides, Metal hydride-carbon nano-composites, nano-chemical hydrides and alienates. Hera can offer Magnesium Hydride and Sodium Aluminum Hydride.

Fuel cells for transforming hydrogen or other gasses (natural gas, methanol) into electricity is a well known example. But researchers are also working on less visible nanotechnologies such as catalysts and membranes for separating different types of gases. These can be used in fuel cells or other energy transforming technologies.

The coming years, Europe will stimulate the real uptake of hydrogen in transport systems along several lines, including the CUTE project where prototype hydrogen powered buses will run in nine European cities. The coming years will also feature experiments in Iceland aiming to create a Hydrogen society on the island, including hydrogen powered buses from mid 2003, a network of hydrogen fuel stations for private cars, and development of plans for hydrogen boats.

There are basically two types of rechargeable batteries where nano-structured materials are applied and the focus of research. The first and most advanced is Lithium based, for example Li-ion batteries. These are dry batteries. The wet batteries, uses basically the same materials as for hydrogen storage, and are based on metal hydrides, where hydrogen is the chemical energy carrier, or carbon nano-tubes.

Improving environment

Airborne nano-robots could be programmed to rebuild the thinning ozone layer. Nano-robots could remove contaminants from water sources and clean up oil spills. Manufacturing materials using the bottom-up method of nanotechnology create less pollution than conventional manufacturing processes. Dependence on non-renewable resources would diminish with nanotechnology. Cutting down trees, mining coal or drilling for oil may no longer be necessary – nano-machines could produce those resources.

Conclusion

Only a few solutions covering saving space, finding alternative space, saving health, saving energy, saving machinery through replicators and improving environment have been discussed at conceptual level which requires detailed experiments. Though lot of work is progressing on nanotechnology, it is in bits and pieces and here and there and the need for joint global effort cannot be overstressed. Globalization has already brought the world close hence the world scientists must join hands to find workable solutions to the global problems which nanotechnologies have a promising role to play. To work on the invisible may look like working with a phantom but it is not fantasy since the reality is gradually emerging in a big way to help the society in need [1-25].

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