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REVIEW ARTICLE

An application of nanotechnology and its risk in developing countries.

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Abstract

The progress and development of different nations of the world is strongly connected with the type of materials under their use. Among those materials used nanotechnology is one of the most active areas of research and has useful applications which are gradually establish itself from the previous century. Recently, its great application is more pronounced in the agricultural and food sectors, energy sectors, textile sectors, water and wastewater treatment, construction sectors, and health sectors. Now a day's the smart delivery of nutrients, bioseparation of proteins, rapid sampling of biological and chemical contaminants and nanoencapsulation of nutraceuticals are some of the emerging topics of nanotechnology. In developing countries the nanotechnology used in different sectors are imported from the developed countries; due to lack of production of nanotechnology materials on the basis of the research they done in their institutions. The potentials and level of utilizing those technologies in different sector has no as much contribution and the communities of those countries have lack of information on the importance and ways of application of nanotechnology. This technology have its own consequence on the health of the community and environment impact, if the community who use the technology have not well informed on the advantage and risks of these technology while they used in different sector.

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Introduction:-

Nanotechnology is the synergy of mechanical, electrical, chemical engineering, material sciences, microelectronics, and biological screening. Nanotechnologies are the design, production, characterization, and application of structures, devices and systems by controlling shape and size at nanometer scale (woodrow, w., 2006). So, nanotechnology is the creation of materials and devices by controlling of matter at the levels of atoms, molecules, and supramolecular (nanoscale) structures (roco, m.; et al, 1999). In other words, it is the use of very small particles of materials to create new large scale materials (mann, s.; 2006). Materials at such small scales often exhibit different electrical, magnetic, optical, mechanical, and other physical properties from their bulk material counterparts, leading to the development of potentially revolutionary technologies in a variety of industries. It is not a discreet industry sector but a range of techniques used to manipulate matter at the nano-scale where size is measured in billionths of meters. A dna molecule is about 2.5 nm wide. A red blood cell is vast in comparison: about 5,000 nm in diameter. Everything on the nano-scale is invisible except with the aid of powerful "atomic force" microscopes (etc group, 2008). Nanotechnology involves the characterization, fabrication and/ or manipulation of structures; devices or materials that have at least one dimension in length. (roco m., et al, 2010).

Their unique physicochemical (e.g., size, shape) and surface (e.g., reactivity, conductivity) properties contribute to technological breakthroughs that enable new and improved technical solutions to problems that have been challenging to solve with conventional technologies. Nanotechnology, with its almost limitless range of novel food and other applications, has been promoted by some as the driving spark for the next industrial revolution (priestly, et al 2007). It is a new and rapidly emerging field, with most of the expansion occurring in the past decade. In 1997,

worldwide nanotechnology research and development was estimated at \$432 million, but by 2005, this amount raised nine fold to around \$4.1 billion (roco m.; 2005).

Many advanced countries such as usa, china, uk, germany, japan and many others have since a decade ago initiated and developed a robust nanotechnology plan for their respective countries. Also, few developing countries that have a clear understanding of the trend have in the recent past launched their own nanotechnology program and are today at various advanced stages with much economic benefits. Unfortunately, most african nations and some other least developed countries (ldc) have only demonstrated interest to start without any practical approach to its implementation (teri: 2012). In a recent study that ranked nanotechnology applications according to their potential benefit for developing countries, water treatment, disease diagnosis/screening and drug delivery systems respectively rated 3rd, 4th and 5th, behind energy storage, production, and conversion (1st) and agricultural productivity enhancement (2nd) (etc group; 2004). Nanotechnology offers an area such as developing country healthcare, "safer drug delivery, and new methods for prevention, diagnosis and treatment of diseases" (chrispeels m., 2000).

General application of nanotechnology in the world:-

The application of nanotechnology can occur in one, two or three dimensions.

I) in one dimension: one-dimensional systems, such as thin films or manufactured surfaces or coatings are one dimensional nonmaterial. Their applications include corrosion resistant, wear and scratch resistant, hydrophobic and self cleaning, dirt repellent, antibacterial and anti-microbial, catalytically active and chemically functionalized and tranperacy modulated surfaces.

Ii) in two dimension: in two dimensions it includes the manufacture of carbon nanotubes, nanowires, nanofibers and nanopolymers are two dimensional nanoparticles.

A) carbon nanotubes: carbon nanotubes are a new form of carbon molecule. Wound in a hexagonal network of carbon atoms, these hollow cylinders can have diameters as small as 0.7 nm and reach several millimetres in length (hett a., 2004).



Figure 1. schematic representation of carbon nanotubes.

Each end can be opened or closed by a fullerene half-molecule. These nanotubes can have a single layer (like a straw) or several layers (like a poster rolled in a tube) of coaxial cylinders of increasing diameters in a common axis (ijjima s., 1991).

Iii) in three dimension: in three dimensions it encompasses the manufacture of small particles no more than a few nanometres in any dimension that might be used as an ingredient in sunscreens or to deliver medicine to a specific type of cell in the body and here are examples of 3d nanotechnology; fullerenes, dendrimers and quantum dots.

A) fullerenes: fullerenes are spherical cages containing from 28 to more than 100 carbon atoms. Fullerenes are a class of materials displaying unique physical properties. They can be subjected to extreme pressures and regain their original shape when the pressure is released. These molecules do not combine with each other, thus giving them

major potential for application as lubricants. Fullerenes products include drug delivering vehicle and electronic circuit.

B) dendrimers: dendrimers represent a new class of controlled-structure polymers with nanometric dimensions. They are considered to be basic elements for large-scale synthesis of organic and inorganic nanostructures with dimensions of 1 to 100 nm, displaying unique properties. Having compatible with organic structures such as dna, they can also be fabricated to interact with metallic nanocrystals and nanotubes or to possess an encapsulation capacity (tomalia d., 2004). These are used in conventional application, drug delivery, environmental and water cleaning.

C) quantum dots: quantum dots can be many things, but the initial products that incorporate quantum dots are small grains (a few nanometers in size) of semiconductor materials (for example, cadmium selenide) (bukowski t. J., and simmons j. H., 2002). These grains are stabilized against hydrolysis and aggregation by coating with a layer of zinc oxide and a film of organic surfactant-technologies already familiar to the chemical industry in making paints and washing powders. These first semiconductor quantum dots are fluorescent-they emit colored light when exposed to ultraviolet excitation and are being tested in displays for computers and mobile telephones, and as inks. These materials are interesting for several reasons; one is that they do not photobleach (that is, lose their colour on exposure to light); a second is that a single manufacturing process can make them in a range of sizes, and thus, in a single process, in all colours (smith a. M., and nie s., 2004).

It represents a special form of spherical nanocrystals from 1 to 10 nm in diameter. They have been developed in the form of semiconductors, insulators, metals, magnetic materials or metallic oxides. Quantum dots are used to track dna molecules in cells, efficient alternatives to conventional lighting sources, biosensors used to detect agents of biological warfare (edward p. And michele m., 2004). Nanotechnology also considers two main approaches: (a) the “top down” approach in which larger structures are reduced in size to the nanoscale while maintaining their original properties without atomic-level control (e.g., miniaturization in the domain of electronics) or deconstructed from larger structures into their smaller composite parts and (b) the “bottom-up” approach, also called “molecular nanotechnology” or “molecular manufacturing” in which materials are produced from atoms or molecular components through a process of assembly or self-assembly.

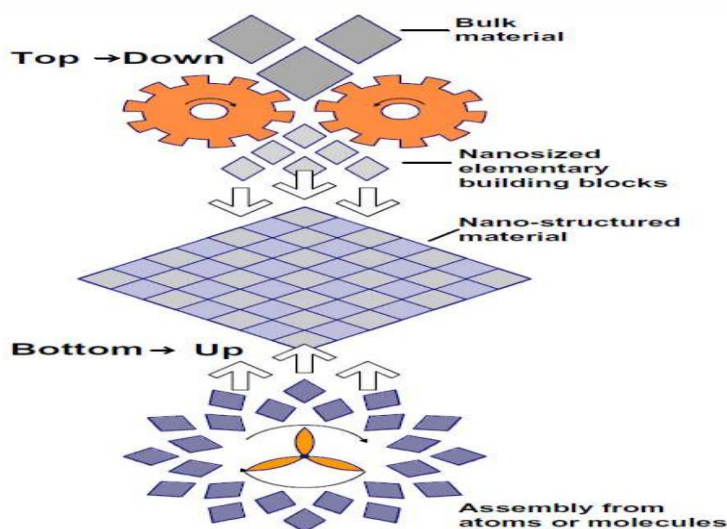


Figure 2: the top-down and bottom-up approaches in nanotechnology.

Thus, the basic concept behind nanomodification of materials is that of bottom-up producing, starting with produced modifications to the molecular structure with an aim to affect the bulk properties of the material (sanchez and sobolev, 2010). In a recent study that ranked nanotechnology applications according to their potential benefit for developing countries, water treatment, disease diagnosis/screening and drug delivery systems respectively rated 3rd, 4th and 5th, behind energy storage, production, and conversion (1st) and agricultural productivity enhancement (2nd)(etc group, 2004).

Nanotechnology in developing countries:-

All around the world, nanotechnology is being promoted as a technological revolution that will help solve an array of problems. According to the current hype, nanotechnology promises to provide new ways of solving some of africa's chronic challenges such as treating tuberculosis and malaria, making water drinkable, conserving food, and diversifying energy sources, among other hosts of applications. In several african countries, nanotechnology has been declared a strategic sector of scientific and technological development. To achieve the strategic goals, public funds have been or are being used to encourage nanotechnology development through the establishment of research networks and research centres. South africa has spent over half a billion rands to support nanotechnology research and development in the country from 2005 to 2012. Research on nanotechnology, and increased commercialization of products containing engineered nanomaterials (generally called nanoproducts), are currently happening in africa (e.g., in south africa, sudan, kenya, zimbabwe, egypt, algeria). (ndeke m., 2012).

The african countries actively involved in nanoscience and nanotechnology include cameroon, ethiopia, kenya, namibia, nigeria, the republic of south africa, senegal, sudan and tanzania (tobin l., 2012). In addition, there are indications of interest in nanotechnology in other countries, such as morocco (rosei f., et al, 2008) and egypt, although they appear not to have well coordinated national programmes in nanotechnology (bajwa r, et al, 2012). Zimbabwe adopted a national nanotechnology programme in 2011. In kenya, activities in nanotechnology research have concentrated on energy storage, production and conversion (soitah t., et al, 2010), agricultural productivity enhancement, agro-chemical delivery (kamau s., et al. 2010), water treatment and purification, nanomedicine and nanobiotechnology (tobin l., 2012). In ethiopia, the main focus areas include electromagnetic properties of nanomaterials (mal'nev v. And senbeta t., 2011), solar energy and single-walled carbon nanotubes (yaya a., et al, 2011). In sudan include the synthesis and characterization of nanomaterials (jan l. And siddig m., 2011) and drug delivery systems (elsayed a., et al. 2011). In tanzania, research revolves around nanotechnology for human and animal health, and nanobiotechnology (wambura p., 2011). In nigeria, the main themes of nanotechnology and nanoscience include nanomedicine (drug delivery methods, the treatment of diseases such as hiv, malaria, and cancer, and the biocompatibility of medical implants (obitte n., et al, 2011), nutrition, applications in electronics -optoelectronics, leds and mems devices (adekunle a., et al., 2011) and catalysis (george r, et al, 2011). In cameroon, the universities of yaoundé, buea, doula and dschang are involved in the synthesis and characterization of nanomaterials (nano composite thin films) (kana j., et al, 2008) and water purification and treatment (tchomgui k., et al, 2010). In senegal has been involved in the area of synthesis, characterization and applications of nanomaterials (chiodi m, et al., 2010).

Application nanotechnology in food sector:-

In food industries, the applications of nanotechnology include nanoparticulate delivery systems (nano dispersions and nano capsules), packaging (nano laminates, nano composites bottles, and bins with silver nanoparticles), food safety and biosecurity (nanosensors) etc. (chen et al. 2006). The nanotechnology will play a vital role in the food processing and would involve two forms of nano; food additives (nano inside) and food packaging (nano outside). The nanoscale food additives may be used to influence texture, flavour, nutritious improvement, provide functionally and even detect pathogens and food packaging involves extend food shelf life, edible, nano wrapper which will envelope foods, preventing gas and moisture exchange, 'smart' packaging (containing nano-sensors and anti-microbial activators) for detecting food spoilage and releasing nano-anti-microbes to extend food shelf life (richardson, piehowski, and miller, 2008). Most polysaccharides and lipids are linear polymers with thicknesses less than nanometers, while food proteins are often globular structures (1-10 nm) in size. The functionality of many raw materials and the processing of foods arise from the presence, modification, and generation of forms of self-assembled nanostructures (chen et al. 2006). Customers today demand a lot more from packaging in terms of protecting the quality, freshness and safety of foods and the nanotechnology, which uses microscopic particles, is effective and affordable and will bring out suitable food and dairy packaging in the near future (el amin, 2006).

Many nano-sized particles occur in nature, such as lactose and whey proteins found in human milk, the focus here is on those purposely manipulated or engineered for new applications. Nanotechnology has the potential to revolutionize the global food system (moraru, 2003; bouwmeester, 2009). The four major areas in food industry that will probably be significantly enhanced by nanotechnology are development of new functional materials; micro- and nanoscale processing; product development; and design of methods and instrumentation for food safety and biosecurity (moraru, 2003). The potential applications of nanotechnology in the food production chain are claimed to be applicable throughout all phases of food production. Current nanotechnology applications in the food

production chain are focused on the development of nano-sized food ingredients and additives, delivery systems for bioactive compounds, and innovative food packaging (chaudhry et al., 2008).

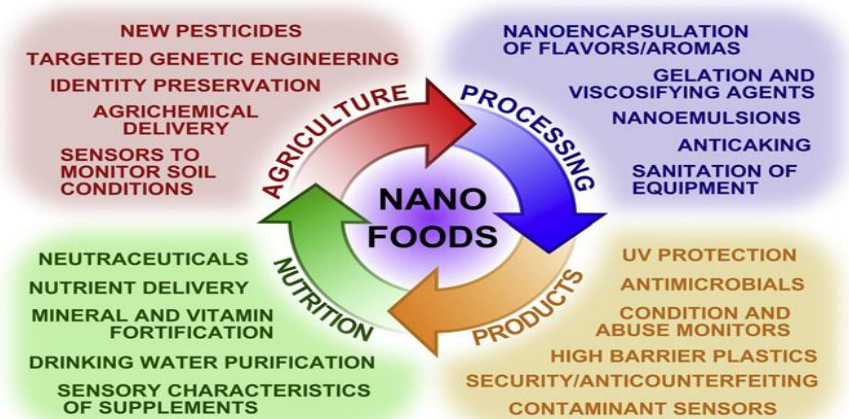


Figure 3: applications nanotechnology in all areas of food science, from agriculture to food processing to security to packaging to nutrition and nutraceuticals.

Indirect contamination of food can be expected when nps or nanotechnological devices are incorporated into packaging materials or storage containers in order to lengthen the shelf life while keeping the products fresh. This type of application is seen as the most important of nanotechnologies in the food sector for the near future (chaudhry et al., 2008).

Application of nanotechnology in health sector:-

An exciting revolution in health care and medical technology looms large on the horizon. Yet the agents of change will be microscopically small, future products of a new discipline known as nanotechnology. Nanomedicine is the application of nanotechnology to medicine. It is the preservation and improvement of human health, using molecular tools and molecular knowledge of the human body. In a present day nanomedicine exploits carefully structured nanoparticles such as dendrimers (borges a. And schengrund c., 2005) carbon fullerenes (buckyballs) (mashino t., et al, 2005) and nanoshells to target specific tissues and organs. These nanoparticles may serve as diagnostic and therapeutic antiviral, antitumor or anticancer agents (o'neal d., et al, 2004). An increasing number of applications are expected for food and agriculture uses, including nanosensors, potentially capable of detecting chemical contaminants, viruses, and bacteria; nano delivery systems, which could precisely deliver drugs or micronutrients at the right time and to the right part of the body; as well as nanocoatings and films, nanoparticles, and quantum dots. Smart delivery systems can detect and treat an animal infection or nutrient deficiency and provide timed-release drugs or micronutrients. A nano additive for animal feed can deactivate aflatoxin, deoxynivalenol, and zealalenone mycotoxins in animal feed. Nanoparticles can also remove food borne patho gens in the gastrointestinal tracts of livestock (guillaume g., et al, 2011).

Nanostructures may also be useful in delivering drugs, as imaging agents, and in clinical analysis (whitesides g.; pen n s., he l., and natan m., 2003; burke p., 2004). Nanotechnology offers an area such as developing country healthcare, "safer drug delivery, new methods for prevention, diagnosis and treatment of diseases" (chrispeels m., 2000). In a joint project between groups in the u.s., india and mexico, inexpensive, maintenance free solar panels, aimed at powering rural clinics and refrigerating medicines, are currently being developed (sani, 2003). Many believe nanotechnology offers new ways to address residual scientific concerns for mycobacterium tuberculosis (tb). In india, the country with the highest estimated number of tb cases (poullier j., et al, 2002), research is underway into the role nanotechnology can play in addressing such concerns.

A nanotechnology-based tb diagnostic kit, designed by the central scientific instruments organisation of india and currently in the clinical trials phase, does not require skilled technicians for use (nsf, 2004). Nanotechnology offers great visions of improved, personalized treatment of disease. One application of nanotechnology in medicine currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer cells). Particles are engineered so that they are attracted to diseased cells, which allow direct treatment of those cells (www.cytimmune.com).

Application of nanotechnology in water and wastewater treatment:-

Water is the most essential substance for all life on earth and a precious resource for human civilization. Reliable access to clean and affordable water is considered one of the most basic humanitarian goals, and remains a major global challenge for the 21st century. Our current water supply faces enormous challenges, both old and new. Worldwide, some 780 million people still lack access to improved drinking water sources (WHO, 2012). It is urgent to implement basic water treatment in the affected areas (mainly in developing countries) where water and wastewater infrastructure are often non-existent. In both developing and industrialized countries, human activities play an ever-greater role in exacerbating water scarcity by contaminating natural water sources. Current water and wastewater treatment technologies and infrastructure are reaching their limit for providing adequate water quality to meet human and environmental needs. Recent advances in nanotechnology offer leapfrogging opportunities to develop next-generation water supply systems. Our current water treatment, distribution, and discharge practices, which heavily rely on conveyance and centralized systems, are no longer sustainable (Qu et al., 2013).

Nanotechnology-enabled water and wastewater treatment promises to not only overcome major challenges faced by existing treatment technologies, but also to provide new treatment capabilities that could allow economic utilization of unconventional water sources to expand the water supply (Gao et al., 2011).

Adsorption:-

Adsorption is commonly employed as a polishing step to remove organic and inorganic contaminants in water and wastewater treatment. Efficiency of conventional adsorbents is usually limited by the surface area or active sites, the lack of selectivity, and the adsorption kinetics. Nano-adsorbents offer significant improvement with their extremely high specific surface area and associated sorption sites, short intra-particle diffusion distance, and tuneable pore size and surface chemistry (Sharma et al., 2009).

Carbon based nano-adsorbents:-

A). Organic removal.

CNTs have shown higher efficiency than activated carbon on adsorption of various organic chemicals (Pan and Xing, 2008). Its high adsorption capacity mainly stems from the large specific surface area and the diverse contaminant-CNT interactions. The available surface area for adsorption on individual CNTs is their external surfaces (Yang and Xing, 2008). In the aqueous phase, CNTs form loose bundles/aggregates due to the hydrophobicity of their graphitic surface, reducing the effective surface area. On the other hand, CNT aggregates contain interstitial spaces and grooves, which are high adsorption energy sites for organic molecules (Pan et al., 2008). Although activated carbon possesses comparable measured specific surface area as CNT bundles, it contains a significant number of micropores inaccessible to bulky organic molecules such as many antibiotics and pharmaceuticals (Ji et al., 2009).

A major drawback of activated carbon is its low adsorption affinity for low molecular weight polar organic compounds. CNTs strongly adsorb many of these polar organic compounds due to the diverse contaminant-CNT interactions including hydrophobic effect, π - π interactions, hydrogen bonding, covalent bonding, and electrostatic interactions (Yang and Xing, 2008). The π electron rich CNT surface allows π - π interactions with organic molecules with C=C bonds or benzene rings, such as polycyclic aromatic hydrocarbons (PAHs) and polar aromatic compounds (Chen et al., 2007; Lin and Xing, 2008). Organic compounds which have -COOH, -OH, -NH₂ functional groups could also form hydrogen bond with the graphitic CNT surface which donates electrons (Yang et al., 2008). Electrostatic attraction facilitates the adsorption of positively charged organic chemicals such as some antibiotics at suitable pH (Ji et al., 2009).

B) heavy metal removal

Oxidized CNTs have high adsorption capacity for metal ions with fast kinetics. The surface functional groups (e.g., carboxyl, hydroxyl, and phenol) of CNTs are the major adsorption sites for metal ions, mainly through electrostatic attraction and chemical bonding (Rao et al., 2007). As a result, surface oxidation can significantly enhance the adsorption capacity of CNTs. Several studies show that CNTs are better adsorbents than activated carbon for heavy metals (e.g., Cu²⁺, Pb²⁺, Cd²⁺, and Zn²⁺) (Lu et al., 2006).

Application of nanotechnology in construction sector:-

Nanotechnology can be used for design and construction processes in many areas since nanotechnology generated products have many unique characteristics. These characteristics can, again, significantly fix current construction problems, and may change the requirement and organization of construction process. These include products that are for:

- ✓ Lighter and stronger structural composites
- ✓ Low maintenance coating
- ✓ Improving pipe joining materials and techniques.
- ✓ Better properties of cementitious materials
- ✓ Reducing the thermal transfer rate of fire retardant and insulation
- ✓ Increasing the sound absorption of acoustic absorber
- ✓ Increasing the reflectivity of glass

The abbreviated list is not an exhaustive list of applications of nanotechnology in construction (zhi g. And Zhili g.; 2008). Some of these applications are;

Concrete:-

Concrete is one of the most common and widely used construction materials. Its properties have been well studied at macro or structural level without fully understanding the properties of the cementitious materials at the micro level. The rapid development of new experimental techniques makes it possible to study the properties of cementitious materials at micro/nano-scale. (li,g.; 2004) found that nano-sio₂ could significantly increase the compressive for concrete, containing large volume fly ash, at early age and improve pore size distribution by filling the pores between large fly ash and cement particles at nanoscale.

Coating:-

The coatings incorporating certain nanoparticles or nano layers have been developed for certain purpose. It is one of the major applications of nanotechnology in construction. For example, tio₂ is used to coat glazing because of its sterilizing and anti-fouling properties. The tio₂ will break down and disintegrate organic dirt through powerful catalytic reaction. Furthermore, it is hydrophilic, which allow the water to spread evenly over the surface and wash away dirt previously broken down. Other special coatings also have been developed, such as anti-fraffiti, thermal control, energy saving, and anti-reflection coating (zhi g. And Zhili g., 2008).

Nanosensors:-

Nano and microelectrical mechanical systems (mems) sensors have been developed and used in construction to monitor and/or control the environment condition and the materials/structure performance. One advantage of these sensors is their dimension. Nanosensors range from 10⁻⁹ m to 10⁻⁵m. The micro sensor ranges from 10⁻⁴ to 10⁻² m (liu et al., 2007). These sensors could be embedded into the structure during the construction process. Smart aggregate, a low cost piezoceramic-based multi-functional device, has been applied to monitor early age concrete properties such as moisture, temperature, relative humidity and early age strength development. The sensors can also be used to monitor concrete corrosion and cracking. The smart aggregate can also be used for structure health monitoring (saafi and romine, 2005; song and mo, 2008).

Application of nanotechnology in energy:-

Nanotechnology could provide technologies that would contribute to world-wide energy security and supply. Although the most significant contributions may be to unglamorous applications such as better materials for exploration equipment used in the oil and gas industry or improved catalysis, nanotechnology is being proposed in numerous energy domains, including solar power; wind; clean coal; fusion reactors; new generation fission reactors; fuel cells; batteries; hydrogen production, storage and transportation; and a new electrical grid that ties all the power sources together (<http://www.rice.edu/energy/publications/docs/nanoreport.pdf>). The main challenges where nanotechnology could contribute are:

- ✓ Lower the costs of photovoltaic solar energy tenfold,
- ✓ Achieve commercial photocatalytic reduction of co₂ to methanol,
- ✓ create a commercial process for direct photoconversion of light and water to produce h₂
- ✓ Lower the costs of fuel cells between tenfold and a hundredfold and create new, sturdier materials,

- ✓ Improve the efficiency and storage capacity of batteries and supercapacitors between tenfold and a hundredfold for automotive and distributed generation applications,
- ✓ Create new lightweight materials for hydrogen storage for pressure tanks, liquid hydrogen vessels, and an easily reversible hydrogen chemisorption system,
- ✓ Develop power cables, superconductors or quantum conductors made of new nanomaterials to rewire the electricity grid and enable long-distance, continental and even international electrical energy transport, also reducing or eliminating thermal sag failures, eddy current losses and resistive losses by replacing copper and aluminium wires,
- ✓ Create super strong, lightweight materials that can be used to improve energy efficiency in cars, planes and in space travel; the latter, if combined with nanoelectronics based robotics, possibly enabling space solar structures on the moon or in space,
- ✓ Create efficient lighting to replace incandescent and fluorescent lights,
- ✓ Develop nanomaterials and coatings that will enable deep drilling at lower costs to tap energy resources, including geothermal heat, in deep strata,
- ✓ Create CO₂ mineralization methods that can work on a vast scale without waste streams.

Nanosolar has developed a material of metal oxide nanowires that can be sprayed as a liquid onto a plastic substrate where it self-assembles into a photovoltaic film. If nanotech solar fabrics could be applied to, e.g., buildings and bridges, the energy landscape could change in important ways (<http://www.lucant.com/press/0904/040928.bla.html>).

Application of nanotechnology in textile sector:-

Nanosize metal oxide and ceramic particles have a larger surface area and hence higher efficiency than larger size particles, are transparent, and do not blur the colour and brightness of the textile substrates. Fabric treated with nanoparticles TiO₂ and MgO replaces fabrics with active carbon, previously used as chemical and biological protective materials. The photocatalytic activity of TiO₂ and MgO nanoparticles can break down harmful chemicals and biological agents. Finishing with nanoparticles can convert fabrics into sensor-based materials. If nanocrystalline piezoceramic particles are incorporated into fabrics, the finished fabric can convert exerted mechanical forces into electrical signals enabling the monitoring of bodily functions such as heart rhythm and pulse if they are worn next to skin (<http://www.rice.edu/energy/publications/docs/nanoreport.pdf>).

Risks of nanotechnology in developing countries:-

Traditional chemical management defines the risk posed by a substance as a function of the hazard characteristics of a specific substance, and the exposure to this substance (i.e., risk = hazard x exposure or $r=hxe$). Historical evidence supported by scientific findings show that all new technologies come with risks to human health and the environment, and nanotechnology is no exception. The increasing number of engineered nanomaterials and nanoproducts gives rise to increasing breadth and extent of the potential risks posed to the human health and the environment. In general, humans are exposed to nanomaterials either through, ingestion, inhalation, or penetration through the skin. It is also important to consider the possibility of accidents, like fires or explosions, which can also expose unprotected individuals to the risk of engineered nanomaterials, which to date is yet to be studied in great depth to allow any form of generalization of what can cause risk or not. Finally, although nanotechnology risks are being explored fairly early in their development compared to other technologies, commercialization of product and thus human and environmental exposure is still happening without due consideration for their potential risks (Museum, et al, 2012). If the wrong people gained the ability to manufacture any desired product, they could rule the world, or cause massive destruction in the attempt. Certain products such as powerful aerospace weapons, and microscopic antipersonnel devices, provide special cause of concern. Clearly, the unrestricted availability of nanotechnology poses grave risks, which may well outweigh the benefits of clean, cheap, convenient, self-contained manufacturing. Once a nanotechnology-based manufacturing technology is created, it must be administered with even more care to environment (Chris P. and Mike T., 2003).

Conclusion:-

Scientific developments and increasing international attention have promoted our ability to work with and understand the nanoscale. Nanotechnology offers almost limitless potential to textile industry, energy, food industries, in construction industries, in the reduction of environmental pollution, better healthcare, and

improvement of quality of life for the aged, better transport and wastewater treatment in both developed and in developing countries. In developing countries; the nanotechnology is not yet developed and import from developed countries rather than creating, developing and manufacturing. Even though it has many advantages in the world, it has also a risk in human health, and environment. Nanotechnology applications have not been marketed long enough in developing countries for claims to be corroborated about risks to human health or the environment. Still, small nanoparticles can enter the human body through pores, inhalation, ingestion, skin uptake, injection of nanoscale materials and may accumulate in the cells. In general, nanotechnology represents a major opportunity to generate new products and industries in the coming decades if the nanotechnology adoption and promotion considers through risk mitigation by creation of awareness on application of the technology during distribution to the community for application.

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