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Nano Technology-Applications Around Us

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ABSTRACT

Nano Technology is the science covering the particles having size ranging below 100 nano meter. It is an emerging & innovative science that deals with designing, characterization, manufacture, application of system & devices by controlling the size & shape of the objects at nano meter scale. It is now being used in every branch of science, namely chemistry, engineering, biology, physics. It is because of the uniqueness of the properties of nano particles that cannot be achieved at macro or bulk level. Various applications of nano technology arise due the fact that the structural features of materials can be tailored at nano scale to achieve useful & specific properties. The materials can be made lighter, stronger, durable, more efficient, cheaper etc. More than 800 commercial products in everyday life exist that find applications of nano technology & nano materials. Nano Technology has numerous applications in various industries & sectors namely medicines, food safety, environmental science, energy efficiency, construction material, defense, textile & fabrics, information technology, sports, cosmetics, glass & plastics, catalysis & many more. However it is still controversial that whether nano technology is safe & environmental friendly. In spite of all above controversies it is being looked as the main driver of technology & business in the world & holds the promise of higher performance materials, intelligent systems & new production methods with significant impact on all aspects of society.

I. INTRODUCTION

Nano Science is the emerging science of objects whose sizes are intermediate between very large molecules & very small one with size ranging from a few nano meters to less than 100 meters .This particle size has been found in micelles, polymers, colloids & similar structures in chemistry. In physics & engineering, Nano science is often associated with behavior of electron & photon at nano scale level. Whereas in biology & similar life sciences, nano science deals with different nano structures such as cell components, DNA, subcellular organelles & many others.

Various chemical products are used to make objects that vary significantly in their size from very big like iron girders for making bridges to silicon chips to be used in microprocessors. Now various techniques are available to manipulate materials on molecular or atomic level to produce objects whose size is a few nanometers. These techniques and processes are called nanotechnology and the materials and objects, thus produced are known as nanomaterials. Nanomaterials are not new to us. These have already existed but the techniques used to manipulate nanomaterials have only been developed during the last two decades. With the invention of Scanning Tunneling

Microscope (STM) in 1981, it has become feasible to work on nano scale. With this basic technology, it has not only become possible to visualize individual atom and molecule, but we can even pick them up and move them around. The discovery of Buckminsterfullerene, C_{60}, an allotrope of carbon, the production of nanotubes and their subsequent use of clay nanoparticles lead to the use of nanomaterials beyond microprocessor industry. Carbon nanotubes resemble graphite sheets that have been rolled into cylinders. These small carbon nanotubes can align themselves into robes by intermolecular bonding. Single, double as well as multi wall carbon nanotubes can be prepared in a similar way.

The smallness of particle confers on them very useful properties. These useful properties cannot be obtained at macro level.

II. PREPARATION

Nanomaterials can be prepared by two approaches- Top-Down approach and Bottom-Up approach. In the former approach, macro particles are cut down to get materials at desirable Nano scale and the later approach uses assembling structures from atoms and molecules. This is less wasteful approach than the first one in which very costly particles gets etched away during the process. Among other methods to prepare nanoparticles physical and chemical vapor deposition are the two main methods. In physical vapor deposition (PVT), heat from furnace or pulsed laser is used to vaporize the material which is then condensed on a cool surface. In chemical vapor deposition (CVD), reaction occurs in the vapor field between two or more materials and/or vapor reacts with the target material. CVD is thought to show the most promise for the production of carbon nanotubes.

III. APPLICATIONS AND USES

After more than two decades of basic Nano science with nanotechnology's promise to benefit society, applications of nanotechnology are delivering in both expected and un-expected ways. Nanotechnology is helping to considerably improve many technology and industry sectors- Information technology, medicine, textiles, food, cosmetics, paints and coatings, glass, plastic, environmental science and many more. Most benefits of nanotechnology depend on the fact that it is possible to tailor the essential structures of the material at the nano scale to achieve specific properties. Some of these properties arise from the enormous increase in surface area which increases the rate of reaction occurring on the surface. The small dimensions of nanomaterials allow them forming intimate mixtures with other material with a view to enhance the properties of the material. In medical treatments they can be tailored to provide opportunities to target the medicines more precisely. In this section a wide range of uses of nanomaterials is discussed.

3.1 Catalysis

Due to extremely large surface to volume ratio, nano particles has been applied in chemical catalysis that ranges from fuel cells to catalytic converters. One catalytic application is a use of cerium (IV) oxide nano particles which are added to diesel and bio-diesel fuels in very small amounts. These act as heterogeneous catalyst and ensures the complete combustion of fuel to give CO2 and H2O reducing the amount of CO and unreacted fuel. It improves the fuel efficiency by 4-11% and reduces pollution. Also because of their very small size, cerium(4) oxide nano particle forms homogenous solution in fuel so these are easily premixed with fuel & requires no special delivery equipment's & any modifications to vehicle engines.

Platinum nano particles are now being considered the next generation of automotive catalytic converters.

3.2. Glass

Titanium dioxide (TIO2) nano particles are used to coat glazing due to its sterilizing & anti fouling properties. Being hydrophilic in nature, TIO2 nano particles help in washing the dirt particles by attracting rain drops, providing self-cleaning properties to glass.

Nano technology also has an application in making fire protective glass. Silica nano particles (SIO2) layer is sandwiched in between glass panels. Upon heating, these turn into a rigid & opaque fire shield. As glass is mainly used on the exterior surface of building, therefore nano technology can give a better solution in blocking light and heat coming from outside.

3.3. Plastics

Silica nano particles in nano composites have ability to withstand higher temp. & therefore finds its use in engine parts of cars.

Carbon nano tubes are flexible as well as strong & can be twisted without breaking. This property of carbon nano tubes (CNT's) can be used in making polymers & composites to strengthen a structure, to increase the electrical conductivity & to increase heat transfer. These materials are used in fuel lines in petrol stations helping in reducing the risk of spark & static buildup as the fuel is delivered from the nozzle. Hence reducing the risk of fire which in case is a very big concern in fuel stations.

3.4. Coating

Coating are applied to walls, windows, doors & other surfaces to provide a protective layer to base coating. The coating should have the self-healing properties & should be corrosive protective as well. Nano Technology gives various applications in this field. CNT's act as multi-functional coating materials. MWNT can reduce bio fueling of ship hulls by preventing attachment of algae & barnacles. So they are one of the possible alternatives to environmentally hazardous bio cide containing paints.

CNT's when mixed with anti-corrosive coating for metals can increase strengths & coating stiffness. These coating are generally hydrophobic. These repel water from metal surface protecting the metal from salt water.

Nano particles based systems provide better adhesion & transparency. TIO2 based coating can capture & breakdown various air pollutants, contributing towards clean environment.

3.5. Foods

Nano technology has solved many engineering & scientific challenges in the food & bio processing industries for manufacturing safe & high quality food using efficient & sustainable means. Nano technology is having an impact on several aspects of food science from how is food produced & up to its packaging. Companies are developing nano materials that will make a difference not only in the taste of food but also in the safety & health benefits that food delivers.

Nano composite coatings can improve food packaging by placing anti-microbial agents directly on the surface coated films. This can improve the mechanical & high resistant properties.

New foods are among the nano technology created consumer products coming into the market namely a brand of canola cooking oil called canola active oil, a tea called nano tea & chocolate diet shake called nano ceutical Slim Shake Chocolate. The canola active oils contains nano drops designed to carry vitamins, minerals & phyto chemicals through the digestive system. The shake uses cocoa in fused nano clusters enhancing the taste & health benefits of cocoa without the need of extra sugar.

3.6 Sports

Nano technology can also play a vital role in sports such as football, cricket & baseball. The need of making the soccer & athlete shoes lighter & tough so that a player can run faster is done possible by the nano technology by using carbon nanotubes. Apart from shoes other sport materials like yoga mats, towels are also used in sports industry which use antimicrobial nano technology.

3.7 Textiles

With the help of nano technology engineered nano fibers already makes cloths strain & water repellant & wrinkle free. The cloths with nano technology needs less washing at lower temp.Nano technology has been used to integrate tiny carbon particles membrane & guarantee full surface protection from electrostatic charges for the wearer.

A fleece fabric has been produced containing nano particles of carbon which is derived from bamboo. Though the highly absorbent, high surface areas & surface modifications of the nano particles, they can be used in such products to enhance properties including anti-microbial, anti-fungal, deodorizing, thermal-regulating & static free, yet soft & comfortable to wear.

3.8 Medicine

Nano technology has a great impact on the healthcare & personal care product industry.

Biological micro electro mechanical devices (bioMEMS) implanted into the body to deliver doses of drugs or carry new cells to damaged tissues bring the concept of nano surgery into being. In the area of bio medical imaging, the

use of nano particles as image enhancer is being developed. The enhanced magnetic properties of iron (III) oxide nano particles make them suitable for use in magnetic resonance imaging (MRI).

Nano carriers can be used for delivering imaging agents to cancer cells thus making it easier to locate the cancer cells precisely & making the treatment much more effective. Gold nano particles because of their resistance to corrosive can be used to destroy the cancer cells.

Magnetic Nano particles can be used for the removal of various toxins, pathogens & proteins from blood similar to dialysis. It allows specific targeting of substances & hence larger molecules which are commonly not dialyzable can be removed. Iron oxide or carbon coated metal nano particles with ferromagnetic or super para magnetic properties are used for this purification process. One of the earliest Nano medicine applications was the use of Nano crystalline silver which is used as an antimicrobial agent for the treatment of wounds.

Nano robots could actually be programmed to repair specific diseased cells, functioning in a similar way to antibodies in our natural healing processes.

Nanoparticles composed of polyethylene glycol-hydrophilic carbon clusters (PEG-HCC) have been shown to absorb free radicals at a much higher rate than the proteins out body uses for this function. This ability to absorb free radicals may reduce the harm that is caused by the release of free radicals after a brain injury.

3.9 Healthcare & Personal care products

Widespread influence of nanotechnology in the cosmetic industries is due to the enhanced properties attained by the particles at the nano level including color, transparency, solubility etc.

Eventually, nanotechnology may help us reverse aging at a cellular level. Until that day comes, we'll have to be content with the ways that nanotechnology is being used in cosmetics to keep our skin more youthful and provide protection from harmful sunlight.

Sunscreen that uses nanoparticles generated by ivy plants. Research has shown that these ivy nanoparticles are more effective than oxide nanoparticles in blocking ultraviolet rays. In sunscreen products, titanium dioxide and zinc oxide, in the size range of 20 nm, are used as efficient UV filters. Their main advantage is that they provide broad UV-protection and do not cause cutaneous adverse health effects.

Skin creams that uses proteins derived from stem cells to prevent aging of the skin. These proteins are encapsulated in liposome nanoparticles which merge with the membranes of skin cells to allow delivery of the proteins.

Skin care lotions in which nutrients are encapsulated in nanoparticles suspended in a liquid, making up a Nano emulsion. The small size of the nanoparticles, compared to particles in conventional emulsions, allows the nanoparticles to penetrate deeper into the skin, delivering the nutrients to more layers of skin cells.

3.10 Solar Cells

Using nanoparticles in the manufacture of solar cells has the following benefits:

- Reduced manufacturing costs as a result of using a low temperature process similar to printing instead of the high temperature vacuum deposition process typically used to produce conventional cells made with crystalline semiconductor material.
- Reduced installation costs achieved by producing flexible rolls instead of rigid crystalline panels. Cells made from semiconductor thin films will also have this characteristic.
- Currently available nanotechnology solar cells are not as efficient as traditional ones, however their lower cost offsets this. In the long term nanotechnology versions should both be lower cost able to reach higher efficiency levels than conventional ones.

Nanotechnology may provide an answer to the efficiency problem, by tinkering with solar power cells at a fundamental level to boost their ability to convert sunlight into power, and by freeing the industry to use less expensive materials.

Organic solar cells, made from elements such as carbon, nitrogen, and oxygen that are found in living things, would be cheaper and easier to make than current silicon-based solar cells.

Hydrophobic & self-cleaning properties combine to create more efficient solar panels especially during inclement weather.

3.11 Water Treatment

Providing clean and affordable water to meet human needs is a grand challenge of the 21st century. Worldwide, water supply struggles to keep up with the fast growing demand, which is exacerbated by population growth, global climate change, and water quality deterioration. The need for technological innovation to enable integrated water management cannot be overstated. Nanotechnology holds great potential in advancing water and wastewater treatment to improve treatment efficiency as well as to augment water supply through safe use of unconventional water sources.

Electro spun Nano fibers and Nano biocides show potential in the improvement of water filtration membranes. Bio fouling of membranes caused by the bacterial load in water reduces the quality of drinking water and has become a major problem. Several studies showed inhibition of these bacteria after exposure to Nano fibers with functionalized surfaces. Nanobiocides such as metal nanoparticles and engineered nanomaterials are successfully incorporated into Nano fibers showing high antimicrobial activity and stability in water.

3.12 Environmental Cleanliness

Green nanotechnology refers to the use of nanotechnology to enhance the environmental sustainability of processes producing negative externalities. It also refers to the use of the products of nanotechnology to enhance sustainability.

Agriculture

Nanotechnology in agriculture has gained momentum in the last decade with an abundance of public funding, but the pace of development is modest, even though many disciplines come under the umbrella of agriculture. This could be attributed to: a unique nature of farm production,

Many technologies have been developed that have the potential to increase farm productivity and also reduce the environmental and resource costs related with agricultural production. These technologies have the ability to conserve land and water by increasing yields through the application of the same or fewer inputs, ultimately conserving the environment.

Nanoscale carriers can be utilized for the efficient delivery of fertilizers, pesticides, herbicides, plant growth regulators, etc.

These carriers can be designed in such a way that they can anchor the plant roots to the surrounding soil structure and organic matter.

Clay nanotubes (Hallo site) have been developed as carriers of pesticides for low cost, extended release and better contact with plants, and they will reduce the amount of pesticides by 70?80%, hence reducing the cost of pesticide and also the impact on water streams

IV. DISADVANTAGES OF NANOTECHNOLOGY

When tackling the advantages and disadvantages of nanotechnology, you will also need to point out what can be seen as the negative side of this technology:

- Included in the list of disadvantages of this science and its development is the possible loss of jobs in the traditional farming and manufacturing industry.
- You will also find that the development of nanotechnology can also bring about the crash of certain markets due to the lowering of the value of oil and diamonds due to the possibility of developing alternative sources of energy that are more efficient and won't require the use of fossil fuels. This can also mean that since people can now develop products at the molecular level, diamonds will also lose its value since it can now be mass produced.
- Atomic weapons can now be more accessible and made to be more powerful and more destructive. These can also become more accessible with nanotechnology.

The extremely small size of nanomaterials also means that they are much more readily taken up by the human body than larger sized particles. How these nanoparticles behave inside the body is one of the issues that needs to be resolved. The behavior of nanoparticles is a function of their size, shape and surface reactivity with the surrounding tissue. They could cause overload on phagocytes, cells that ingest and destroy foreign matter, thereby triggering stress reactions that lead to inflammation and weaken the body's defense against other pathogens. Apart from what happens if non-degradable or slowly degradable nanoparticles accumulate in organs, another concern is their potential interaction with biological processes inside the body: because of their large surface, nanoparticles on exposure to tissue and fluids will immediately adsorb onto their surface some of the macromolecules they encounter. This may, for instance, affect the regulatory mechanisms of enzymes and other proteins.

Other properties of nanomaterials that influence toxicity include: chemical composition, shape, surface structure, surface charge, aggregation and solubility, and the presence or absence of functional groups of other chemicals. The

large number of variables influencing toxicity means that it is difficult to generalize about health risks associated with exposure to nanomaterials – each new nanomaterial must be assessed individually and all material properties must be taken into account.

Presently, nanotechnology is very expensive and developing it can cost you a lot of money. It is also pretty difficult to manufacture, which is probably why products made with nanotechnology are more expensive.

V. CONCLUSION

Nanotechnology is a brand new technology that has just began, it is a revolutionary science that will change all what we knew before. The future that we were watching just in science fiction movies will in the near future be real. This new technology will first of all, keep us healthy because of Nano robots that will repair every damage that we have in our body. Secondly it will give scientists the ability to manipulate the combination of atoms in an object and to turn it into a lighter, stronger, and more durable object than before, just by using carbon nanotubes that are known to be a hundred times stronger than steel and in addition to that they are very flexible. That will lead to the creation of objects that can change their forms and have multiple purposes as the Nokia Morph for example which is a prototype that will soon be out on the market. Thirdly, Nanotechnology will give us an abundant energy because it will transform energy more effectively, for example windmills which are known to have the ability to transform wind energy into electrical energy, well new windmills that will use Nanotechnology will have lighter and stronger blades (using carbon nanotubes) that will transform a lot more energy than before. On the other hand, many of the people in the world are aware of the advancements that various field have made since the introduction of Nanotechnology into the world. But little do they know of the hidden dangers and potential risks involved with Nanotechnology running under the carpet. Also, there are hardly any study or research groups so far to unveil the hidden implications associated with the Nanotechnology. In midst of all these, it is very difficult to decide on the merits and demerits of the Nanotechnology. On one side, the Nanotechnology provides an amazing base for the world to advance in many of the key areas and on the other side, it itself poses as a potential risk by elaborating the possibilities of destruction of the whole world.

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