Applications and Environmental Impact of Nanotechnology

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Abstract:

In this review article we are trying to focus on the current scenario going on today in the field of nanotechnology in various fields of basic sciences and engineering. A little is also told about the general properties and fabrication of nanotechnology. Advances in green technology is also discussed which is very useful to prevent pollution from air and water bodies. Toxicity is also discussed as without the knowledge of possible ill effect this technology would not be implemented accurately with guards on it. Other hazardous factors that are not suitable for the humans, animals and plants are briefly discussed.

1- Introduction:

Richard Feynman lecture "There is plenty of room at the bottom" at Caltech in 1959 is considered a milestone onto the path of research in Nanotechnology. Though a focused research interest into nanotechnology grew after the development of scanning tunnelling microscope (STM) in 1981 and fullerenes in 1985.Nanotechnology is considered one of the fastest-growing field of science and technology. This is most prominent researches filed of 21st century and have the capacity to change the current industries. Nanotechnology has promises to make our life better by making faster, lighter, cost efficient and long-lived materials. Question is how small nano actually is? Nano is one billionth of a meter (10^{-9}) Nano is a Greek word which means dwarfs and the in general we can say width of human hair is in nano-range. It seems that nano material should be strictly limited to few nano-meters but in practice it could go up to hundreds of nanometres which actually fall in micro-range. One interesting fact about nanotechnology is that in order to exploit boons of nanoscience we don't need to reduce all the three dimensions of bulk material to nanoscale, we can observe changes by reducing just one dimension of the bulk material [1-20].

Electronic, optical and magnetic properties of nano-structured materials depend on the size of nanomaterials, which can be easily manipulated by varying sizes of these smart materials. Another factor that plays very important role to make these nanomaterials so special is that at the nano level surface to volume ratio is very high; therefore these materials are highly

interactive and change the chemical properties to significant level. Owing to these modifications in chemical and physical properties this can be safely said that nanotechnology would one day change all the present-day human made metric scale bulk objects. Entirely new physical and chemical properties of these advance materials make it possible to create new smart materials with tremendous future applications in many disciplines such as Electronics, Agriculture, Renewable Energy, Food industry, Medicines and Surgery Transportation, Energy, Biotechnology, Metrology, Robotics, IT industries, Sports etc. In present short communication we will discuss its general fabrication methods held in laboratories along with its applications in various fields.

Nanomaterials could be found in nature. Colour of butterfly wings is due to its nanostructures, natural colloids, and many biological systems falls into the category of natural nanomaterials. Fabrication of nanomaterials in laboratory is categorised in two basic categories- Bottom up approach and Top down approach. Bottom up approach atoms or molecules are assembled into desired nanostructures. Various chemical methods such as chemical vapour deposition, electrochemical deposition etc, laser ablation, pyrolysis, combustion, precipitation synthesis techniques, molecular beam epitaxy are few methods for the bottom up approach. Top down methods require a mechanical force that could break large materials into nanostructures. Ball milling is most famous method for this approach. In laboratory nanomaterials are fabricated in three basic dimensions Zero (Quantum dot, nanoparticles), one (quantum wire, nanowires) and two (thin films of few nanometres) [21-32].

2- Current Scenario of Nanotechnology:

In present scenario nanotechnology has served purpose in many important fields. One of the very common examples we see is sun's scream. Our regular sun's cream contains Zinc Oxide (ZnO) based nanoparticles which are very helpful to absorb helpful UV-light falls directly on our skin from Sun. To understand nanoscience a new field NanoArt is also explored to make us visualise world of nano even more. Following are few fields where nano has been proved very promising.

(a) Medical/Biotechnology:

In medical field it is found very useful and termed as nanomedicine. Nanomedicine has wide range it exploits the application of nanomaterials, biosensors, molecular nanotechnology, biological machines, tissue engineering, blood purification etc. Though many issues are there to consider before utilizing nanotechnology in medical field due to toxicity and

environmental hazards problems, DNA nanotechnology is also emerging in which artificial nucleic acids are manufactured and would be very helpful to understand biophysics.

(b) Energy and sustainable development and Green technology:

Energy crisis is one of the issues which are almost inevitable and the only solution to avoid this is hidden in nanotechnology. Solar cell fuel cells, capacitor etc based on this technology are one of the blessing in the field of energy and energy storage. Sustainable development today is the only way to make earth a better and secure place for future generations. Green nanotechnology is one the finest example of sustainable approach. Green nanotechnologies are considered clean technologies. In general, Green Technology means the fabricator of nanomaterials without harming the health of environment. Green technology is very useful in solar cells and proving helpful for water treatment such as its cleaning, filtering etc. Also, green technology is useful for controlling air pollution and also removing plastics from oceans. To remove plastics a bacterial would be bioengineered and that would decompose plastics.

(c) Nanoelectronics/Nanophotonics/Optoelectronics:

Transistor, MOSFET, CMOS, nanowires, CNTs are few examples how nanotechnology is grabbing the electronic industries. Quantum mechanical properties are still understood for the nanoelectronics materials. Moore's law of doubling transistor in two years also is a challenge for further growth of nanoelectronics and this raises lot of issues in mechanical fabrication of these nanoelectronics materials. Computers would have at very best if nanoprocessor comes to market but again fabrication part could be got way more complicated. Along with this new processor nanotechnology provides computers one more gift that is in the field of memory storage. NANO-RAM, MRAM, SRAM are few examples where the work is being continued by different companies. Another emerging filed in nanoscience is nanophotonics. Nanophotonics come into play when we observe the matter and light interaction. Metamaterial, an engineered material is one of the prime examples which manipulate light by creating negative refractive index. Optoelectronics a field that is actually made of many basic fields is going to be enrich its bag by using this technology.

(d) Carbon Nanotubes:

One of the achievements of the nanotechnology we see today is carbon nanotubes (CNTs). CNTs have high thermal conductivity, high electrical conductivity, high tensile strength along with better elasticity and flexibility among other of its properties. CNTs bicycles made today are stronger, lighter and more durable than the others existing bicycles. Performance of

semiconductors has been greatly enhanced in the realm of nanoscience. And this directly boosts the performance of electronic industries and has the potential to overcome the limits of the silicon-based electronics. Graphene transistor and CNTs electronics and the field of spintronics are going to change the field of traditional electronic industries.

(e) Military:

In case of military uses nanotechnology has been proved very potent. Nanoweapons are the future of military. Apart from these weapons' nanotechnology is useful in many other areas of military such as in improving thermal camouflage, infrared signature etc. Biosensors are produced to detect bioweapons, also improving the quality and usefulness of the uniform. Nanotechnology is able to improve the communication system and health-based facilities in the areas where military forces are situated.

(f) Construction:

In this field nanotechnology is very important. This would make construction material cheaper. Very important aspect of nanoscience in construction is automation, which would make construction easier and safer. Nanotechnology has many applications in coating and improvement of cement qualities etc.

Other than these fields, there are several industries which are making nonmaterials for the use of humanity or using nanomaterials to make other useful materials.

3- Issue of Toxicity:

There are also some negative aspects if we talk about nanotechnology. Its unknown toxicity and reactivity could be lethal. Many nanoparticles are already present in our daily uses such as in cosmetics products and due to their small sizes, they are easily spread in water and air. Hazardous nature of nanoparticles can't be ignored so it's very important to study the toxicity and reactivity of it. Laboratory fabricated nanoparticle with radioactivity are very harmful and difficult to detect. Hazard effect of nanomaterials is very harmful for respiration. Many nanoparticles owing to its small sizes have abilities to enter into human skin make damages. Nanopollution is the term coined to address problems emerging from the waste of nanodevices. Nanowaste is another term to define problems with nanoparticles. For example, nanoparticles used in cloths and another material when washed off or disposed of are not going to disappears completely and can stay in air, which ultimately penetrate animals and humans' bodies and causing unknown diseases. Nanowaste, when finally drained into oceans/rivers they still continue their high reactivity and cause problems there and are very dangerous for the plants and elements living there. Even though green technology is for sustainable development and reduce the pollution from air, water and oceans, still toxicity

from green technology can't be ignored and dedicated research is very necessary to protect the environmental hazards of nanotechnology.

4- Conclusion:

Nanotechnology could be boon and it could be curse depending on how we use it. To make this impressive technology lethal we don't need to make war-machine, its unknown toxicity could play that role. A continuous research is the demand of present day to explore every aspects of its good and bad side. Many government regulations are required to maintain the health of nature and make the environment liveable for animals and human.

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