

# Current and Potential Uses of Nanotechnology

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## ABSTRACT

Currently, the usage of nano technology can be seen in the commercial market in the form of nano devices and nano materials which are playing a revolutionary part in the implications of safety, health and advancement in technology. The applications of nano technology can be seen in almost every field of life resulting in making the daily life tasks so easier for the current and future generation. New and advanced materials are generated with the help of nano science. Top-down approach can be used in order to construct the nano materials. The current article highlights the usage of nanotechnology.

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## 1. Introduction

In top-down approach, if the nano-material to be constructed, is found bigger in size then it is broken down into small structures and if these small structures are also found big in size then these are further decomposed in more smaller structures. Here, this process of decomposing the big material into small structure continues until the nano material becomes the less complex.

In some cases, it is observed that the bottom-up approach is used in making the nano-materials. In this approach, a number of small structures of particles are processed and integrated to form the required nano material. Here, a number of atoms or molecules are used to make a nano material.

Practically, at the commercial level, it is observed that top-down approach is used widely by the industries as this approach is more feasible than that of bottom-up.

In some cases, the self-assembly technology is also used to construct the nano materials. Here, atoms and molecules adjust each other in such a way that it makes a structure for nano-materials.

The second approach is to move each molecule or atom with the help of tools individually. The construction level can be controlled in an efficient way by using the positional assembly. But, this process is not so much feasible for the commercial applications and is rarely used at that level and consideration.

Thin coating is used in order to use the nano materials like coating is used on electronic surfaces. The best example of this application is self-cleaning window.

It is observed that the components of nano materials are fixed or embedded in many cases like which are used in environmental and cosmetic applications where ,generally, the particles of nano materials are used.

The accuracy level in the machine materials is observed to be about 100nm which opens its use in the commercial market at very large scale. There are many sectors where these

materials can be used. Some of these sectors are automotive, aerospace and information technology sector.

The research works are going on in order to improve the performance of the nano materials and it is going to be better and better with the passage of time as new advanced techniques are being used in association with nanotechnology so that its performance and accuracy level can be enhanced.

Catalysts and silicon based materials are used with the nano materials to improve their accuracy and performance. There are many composites which can really explore the properties of carbon nanotubes. The diameter of the nano tube is measured as few nano meters and its dimension of length is measured in centimetres. These nanotubes are considered as very strong, flexible and good conductor of electricity in nature.

Since these nano tubes are generated in non-uniform pattern, hence, its applications are limited and efforts are being used so that these tubes can be produced on the large scale so that it can be used widely at commercial level.

Also, it is observed that energy efficient water purification is used for nano spheres and nanocrystalline grains are used by magnetic materials. Similarly, nanoceramics are used for medical purposes and membranes are used for the purpose of purification of water.

## 2. Current and potential uses of nanotechnology

### Metrology

By using the technique of metrology, the materials are characterized and measured in terms of dimensions and attributes like mass and electrical properties.

### Electronics, optoelectronics and ICT

The role of nano technology in information technology sector can be predicted due to its application in making the devices using semi-conductors. It is estimated that the application of nano science in the semiconductor industry will be very high upto 2020. Here, the main role of nano technology

is the manufacturing of the silicon chips with a particular length that can be adjusted in the memory cell so that the size of the resulting equipment can't be large.

In 2004, when a nano device was made then its size was observed to be about 90 nm and the nano device made in the year 2016 was of size about 22 nm. In 2022, it is predicted that the size of the nano devices will be around 20 nm or less than that.

Computer chips are made smaller and smaller in size with the help of nano science and nano technology, resulting on the production of computer systems with smaller size that are easy to carry from one place to another place.

With the help of the nano technology, the storage space in the computer chips is created with the help of magnetic or optical properties. Hence, with the advancement in technology, it is observed that the size of the chips is reducing but the capacity of storage is also increasing.

In the electronics field, with the help of nano technology, the plastic electronics is being used in place of silicon-based electronics. Sensors are also developed with the help of this technology and these sensors are used to detect various chemicals in the environment. Also, the status of level of strain in the buildings can also be controlled with the help of these sensors.

Quantum dots are also generated by this technology and these dots are further used for the purpose of release or absorb the light colors in the cells operated by the solar energy.

### ***Bio nanotechnology and nano medicine***

Nanotechnology is used widely in the medical sector for the purpose of the diagnosis of diseases, drug delivery and imaging of molecules and much more clinical trials.

It is observed that there are antimicrobial properties in Nanocrystalline silver, hence, it can be used for the dressing of wound. Many devices like scaffolds and sensors are produced with the help of nano technology and these types of medical devices are very useful in cell and tissue engineering. With the help of nano technology, an artificial retina is made which has the ability and detect and process the information.

### ***Industrial applications***

Most of the applications of nano technology is found in the areas like the determination of material properties, chemical generation, manufacturing and computing. Many materials are used in the mobile phones and these materials are generated with the help of nano technology and can be used in batteries of higher capacity, electronic circuit and chips.

It is noticed that the size of the nano materials is very small but these materials help in the processing of many functions in the main system and improper functioning of any nano material may cause interruption in the processing of the while device.

Nanotechnology has very wide scope in the future and a lot of nano devices will be made by using this technology but the main challenge would be the fulfilment of the market demand as it is estimated that at that time, the production level of nano devices might be lower than that of the demand level.

The main advantage of using nano technology is that it is feasible in nature as the cost of the production of nano devices is not so much high and it provides a lot of services and reliability with accuracy to the devices. The wastage of resources is minimum in case of nano technology.

It is also considered that a material should not be harmful for the environment throughout its life cycle as it is noticed that some materials like plastic are harmful after disposal. So it is necessary to check whether the manufactured material is eco-friendly or not. Taking this into consideration, it is observed that most of the devices or materials manufactured by using nano technology are eco-friendly and they don't cause any harm to the environment from their production to the disposal.

The development of mechanical nano machines still in the progress and it is considered that these nano machines will be capable of manufacturing the materials atom by atom.

With the help of nano technology, self-replicating machines can also be generated. But, there are some challenges of these machines as it will be difficult to control these machines as they will produce the copies of itself and may consume all the resources available.

### **3. Discussion**

It is estimated that the nano particles can be also harmful for the environment and human health. But, in most of the cases, it is safe to use nano science and nano technology to manufacture the nano device.

There are few chemicals which are produced in the form of nano particle and their exposure is limited in nano particles and nano tubes in some work places and laboratories due to their harmful effects on the environment and the human health.

It is also observed that there are very few chances of releasing the nano particle and it is considered that the manufacturers utilize this possible risk for the complete cycle of the material and provide these materials at the commercial level.

It is also observed that very few nano particles are found toxic in nature. The surface area of small particles is found to be larger than that of larger particles and toxicity of a particle is directly connected to its surface area and its rate of chemical reaction.

Surface coating is used in order to increase or decrease the chemical reactivity of a particle. If a comparison is done between the nano particles and larger particles then it is seen that the nano particles can penetrate into the cells more easily than the larger particles as the size of the nano particles is very small.

Novel nano particle can be entered in human body in the form of doses and effects the health. The precautions should be made in the laboratories where the process of manufacturing of these particles is going on.

Nano particles with varied characteristics should be treated differently for precautions. The presence of carbon in nano tubes indicates about the toxic properties as in the case of asbestos fibres. The toxicological studies are going on in order to know the fatal nature of airborne nanotubes and till then the usage of these airborne nano tubes should be prohibited.

The damage of the cell can also take place of the reactive molecules are produced by penetrating the nano particles into the skin. It is found that the no penetration of TiO<sub>2</sub> nano particles in the skin take place but there is some doubt that whether it may cause damage of skin by sun or other diseases like eczema.

There is no detailed information is available whether the nano-particles used in the cosmetic products penetrate the skin or not. But, the safety measures are taken into consideration while using the nano particles in the industry.

A safety advisory is generated at the work-places in order to spread the information regarding the toxicity of the main components like nano particles. In the laboratory, the nano particles and nano tubes are used under the safety measures so that no harmful effects should be there in case of any misunderstanding.

The toxic properties of the nano particles should also be taken into consideration while performing the safety test of the methods of drug-delivery keeping in mind their ability of affecting the organs and cells which are placed at an appropriate distance from the proposed aim of the drug.

There is information available about the impact of nano particles on the human body but there is no much detail is available regarding the impact of these particles on the other species or how they behave in the air, soil or water.

#### 4. Conclusion

For the safety concerns, the nano particles and nano tubes are not permitted to release in the air as the carbon particles present in the nano tubes may harm the environment.

Also, at the factory and laboratory level, it is considered that the manufactured nano tubes and nano particles are injurious to health and these nano materials are separated from the waste products. Furthermore, the use of these nano particles for the recovery of ground water is banned so that these particles can't be mixed in the soil or air which can be more harmful for the living bodies.

As the surface area of the combustible nano particle is found to be very large, hence, the risk of its explosion is very higher. Also, the possibility of enhanced reaction is there which may certainly cause the risk of explosion. To avoid these kinds of risks, it is suggested that no large amount of these nano particles should be airborne.

Since the full detail of the nature and behaviour of the nano particles and nano tubes is not available so much research is going on in order to understand the behaviour of these nano particles so that all the advantages and non-advantages of these particles can be considered individually.

Some studies are also into the consideration by the UK Research Councils in order to get the details about the properties like toxicity, persistence and epidemiology etc. exhibited by the manufactured nanoparticles and Nanotubes.

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