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Current and Potential Uses of Nano Science and Nanotechnology

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Abstract – Nanotechnology is very useful in manipulating the matter that there is scope of improvement in technologies in order to secure the environment. With the help of nanotechnology, we can get an advanced technology which is capable of providing the dimensions of high accurate. 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. The purpose of this paper is to explore various uses of nanotechnology in metrology, Electronics, Optoelectronics, Nanomedicines, Bionanotechnology and other fields.

Keywords: Commercial, Electronics, Nanomedicines, Nanoscience, Nanotechnology.

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INTRODUCTION

There are mainly three level at which the nanotechnology is developed. These levels are materials, devices and systems. In the commercial applications, the usage of nano-material level is growing with the scientific knowledge. The size of nano-particles is found to be about 100nm and it is observe that the size of these particles tend to reduce with respect to the variation in their physical properties. These materials can be polymer, mineral or metallic. The decrease in size of the nano particle can also be observed due to the increase in ratio of surface area to volume. As a result, the number of atoms on the surface tends to increase at a specific region which is very critical point for this process.

The use of nanotechnology is very convenient as it requires less space and effort; hence, its maintenance is quite easy as compared to other technologies. Also, the level of production is found to be on higher side in case of nanotechnology as no other technology can generate the devices of similar power and features.

This technology is found feasible in nature as it is cost-effective and it provides many benefits to the users. Also, the quantity of energy and material to be used in this technology is so small that many industry can afford it and make devices with the help of technology which are more reliable in nature.

Many products can be studied with the size of about 100 nm which makes the comparison with human hair having a width of 80000. The importance of molecular systems can also be realized in case of nanotechnology which further provides the reference to the functional system.

The good thing about nanotechnology is that it generates the devices with smaller size which becomes a revolution as computer chips made through this technology minimized the average size of a computer or laptop as compared to the super computer.

APPLICATIONS OF NANOPARTICLES

(i) Nanomaterials

Basically, all the nano materials come in the category of single phase solids. All the coated materials fall into the category of composite materials. On the other hand, aero gels, colloids and fluids come in the category of multi-phase materials.

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. 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. 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.

(ii) Metrology

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

(iii) 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.

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.

(iv) 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.

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 to detect and process the information.

HEALTH AND ENVIRONMENTAL IMPACTS

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 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 utilizes 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 partices 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 taken 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 by penetrating the nano particles into the skin. It is found that the no penetration of TiO_2 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 drug-delivery keeping in mind their ability of affecting the organs. 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.

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. 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.

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 disadvantages 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.

STAKEHOLDER AND PUBLIC DIALOGUE

The potential of an advanced technology can be realized with the help of public feedbacks. Since the nanotechnology is in its initial stages so its awareness among the people of world is growing slowly. In the next twenty to thirty years, this powerful technology would be at its peak and many revolutionary inventions would have been made using nanotechnology.

But now, in a survey it was concluded that only 29% people of Great Britain are aware about the nanotechnology. Some people also agreed that this technology is going to be more powerful in the future as its scope is very wide.

A debate was organized between two groups of people. These people were given the task of describing the good and bad effects of nano technology. The positive feedbacks were that this is the most powerful technology as yet, very exciting

technology; wide usage in the medical industry; potential usage in the information technology sector and also can be used in the field of biotechnology.

The negative feedback included the financial issues, licence of controlling this technology, side-effects of this technology and reliability of this technology.

We recommend that the Governments should take initiative to promote the field of nano technology and its scope. They can advise the job-seekers to learn this technology as the unemployed persons can get the best opportunities to earn more and more.

Some programs should be conducted at the industry level in order to make the people aware about the nano technology. A public debate can also be conducted to spread more and more information of nano technology to the people.

REGULATION

Now, the biggest question arising here that how the development and deployment of nano technology can be regulated in order to exploit the required results and unrequired results can be restricted to the minimum level.

Currently, the efforts made by the regulatory frameworks at EU and UK level are satisfactory and flexible enough to control the nano technology in the initial phases of development. Also, this is an area of concern that some kinds of chemicals may present in the nano particles and nano tubes which can have the toxicity properties causing the bad effects on the human and environment. Currently, there are few places like laboratories and work-places where the manufactured nano particle or nano tubes can be found and all other places are prohibited for the safety concerns.

Under the regulatory frameworks, the new chemical should be considered in the form of nanoparticles and Nanotubes. The testing methods being used for measuring the toxicity level in the substances should be regulated enough so that it can provide the useful information about the nature of the nano-particles.

In some cases, it is observed that the chemicals used in the manufacturing of cosmetic products are not checked for their side-effects and properties as these ingredients may contain the toxic nanoparticles which can be harmful for the users. Hence, some kind of pretesting techniques should be implemented before using the ingredients in the cosmetic products. As it is believed that it may cause many ill-effects to the skin if the nano particles penetrate into the skin so it is essential to perform the pre-testing of each and every ingredient before using to manufacture cosmetic products.

Advisory committees assess the chemicals before using it as ultra violet filters for the form of nano particulate and in this scenario, the results regarding titanium dioxide were found positive but that in the case of zinc oxide was found to be insufficient.

Manufacturers should publish the advisory regarding before using the products containing nano particles as these particles may be harmful for the users. For example, if a cosmetic product contains the nano particles as ingredient in it then the manufacturers theirselves should publish an advisory or warning for the users for safety concerns.

This advisory should be applied on the products having nano-particles. There may be the case where the same product made by different manufacturers may or may not contain nano-particles in it. Hence, it is the responsibility of publishing the advisory on the products by that manufacturer who uses nano-particle as ingredient in the product. For example, in Europe, the manufacturers don't use any kind of nano particle in their products so they need not to publish any kind of advisory.

Also, it is the responsibility of the committee to check whether the product contains nano-particle as ingredient or not and if it contains then advisory is published or not. If no advisory is found then the committee may take appropriate action against the manufacture.

This review of regulation is not extensive and we hope that all related regulatory organisations examine whether the present regulations are sufficient in order to protect the environment and living bodies from the hazards that we have specified, publish their opinions and describe how these regulatory gaps can be recovered.

RESOURCE MANAGEMENT AND ENVIRONMENTAL ISSUES

Life Cycle Assessment is established to ensure that the technologies being used for the development of the materials don't harm the human environment. If LCA find that any technology is harming the environment then it can prohibit that technology.

There are many technologies available which have the capability of producing the mass manufacturing of the materials but these are not found to be eco-friendly as the waste products left at the end of the process may harm the environment if the proper guidelines of disposing these waste products is not implemented.

Hence, it is the responsibility of life cycle assessment agency to examine the whole process and check whether it is affecting the human environment in bad way or not. Appropriate actions

are also taken by this agency if any violation of rules and regulations is found at any corresponding level.

Many manufacturers uses the nano particles as ingredients in the cosmetic products. Their synthesis is performed in special laboratories. It is observed that a lot of waste material is formed at the final stage of this process. It is the responsibility of the manufacturer to dispose this harmful wastage in such a way that it could not harm the environment. Life cycle assessment also provides a guideline containing all the rules and regulations regarding the disposal of any harmful material or product.

Life cycle assessment is a powerful tool which covers a sequence of international standards. This assessment is also applicable in nano science and nano technology.

It is observed that life cycle assessments are done frequently in case of nano science and nanotechnology as the products manufactured with the help of this technology can cross the specified line limit at any stage. Hence, extra efforts are made there in order to produce the product in such a way that the savings in the consumption resources can be done easily.

Generally, a neutral agency is given the task of assessing the life cycle of a product so that satisfactory results can be obtained at the final stage of any synthesis and there is no allegations in the future regarding any rule or regulation violence.

CONCLUSION

Till now, we have studied that nano technology is far better from the existing technologies of manufacturing the products. We can see lots of application of Nanotechnology today in the various fields. But, there are many barriers which can certainly affect the usage of this technology at large scale. The most important barrier is economical as there are many technologies are available at the commercial level which is capable of manufacturing the products with less cost as compared to the nanotechnology. As we know that the most of the consumers prefer purchasing the less expensive products, therefore, the industries may avoid the usage of nanotechnology. There are many other barriers which can certainly come against the usage of nano technology at industrial level. There is a fact that this technology is not developed fully and many research works are going on to know the properties and behaviour of nano particles as it is the area of uncertainty. Nanotechnology is used in making small devices but not the large devices. There is a need to develop large devices with the help of nanotechnology to compete the industry. Many research are already going on in various field of nanotechnology but there is need of more advancement in making the material and devices with less cost.

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