REVIEW PAPER ON APPLICATION OF NANOTECHNOLOGY

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Abstract

With the passage of time, there is need for continuos advancement in technology in each and every field. Nanotechnology is an upcoming science focussing on microscale development which can be implemented across almost any fields to get desired characteristics and effects. The variety of fields where nanotechnology can find applications is amazing. Keeping the point of sustainable development in mind, nanotechnology is intended to get desired properties by using much less space and much less natural resources. In this review paper, there will be brief discussion about application of nanotechnology across various fields.

Keywords: *Nanotech; DNA; CNT, PDT, PTT, RFId*

Introduction

Nanotechnology (nanotech) is controlled engineering conducted mostly at atomic or super molecular scale. Nanotechnology can be described as manipulation of atoms or molecules for microscale product modification. Nanotechnology in other words can be termed as utilization of matter employing at least one dimension ranging between 1 to 100 nanometer [1]. Due to it being a landmine of opportunities, governments all across the globe are investing billions for further advancement in nanotechnological studies. Its application and research is widespread like molecular engineering, surface science, energy storage, treatment, horticulture, water treatment, clothing, energy production, waste water treatment and many more. The aim of all is common i.e. development of materials in nanoscale for implementation at the atomic scale. Nanotechnology is sure to have a major impact on our lives in the near future. Using nanotech upgraded technology, medicines and stronger materials for structural implementation can be created. One of the highlighted properties of nanoparticles is improved physio-chemicality when compared to original bulk materials. Many different processes can be employed for the synthesis of nanomaterials. These methods include processes like micro emulsions, microwave plasma processing, precipitation processes, spray hydrolysis etc.

The fundamental of nanotech is simple i.e. the properties of materials undergo drastic changes when size is compressed to the nanometer range. When a bulk material is divided into finer particles with any one dimension in the nanometer scale, the particles exhibit unexpected properties different from their bulk material. Example- Ceramics are generally brittle but can be transformed to be deformable when their respective grain size is decreased in the nanometer range.

While nanotech can be utilized to get desirable properties, it may also expose humans to new pollutants and hazards like exhibiting new kind of toxicity or pollution. There is very less knowledge about the ill effects of using food containing nanoparticles or prolonged exposure when working with nanoparticles. Many experts have requested to put further researches on hold until we figure out the ill effects of nanotech.But irrespective of

concerns raised over nanotech, it remains to be one of the most funded and researched topic in all of sciences.

Literature review

Ashwani K. Rana et.al.(2009) in their paper [2] stated the possible implementation of nanotech on design and construction work. Concrete is among the mostly widely used and common material in architectural materials. Encapsulating nanoparticles like nano-Si02 within the concrete can highly boost its compressive strength and can result in upgraded pore size distribution. Better segregation resistance in case of self compacting concrete can be achieved by using slurry of nanosilica. Compressive as well as flexural strength can be upgraded by mixing small aggregate of nanotube(1%) by weight. Adding copper nanoparticles at steel grain boundaries can develop better corrosion resistance as well as weld ability in steels. MMFX2 (a nanoscale modified steel created at MMFX Steel corp) have much desirable properties of improved ductility, ultra strength(nearly 3 times), better corrosion resistance and toughness. MMFX2 can be employed in place of steel as not only it have similar properties but is substantially cheaper. Certain nanolayer coating like Titanium dioxide(used for coat glazing) possess the ability to break down organic dirt and will ease in washing away this dirt due to it being hydrophilic. Nanosensors are employed in construction to check and oversee material performance and environmental situation. Due to its much smaller size these nanosensors can be easily incorporated into the structure. Ex. Smart aggregate is a multifunctional device used to check early age features of concrete like moisture, strength development, temperature and can also be utilized in checking for corrosion, structure health monitoring and cracking and hence it acts as an premature indicator of structure health before failure occurrence.

Gyorgy SCRINIS and Kristen LYONS (2007) in their paper[3] enlisted uses of nanotech in food, packaging and agricultural applications. Nanotech can be employed to promote/ease futuristic advancement of genetically modified crops, accurate farming techniques, pesticides etc. Nanotech may also incorporate better micro managing of soils, creation of better pest control pesticides and efficient use of available inputs. Further desirable characteristics can be implanted in plants and crops through nanotech and biotech coming together. Nanotech is being employed to usher external DNA(Deoxy ribonucleic acid) or chemicals to host cells. Ex- Researches found success in drilling holes through rice cell membranes to insert nitrogen atoms for desired properties like rearrangement, change in color and they intend to expand the growing time period of rice hence enabling rice to be produced year long. Nanotech is also implemented in targeted delivery of pesticides to increase the effectiveness of the same. This application is solely due to property of nanomaterials to be immensely stable and high dissolution in water. The release of pesticides can also be controlled through nanotech, i.e. with the help of nanotech, pesticides will be released at a particular rate according to the conditions and need. Ex- Gutbuster is a microcapsule which breaks open the pesticide in it in alkaline environments. Nano particle pesticide will be more efficient because of readily absorption by plants due to its comparatively smaller size but may give rise to threat to consumers. Due to them being readily soluble in water, it may easily contaminate groundwater, river bodies etc. Nanosensors can be spread across farms for real time monitoring of various aspects like crops, soil, detection of possible attacks of pests, rodents and keeping an eye on soil nutrition level. Proper nutrition delivery by food can be ensured by nanotech. For example- it will automatically detect the part in need of nutrients and will supply the said nutrient to that part according to its requirement. But an argument remains about how safe these nano produced food are. In recent times, Nanotech has been promoted and used extensively for packaging with an objective of increasing durability, distance transportable, shelf life, variety of food packaged and quality. This will greatly help in inter country transport of food and will be a reliable source of secure and pathogen free food. Recently, researches are working on implementing nanosensors to notice emission

of toxic chemicals and subsequently warn the consumers about the spoiling of the food commodity through change in colour of packaging. Smart fridges available today in the market are fitted with nanoparticles which inhibits smell and bacterial growth.

Lei Qian and Juan P. Hinestroza [2007] in their paper[4] stated that nanotech can be used in textile industries. Nanosize fillers are employed for the production of composite fibres. These fillers enhance the mechanical strength and physical properties which includes conductivity as well as behaviour. These fillers are easily absorbed into the matrix and their small size helps them to impede polymer chain movement hence reducing chain mobility. Due to these nanosize fillers being evenly distributed throughout the matrix, it can carry loads due to increased abrasion resistance and toughness, and can transport stress away from he matrix leading to enhanced tensile strength. Clay nanoparticle can result in increased properties like better heat, chemical, electrical resistance and exhibits the ability to block UV(Ultraviolet). Research is being conducted to use these properties to create self decontaminating, UV radiation blocking gears and products for the military as well as citizens. CNT(carbon nanotube) is the future of building blocks. With outstanding properties like electrical conductivity at the same level as copper, thermal conductivity only second to the purest diamond, 100 times more tensile strength than that of steel as well as the ability to wield high loads of current makes CNT a dream material. CNTs find their application is sensors, energy conversion and storage, electromagnetic shielding, bulletproof and explosion proof blankets etc.

WJvdM Steyn in his paper[5] explains the possible use of nanotech in transportation. He states that nanotech can help find better alternatives in various factors related to transportation. Incorporation of nanoscale silicon carbide in vehicle tyres may help decrease tyre abrasion and can substantially increase wet skid resistance. The surface can be made hydrophobic by the addition of ZNo_2(zinc peroxide) nanomolecule. Also it is possible to add the same to roads to ensure better run-off of water and hence make the road more hydrophobic and hence preventing wet tire skidding. Nanophosphors is being worked on for implementation on auto surfaces to render the vehicle auto luminescent and hence increase its visibility at night or during fog. Nanotech can be employed in making the material used for transportation more durable which can easily withstand any stress or strain. Even though the initial cost of using nanotech is high, but when considering a long time plan it seems economical. This is because nanotech infused materials are stronger, more durable and exhibit better properties than the bulk material. Hence any transportation aspect built by implementing nanotech will last longer and can help save source material. Existing materials can be modified to be more sustainable. While using nanotech infused materials modified in such a way to provide longer life automatically deducts the usage of naturally availably resources(as discussed in previous point), it also results in less energy consumption. Ill effects of various factors during transportation can be countered by re-engineering using nanotech.The main challenges here are still the same as encountered in other fields i.e. very high cost and unawareness about the effects nanotech may have on the environment.

Akin Aliosmanoglu and Ilker Basaran (2012) in their article[6] mentioned the use of nanotech in cancer treatment and detection. It was fount out that mutagenic particles emitted during Xrays, tomography etc may also cause cancer. To bypass this issue nanoparticles could be employed as it involves usage of special dyes that react with the tumours and it is quite easy to then detect optical nanoparticles. Nano polymer micelles consists of anticancer medicines which is covered inside a pH level controlled coating like hydrazone. It is adjusted or made in such a way that this coating breaks away when interacted with a certain pH levels and emits the medicine there. This can be easily implemented if we know about the pH level of tumours. This method is said to provide 10 times the drug delivery to the target organ than by ordinary drug delivery methods. Nanotechnology can also be used for treatment of cancer cells. For ex-

PDT(Photodynamic Therapy) incorporates photosensitizer and a specified type of light. These light particles on reaction with photosensitizer creates a type of oxygen that finishes off nearby cells. PTT (Photothermal therapy) can also be used which implements the application of heat to kill off tissues with usage of dyes that help target specific tissues only.

MA Rather et.al. [2011] in their paper[7] talked about nanotech being a ideal technology for development of aquaculture as well as fisheries. The major roadblock in aquaculture is the frequent outbreak of diseases. To counter this nanoparticle carriers of vaccine are used which protects the fish and other life forms from viral as well as bacterial epidemic. Nanocapsules can also be implemented for mass vaccination. Short strand DNA present in these are readily absorbed into the fish cells which imitates a cellular reaction to vaccination. Further these can be controlled in such a way that the drug delivery is time and quantity controlled. Hence many more drugs when implemented and delivered in the nanoscale prove to promote fish growth. Nanoscale sensors like Rfid(Radio frequency identification) chips can be used to keep an eye on the fish position, its associated metabolism, patterns in swimming etc. A little deeper implementation of these nanosensors with synthetic DNA can give indications of pathogen infection or even changes in surrounding temperature. One of the most commonly used water filtration methods is nano activated water treatment. Many products like activated carbon is known to remove impurities from the water. Altair Nanotechnologies have developed Nanocheck. This uses nanoparticles to absorb phosphates from the water hence halting any algae growth.

Mohammad Israr et.al. [2014] in their paper[8] talked about the possible application of nanotech on industries. Nanowires are wires having dimensions in the nanoscale. If these are developed, then the results may be revolutionary. With this it would be possible to make extremely and relatively smaller circuits. Nanotechnology will soon cause current practices to go obsolete. For ex: we would no longer need a expensive machine consuming precious fossil fuels and involving thousand of humans. Instead nanotech can gives us a factory of nanobots constructing steel atom by atom. All we have to do is to maintain a required parameter and feed it to the softwares and the nanobots will do the rest. Rather than cutting down trees for paper, the nanobots will construct paper, instead of using oil energy we can have nano scale solar cells.

Conclusion

It is quite evident that nanotechnology is a goldmine of opportunities waiting to be discovered. Further research should be conducted on these nanotech as it can be manipulated to give desired properties in applicant. While there are number of applications of nanotechnology in almost every field, one should also consider the fact the dangers to it is also unknown. We are unsure of the long term nature of nanotech and it may or may not be toxic to the environment. Hence proper research should be conducted particularly about the ill effects of nanotech, so that we know all the pros and cons of it and can implement it accordingly.

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