ejpmr, 2020,7(1), 227-233

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

HARNESSING NANOTECHNOLOGY

***Vijai Malik**

Department of Botany, CCS University, Meerut.

***Corresponding Author: Vijai Malik**

Department of Botany, CCS University, Meerut.

Article Received on 28/10/2019 **Article Revised on 18/11/2019** **Article Accepted on 08/12/2019**

Abstract

Nanotechnology offers great potential for benefits to mankind. It will affect every aspect of our lives, from the medicine we use, to the power of our computers, the energy supplies we require, the food we eat, the cars we derive, the building we live in, and the cloths we wear. It is emerging as one of the most rapidly growing areas of science and technology with application in biology, physics, chemistry, earth sciences and material sciences. The present paper reflects some achievements, types of nanomaterials and applications of nanotechnology.

Keywords: Nanotechnology, Nanomaterials, Nanostructure, Carbon nanotubes.

1. Introduction

The vision of nanotechnology was introduced in 1959 by Nobel Physicist Richard Feynman (Feynman, 1960). Richard Feynman is rightly known as father of nanotechnology. The term nanotechnology was coined in 1974 by Tokyo Science University professor Norio Taniguchi to describe precision manufacturing of materials at the nanometer level. The term nano has been derived from a Greek word for "dwarf" and means 10-9, or one-billionth. Here it refers to one-billionth of a meter, or 1 nanometer (nm). 1 nanometer is about 3 atoms long. 1 nanometer (nm) = 1 billionth of a meter. Nanotechnology is the art and science of manipulating matter at the nanoscale (down to 1/100,000 the width of a human hair) to create new and unique materials and products...with enormous potential to change society. Some definitions of nanotechnology are given below-

"Nanotechnology"–Building and using materials, devices and machines at the nanometer (atomic/molecular) scale, making use of unique properties that occur for structures at those small dimensions.

"The creation and utilization of materials, devices, and systems through the control of matter on the nanometer scale (1-100 nm), i.e. at the level of atoms, molecules, and super molecular structures"

Nanotechnology is the art and science of manipulating and rearranging individual atoms and molecules to create useful materials, devices and systems.

Nanotechnology is a generic term used for a broad range of different activities and applications ranging from energy production and storage, manufacturing, information technologies to medicine.

Nanotechnology is knocking at our doors. It is the field of future that will replace microelectronics and many fields with tremendous application potential in the areas of medicine, electronics and material science.

Dr. A. P. J. Abdul Kalam (Ex- President of India)

A number of physical phenomenons became pronounced as the size of the system decreases. These include statistical mechanical effects as well as quantum mechanical effects e.g.,

- The hardness of copper increases with decreasing grain size.
- Ohm's law V=IR is not obeyed by a nanour
- Bulk gold (inert) can change into nano gold (highly reactive) under the specific conditions.

The confinement of electrons holes polarons and bipolarons due to size reduction gives rise to discrete energy level and increase band gaps in inorganic materials and polymers. This confinement of carriers is usually known as quantum confinement. Maximum benefit of quantum confinement is experienced when the size of micro-crysllites approaches 1-3 nm. On reducing the size of particle of a material, there is a drastic change in its mechanical, thermal, optical, structural, electrical and other properties. In this way with same material one can get a range of properties. The following properties are affected while working at nanoscale.

- Electrical and electronic properties
- Optical properties
- Opto-electronic properties
- Magnetic properties
- Modification of surface topography
- Mechanical strength and stress endurance

2. Types of Nanomaterials

The unique properties of various types of intentionally produced nanomaterials give them novel electrical, catalytic, magnetic, mechanical, thermal, or imaging features that are highly desirable for applications in commercial, medical, military, and environmental sectors. These materials may also find their way into more complex nanostructures and systems. As new uses for materials with these special properties are identified, the number of products containing such nanomaterials and their possible applications continues to grow. The four main types of nanomaterial are-

- Carbon-based materials (fullerenes and nanotubes)
- Metal–based materials (quantum dots, nanogold, nanosilver, metal oxide like titanium dioxide)
- Dentrimers (providing interior cavities for other molecules)
- Composites

2.1. Carbon Based Materials

These nanomaterials are composed mostly of carbon. Mosty they take the form of a hollow spheres, ellipsoids, or tubes. Spherical and ellipsoidal carbon nanomaterials are referred to as fullerenes, while cylindrical ones are called nanotubes. These particles have many potential applications, including improved films and coatings, stronger and lighter materials and applications in electronics.

Carbon Nanotubes (CNT)

CNTs are the strongest, lightest and most conductive material known. CNTs are tubular cylinders of carbon atoms that have extraordinary mechanical, electrical, thermal, optical and chemical properties. CNTs have been recognized as fascinating materials with nanometer dimentions promising exciting new areas of carbon chemistry & physics. CNTs typically have diameters ranging from ‹1 nanometer (nm) up to 50 nm (a nanometer is one thousand millionth of a meter). Typical CNT lengths are several microns—several thousand nanometers long; by contrast, Nanocomp's produced fibers are measured in millimeters—thousands of times longer than all other commercially produced CNTs. At the individual tube level, these unique structures exhibit: 200X the strength and 5X the elasticity of steel; 5X the electrical conductivity ("ballistic transport"), 15X the thermal conductivity and 1,000X the current capacity of copper at almost half the density of aluminum.

CNT are exciting candidates as a re-inforcement for new generation super-strong composites. Based on tremendous stress endurance of such carbon nanotubes, scientists envision a space elevator into space (above one lakh kilometer long) that could rise a satellite in geosynchronous orbit (Editor's letter, 2005). It will be lightweight and cost effective as well. It may really make science fiction into reality.

The dispersed SWNTs (single walled carbon nanotube) in a proper medium can be used as biosensor. The principle of this biosensor is based upon the fact that florescence spectrum of the SWNT depends on the local dielectric environment. When we add ssDNA in a dispersed solution of nanotubes, it wraps around SWNT surface and in turn changes the local dielectric constant of the environment, which causes a shift in the florescence spectrum of the nanotubes (Bhatnagar, 2009).

2.2. Metal Based Materials

A quantum dot is a metal based material. It is a closely packed semiconductor crystal comprised of hundreds or thousands of atoms, and whose size is on the order of a few nanometers to a few hundred nanometers. Changing the size of quantum dots changes their optical properties. Fabrication of Quantum dots (QDs) embedded in glass matrix by means of diffusion controlled growth processes, are greatly used in laboratories to study characteristics and optical properties, because of their high optical quality, low cost and easy manufacturability, stability of nanocrystals for long duration and large optical non-linear properties (for ultra fast switches). Nucleation, crystallization and coalescence are examples of double step annealing growth of QDs.

2.3. Dendrimers

These nanomaterials are nanosized polymers built from branched units. The surface of a dendrimer has numerous chain ends, which can be tailored to perform specific chemical functions. This property could also be useful for catalysis. Also, because three-dimensional dendrimers contain interior cavities into which other molecules could be placed. This is why they may be useful for drug delivery.

2.4. Composites

Composites combine nanoparticles with other nanoparticles or with larger, bulk-type materials. Nanoparticles, such as nanosized clays, are already being added to products ranging from auto parts to packaging materials, to enhance mechanical, thermal, barrier, and flame-retardant properties.

3. Nanostruture in Nature

Many plants and animals around us have developed special features at the nanoscale level. Some of the examples where nature has used nanostructures are given below (www.nnin.org).

3.1. A moth's eye has very small bumps of hexagonal shape on its surface. These are a few hundred nanometers tall and apart. Since these patterns are smaller than the wavelength of visible light (350-800nm) so the eye surface has a very low reflectance for the visible light. Thus the moth's eye can absorb more light. Due to absorbance of light very efficiently, these nanostructures has enabled the moth to see much better than humans in dim or dark conditions (Fig.-1a).

3.2. The butterfly's wings have multilayer nanoscale patterns on its surface. These patterns filter light and reflect mostly one wavelength, so we see a single bright color. For instance the wings of the male Morpho Rhetenor appear bright blue. But in fact the wing material is not blue. It just appears blue because of particular nanostructures on the surface. The nanostructures on the butterfly's wings and the wavelength of visible light are about the same size. Due to multiple layers in these structures, optical interferences are created. There is constructive interference for a given wavelength (around 450nm for the Morpho Rhetenor) and destructive interferences for the other wavelengths, so we see a very bright blue color (Fig.-1b).

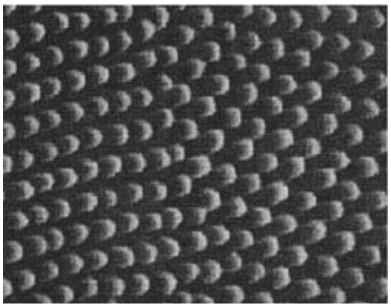

Fig.-1a

Fig.-1b

3.3. The edelweiss (*Leontopodium nivale*) is an alpine flower of high altitudes (3000m / 10,000 fit) where ultraviolet radiation is strong. The flowers have thin hollow filaments of nanoscale (100-200nm) on their periphery. They absorb ultraviolet light of same wavelength as that of the filaments. But it reflects all visible light. This explains the white color of the flower. Since nanocsale structure on filaments absorbs UV light, flower's cells are protected damage caused by this high-energy radiation.

3.4. The discovery of Carbon nanotube is new, whereas we have utilized wood since the dawn of civilization. Wood is also composed of nanotubes or "nanofibrils"; namely, lignocellulosic (woody tissue) elements which are twice as strong as nanofibrils. It would lead to a new paradigm in sustainable construction as both the production and use would be part of a renewable cycle. Some worker are of the opinion that building functionality onto lignocellulosic surfaces at the nanoscale could open new opportunities for self-sterilizing surfaces, internal self-repair, electronic lignocellulosic devices etc.

4. Application of Nanotechnology

Today's nanotechnology harnesses current progress in chemistry, physics, material science, and biotechnology to create novel materials that have unique properties because their structures are determined on the nanometer scale. Some current application of nanotechnology are Medicine and drug, energy, nanobiotechnology, nanoservices, optical engineering, nanofabrics, cosmetics, bioengineering, defence & security etc (www.nanowerk.com/nanotechnology).

4.1. Nanotechnology in Wastewater Treatment

Nanotechnology has been utilized to treat waste water in many parts of the world. Filter candle coated with silver nano-materials to reduce organic impurities in water have been developed by Scientist from Hyderabad based international advanced research center for metallurgy and new materials. Magnetic nanoperticles offer an effective and reliable method to remove heavy water metal contaminants from waste water by making use of magnetic separation techniques. Nanoscale particles increases the efficiency to absorb the contaminants from waste water and is comparatively inexpensive compared to traditional precipitation and filtration methods (Joseph, 2011).

4.2. Nanotechnology in Food Production and distribution

There are many application of nanotechnology in the food sector. Many vitamins and their precursors, such as carotenoids, are insoluble in water. But when these are skillfully produced and formulated as nanoparticles, these substances can easily be mixed with cold water. Besides, their bioavailability in the human body also increases. These specially formulated additives are found in many lemonades and fruit juices. An attractive color may also be provided by them.

Nanotechnology can also be applied in the production, processing, safety and packaging of food. A nanocomposite coating process could improve food packaging by placing antimicrobial agents directly on the surface of coated film. Nanocomposites could increase or decrease gas permeability of different fillers as is needed for different products. They can also improve the mechanical and heat resistance properties and lower the oxygen transmission. Detection of chemical and biological substances for sensing biochemical changes in food can be achieved by nanotechnology (Joseph, 2011).

4.3. Nanotechnology and Neurosurgery

Nanotechnology offers endless opportunities for better understanding of neurological processes. Interventions at the cellular and sub cellular are at the heart of improving patient care through nanoneurosurgery. It is likely that nanotechnology will bring about next revolution in neurosurgery.

The most important application of nanotechnology is deciphering brain function. An integrated approach for monitoring neuronal anatomy, chemistry and electronics appear to be ideal in this regard. Carbon nanotubes (CNT) can monitor both electrical and chemical activity at single neuron level. These CNT can be arranged into arrays for electrical and chemical monitoring for prolonged period of time. Similarly nanowires electrodes placed in capillaries can be utilized for electrical recording from neurons. Such arrays can also be used for deep brain stimulation for patient with Epilepsy, Parkinson's disease, essential tremor, and other applications under development.

Nanotechnology based models have been utilized for understanding neurogeneration. Various nanoscaffolds have been developed to tackle some of the issues related to inhibitory environment for neuronal regeneration. Electrospun nanoscaffolds of L-Lactic acid have been studied to augment neuronal growth. Self-assembling peptide nanofiber scaffold (SAPNS) deserve a special mention. SPANS is composed of positively and negatively charged amino acids that have property of self assembly into interwoven nanofibers of size 10 mm. It is shown to promote nerve growth in experimental models of hamster optic nerve injury. It is also associated with both histological and functional recovery.

Nanorobots can be utilized to manipulate and repair injured axon utilizing direct fusion of grafts. Nanotechniques can be utilized for delivering drugs precisely to the target e.g. tumor without opening the brain.

4.4. Nanotechnology in Building material

Nanotechnology-based coating products may be utilized in construction material. Three nano-sized particles that are utilized in construction materials are titanium dioxide (TiO_2), nano-silica (SiO_2) and carbon nanotubes (CNT's). TiO_2 is a white pigment and can be used as an excellent reflective coating. It is used as nanoparticle. Titanium Dioxide is a nano-particle added to concrete to improve its properties. Building tiles coated with Titanium Dioxide nano-particles never need repainting or washing. Since TiO_2 breaks down organic pollutants, volatile organic compounds and bacterial membranes through powerful catalytic reactions so it is added to paints, cements etc. It can therefore reduce airborne pollutants due to its sterilizing properties when applied to outdoor surfaces. Due to its hydrophilic properties it gives self-cleaning properties to surfaces to which it is applied. When SiO_2 is added to cement based materials, it can control the degradation of the calcium-silicate hydrate reaction caused by calcium leaching in water, blocking water penetration and leading to improvements in durability. Carbon nanotubes increase the compressive strength of cement mortar specimens and change their electrical properties which can be used for health monitoring and damage detection. The addition of small amounts (1%) of carbon nanotubes can improve the mechanical properties of mixture samples of portland cement and water.

4.5. Role of Nanotechnology in Defence

"Nanotechnology is recognized as a very strong innovation driver and is therefore seen as a strategic technology for the world's future economy impacting virtually all technological sectors including defence and security. "Nanotechnology is an emerging field, which can lead to the development of new weapon systems and products that can benefit our nation". NT produces stronger, less weight material which is ideal for military applications (Altmann, 2004).

What can nanotechnology do for the military?

Nanotechnology research in the following areas can help the military:

- Clothing with greater tolerance for temperature changes
- Increase surveillance for better protection
- Smaller cameras
- Cheap, small, and more effective weapons
- Exploration of the oceans
- Augmenting human performance
- Scratch resistant surfaces
- Stronger, thinner and cheaper glass
- Change shape of objects, i.e. armor-like fabric
- Coatings that don't degrade (doesn't need repainting)
- "Invisibility"
- Faster intensive medical help
- Lighter, faster aircraft which use less fuel
- Submarines and planes that can go undetected by radar

Scientists are manipulating light so soldiers seem to disappear. Scientists are also working on "electrochromic camouflage"–fabric which changes colors instantly to blend in with the surroundings. A detailed account on product and application of nanotechnology in defence include the following-

4.5.1. Electro Chromic Camouflage

Electro chromic camouflage can be achieved by nanotechnology, by which soldiers can disappear to, seen by necked eye. Fabric made of Electro-chromic camouflage, which changes colours instantly to blend in with the surroundings. Nanotechnology has currently developed a special paint that makes drones, missiles, or aircraft simply disappear, or to be more precise, they become very difficult to detect. Nanotechnology has developed such materials that absorbs the radio waves emitted by the radar, and releases them as heat energy scattered in space. In doing so, the material disguises the object, making it difficult to identify by Radar (Tiwari, 2012).

4.5.2. Artificial Muscles

Artificial muscles made from nanotech yarns and infused with paraffin wax can lift more than 100,000 times their own weights and generate 85 times more mechanical power than the same size natural muscle. These muscles may enable soldiers to leap tall walls.

4.5.3. Fabrics

Dust repellent /strain resistance/ fire resistance cloths for warfare have been developed by Nanotechnology. Nanopolymers developed for soldier act as fabric to breakdown bio/chemical warfare agents. Biosensors can be used to monitor a soldier's health. Nano-sized silicon carbide particles have been developed for physical protection.

4.5.4. Nano-"Fingerprint''

Scientists have developed invisible nano 'fingerprints' that could be embedded into money, gadgets and credit cards, making it impossible to counterfeit the objects. The 'fingerprints' are almost impossible to replicate because of the natural randomness of their creation and the difficulty associated with manipulating such small material. Using nanotechnology scientists can recognize the inherent patterns within all materials such as paper, plastic, metal and ceramics. Each 'fingerprint' is impossible to duplicate and can be easily read using a low-cost portable laser scanner. This nanotechnology has the ability to verify passports, ID cards and other documents such as birth certificates with just a scan. It can even be used on product packaging. The accuracy of measurement is greater than tests for DNA, a reliability of at least one million trillion.

4.5.5. Nano Sensors

Nanosensors are any biological, chemical, or surgical sensory points used to convey information about nanoparticles to the macroscopic world. Their use mainly include various medicinal purposes and as gateways to building other nanoproducts, such as computer chips that work at the nanoscale and nanorobots (www.nanosensors.com). Nanosensors can detect either minute particles or miniscule quantities of something. Nanosensor may be mechanical or chemical. Nanotechnology enable tiny sensors called nano-units, of which some simple types are available like "smart materials" that change in response to light or heat. Thus physical parameters may be monitored using nanosciences. Artificial "electronic nose "trained to detect toxic gases and vapours for detection of bio/chemical/ nuke agents is because of the nanotechnology. "Nanowires" built from sub-micrometer layers of different metals, including gold, silver and nickel, are able to act as "barcodes" for detecting a variety of pathogens, such as anthrax, smallpox, ricin and botulinum toxin.

4.5.6. War Tag

Smart NT alloy with RFID (Radio-Frequency Identification) is proposed as war tag with nanosensor. Presently, Indian Armed Forces soldiers use metallic piece on which name, number and religion is engraved. In miniaturization of gadgets like RFID/search and rescue mission, nano sensors embedded in combat suit can emit signal which can be picked by search and rescue operation (Tiwari, 2012). Nanotechnology has given PDA (Personal Digital Assistance) weapon watch.

4.5.6. Nanotechnology in Cosmetics

Nanotechnology and nanomaterials have been utilized in the production of many cosmetic products including moisturisers, hair care products, make up and sunscreen. Titanium dioxide and zinc oxide are the main compounds used in these applications. Nanoparticles used in cosmetic improve UV resistance or act as UV filters. Nanocosmetics prevents the signs of ageing. Nanotechnology and nanosomes transport active ingredient such as pure vitamins through skin. Encapsulation techniques have been proposed for carrying cosmetic actives. Nanocrystals and nanoemulsions are also being investigated for cosmetic applications. 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 (Pierfrancesco, 2010). Types of nanomaterials used in cosmetics are the following.

4.5.7. Liposomes

Liposomes are concentric bilayered vesicles or bag of lipid in which the aqueous volume is entirely enclosed by a lipid bilayer. It is composed of natural or synthetic phospholipids. The lipid bilayer of liposomes can fuse with other bilayers such as the cell membrane, which promotes release of its contents, making them useful for cosmetic delivery applications. Their ease of preparation, enhanced absorption of active ingredients by skin and continuous supply of agents into the cells over a sustained period of time make them suitable for cosmetic applications.

4.6.2. Nanoemulsions

They are dispersions of nanoscale droplets of one liquid within another. They are metastable systems whose structure can be manipulated based on the method of preparation. The components used for their preparation are GRAS (generally regarded as safe) products and are safe to use. Their smaller particle size provides higher stability and better suitability to carry active ingredients. They also increase the shelf life of the product (Sonneville-Aubrun et al., 2004).

4.6.3. Nanocapsules

Nanocapsules are submicroscopic particles that are made of a polymeric capsule surrounding an aqueous or oily core. It has been found that the use of nanocapsules decreases the penetration of UV filter octyl methoxycinnamate in pig skin when compared with conventional emulsions (Hwang and Kim, 2008).

4.6.4. Nanocrystals

They are aggregates comprising several hundred to tens of thousands of atoms that combine into a “cluster”. Typical sizes of these aggregates are between 10 and 400 nm and they exhibit physical and chemical properties somewhere between that of bulk solids and molecules. They allow safe and effective passage through skin (Petersen, 2008).

4.6.5. Nanosilver and Nanogold

Cosmetic manufacturers are harnessing the enhanced antibacterial properties of nanosilver in a range of applications. Some manufacturers are already producing underarm deodorants with claims that the silver in the product will provide up to 24-hour antibacterial protection. Nano-sized gold, like nanosilver, is claimed to be highly effective in disinfecting the bacteria in the mouth and has also been added to toothpaste**.**

4.6.6. Cubosomes

Cubosomes are discrete, sub-micron, nanostructured particles of bi-continuous cubic liquid crystalline phase. It is formed by the self assembly of liquid crystalline particles of certain surfactants when mixed with water and a microstructure at a certain ratio. Cubosomes offer a large surface area, low viscosity and can exist at almost any dilution level. They have high heat stability and are capable of carrying hydrophilic and hydrophobic molecules. Combined with the low cost of the raw materials and the potential for controlled release through functionalization, they are an attractive choice for cosmetic applications as well as for drug delivery.

4.6. Nanomedicine

Nanotechnology when incorporated into biology is referred as “nanobiotechnology” or “nanomedicine.” Nanomedicine is the application of nanotechnology to health. It exploits the improved and often novel physical, chemical, and biological properties of materials at the nanometric scale. Nanoparticles for medical applications are defined, as common in pharmaceutical sciences, as particles with a size between 1 and 1000 nm. Nanomedicine is the process of diagnosing, treating, and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using molecular tools and molecular knowledge of the human body. Some selected examples of nanotechnology tools and nanomachines in medical research, experimental therapeutics and diagnostics are-

4.7.1 Nanopore sequencing

This is an ultra-rapid method of sequencing based on pore nanoengineering and assembly. A small electric potential draws a charged strand of DNA through a pore of 1–2 nm in diameter in hemolysin protein complex, which is inserted into a lipid bilayer separating two conductive compartments. The current and time profile is recorded and these are translated into electronic signatures to identify each base. This method can sequence more than 1000 bases per second. This technology has much potential for the detection of single nucleotide polymorphisms, and for gene diagnosis of pathogens (Moghimi et al., 2005).

4.7.2. Nanomedicine for Cancer

Cancer biomarkers are the indicators which are commonly used for cancer detection. Tumor cells produce cancer biomarkers in too low concentrations to be efficiently detected in early phases. However the targeted delivery of specific nanoparticles into the tumor can induce a local interaction with cancer cells and forces them to significantly increase the production of these biomarkers. Biomarkers detection becomes thus much easier and can provide an earlier diagnosis to doctors than biopsies. Early detections of cancers allow early and less burdensome treatments, increasing also the chances of recovery. Nanotechnology has leading for both targeted drug delivery and intrinsic therapies. For instance, nanoparticles can already be injected into the tumor and then be activated to produce heat and destroy cancer cells locally either by magnetic fields, X-Rays or light.

4.7.3. Nanospheres

Nanospheres are the particles having the size range between 10-200 nm in diameter. Nanospheres can be amorphous or crystalline in nature. Nanospheres have great potential and they have the ability to convert poorly soluble, poorly absorbed drugs into the better deliverable drugs. Nanospheres are site specific and also protect the drug from various body fluids (enzyme action) which can degrade the drug during targeting. Nanospheres can easily pass through the smallest capillary vessels due to their ultra tiny volume.

4.7.4. Nanomedicine and Ophthalmology

Nanomedicine tools offer innovative solutions to ophthalmological problems. There are nanomachines for monitoring the physiology of tissues and cells (intraocular pressure or oxygen tension); valves for glaucoma drainage; prosthetics for ion channels that are sensitive to light and can cure blindness; and many novel tools for surgery, such as nanoneedles and nanotweezers. In terms of drug delivery devices, a small, refillable and implantable ocular drug pump has been developed that is capable of dispensing nanoliter-sized doses of drugs for the treatment of glaucoma and AMD (Age-related Muscular Degeneration). Nanostructured matrices have also been proposed for the regeneration of functional tissue, to promote cell transplantation and to induce cell differentiation and repair. These nanostructured matrices are engineered either for cell-based therapy in pathologies involving the retina, or for the regeneration of axons following injury of the optic nerve.

4.7.5. Aquasomes

These are spherical carbohydrate-ceramic 60–300 nm particles used for drug and antigen delivery. The particle core is composed of nanocrystalline calcium phosphate or ceramic diamond, and is covered by a polyhydroxyl oligomeric film. Drugs and antigens are adsorbed on to the surface of these particles. Aquasomes are called as “bodies of water”, their water like properties protect and preserve fragile biological molecules.

5. Risk of Nanotechnology

The toxic effect of nanoparticles on human body is being evaluated in many parts of the world. Various body organ and cells of human body are prone to the toxic effect of nanoparticles. Skin is not a barrier for nanoparticles. Titanium dioxide can penetrate the skin to accumulate in hair follicles. Some smaller particles penetrated through the skin are taken by macrophages (Hoet et al., 2004). Like dust particles, nanoparticles also enter into lungs through the inhaled air and are taken by macrophages (dust cells). Higher concentration causes inflammation. Experiments with rodents have demonstrated the toxic effect of carbon nanotubes through inhalation. Inhaled nanoparticles have also been associated with adverse in the nervous system and cardiovascular system.

Nanoparticles after being absorbed in intestine enter the circulatory system and affect it adversely. Nanoparticles are readily taken up by many types of cells and expected to cross the blood brain barrier that protects the brain from ill effect of many substances. Studies have shown that nano particles cause oxidative stress in liver, contribute to lung inflammation and activate blood platelets that may contribute to clot formation (Hoet et al., 2004). High concentration of nanomaterials and particles causes morphological changes in vascular endothelial cells and induce cytotoxic and lethal effects (Hideyuki and Iwai, 2006).

6. Conclusion

Nanotechnology is emerging as one of the key technologies of the 21st century and is expected to enable developments across a wide range of sectors that can benefit citizens and improve industrial competitiveness. Scientist believe that even within next 50 years, nanotechnology will change the world in ways we can barely begin to imagine today. Nanotechnology will be incorporated into every faces of our lives, making things faster, easier and longer lasting than one can imagine today. Nanotechnology has the potential to revolutionize the agriculture and food industry sector with new tools for molecular treatment, rapid detection diseases, enhancing the ability of plants to absorb nutrients thus increasing soil fertility and crop productivity. Nanotechnology has so much to offer the world and, if used with proper caution and careful planning, it could be the best thing humankind has ever done for the environment. The promises of nanotechnology sound great, may even be unbelievable. But researchers say that we will achieve these capabilities within next century.

7. References

1. Feynman RP (1960). There’s plenty of room at the bottom. Eng Sci, 23: 22-36.
2. Editor’s letter, ‘Space Elevator,’ p.18, Science reporter, January, 2005.
3. Bhatnagar PK (2009). Nanomaterials and some of their applications in electronic devices: in Nanoscale Science & Technology, Proceedings of the symposium held at Maharaj Singh, Saharanpur (CCS University, Meerut) on 21 & 22 Feb. 2009.
4. http://www.nnin.org/nnin_edu.html
5. www.nanowerk.com/nanotechnology-applications.php
6. Joseph, S. SJ (2011). The future is small. Science reporter, February, pp. 8-12.
7. Altmann J (2004). Military Uses of Nanotechnology: Perspectives and Concerns: in Security Dialogue, 35(1): 61-79.
8. Tiwari A (2012). Military Nanotechnology. International Journal of Engineering Science & Advanced Technology, 2(4): 825-830.
9. www.nanosensors.com
10. Pierfrancesco M (2010) Use and potential of nanotechnology in cosmetic dermatology. Clin Cosmet Investig Dermatol, 3: 5–13.
11. Sonneville-Aubrun O, Simonnet JT, L’Alloret F (2004) Nanoemulsions: A new vehicle for skincare products. Adv Colloid Interface Sci., 108-109: 145–9.
12. Hwang SL, Kim JC (2008) *In vivo* hair growth promotion effects of cosmetic preparations containing hinokitiol-loaded poly (epsilon-caprolacton) nanocapsules. J Microencapsul, 25: 351–6.
13. Petersen R (2008) Nanocrystals for use in topical cosmetic formulations and method of production thereof. Abbott GmbH and Co., US Patent 60/866233.
14. Moghimi SM, Christy Hunter AC, Murray JC (2005). Nanomedicine: current status and future prospects. The FASEB Journal, 19: 311-330.
15. Hoet PHM, Bruske-hohfield, Salata OW. (2004). Nano particles-Known and unknown health risk. J. Nanobiotechnology, 2: 12-26.
16. Hideyuki Y, Iwai N (2006). Cytotoxicity of water soluble fullerene in vascular endothelial cells. Ann. J. Cell Physio., 290: C1494-1502.