



TINY DEVICES- NANO - THE EMERGING WORLD TECHNOLOGY

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ABSTRACT

The word "nano" comes from a Greek word, *nainō*, that means "dwarf". The above word is usually mentioned as International System of Units (SI) to consider as a factor of 10⁻⁹. If "nano" may consider as meter (m) then 1 nm (nanometer) = 10⁻⁹ meter. Anyhow, "nano" may considered a "very small" particle. Moreover, it is very known factor that individual atoms are smaller than 1 nm (1 nanometer) in diameter. If we like to select 1nm material where 10 hydrogen atoms should be present in the row. Naturally, a typical virus is about 100 nm in diameter and a bacterium is about 1000 nm in length (head to tail). This sophisticated nanoscale materials can observe through Atomic Force Microscope and also by Scanning Tunneling Microscope. This atom scale structure exhibits a tremendous functions in every sphere of life processes. The sophisticated phenomenon of tiny small particles will be discussed in the following text.

KEY WORDS- Nanoparticles, Individual atoms, Hydrogen atoms, Nanoscale Materials, Atomic Force Microscope, Scanning Tunneling, Microscope, Tremendous functions.

INTRODUCTION

In the present century "Nano Particle" is very popular term. Though nanoscale materials are magnetic materials and can be applied in nanotechnology. In nature, if we concentrate our ideas on living organisms from bacteria to beetles where nanometer-shaped protein can established the building block of their architecture. This technology is a promising field of research opens up in the present decade and is expected to give major boost for innovations of new techniques in a variety of industrial sectors in the future.

Naturally, it will be a unique phenomenon if the same is illustrated in a broad spectrum. In the year 1959 Richard P. Feynman, Nobel Laureate Physicist, proposed the importance of some strange particles, but he is unable to say that these are nanoparticles. The term nanotechnology was proposed by Norio Taniguchi of Tokyo University in the year 1974. Later Eric Drexler in the 1980s, refers the term nanoparticles by introducing his tiny devices and machines. This technology can fabricate structures and also has the ability to maintain the structural orientation of the particles. The book of Taniguchi - "Engines of Creation : The coming era of nanotechnology" in the year 1986 is a unique contribution for the proper knowledge on nano-

bioapplication (Roy, 2009). As we know a nanometer (nm) is one thousand millionth of a meter. A single human hair is about 80,000 wide and thickness of the hair is about 60,000 - 120,000 nanometers, a red blood cell is approximately 7000 nm wide, a DNA molecule is 2-2.5nm and a water molecule is almost 0.3nm. The nanometer is the unit of measurement (Goldman, 2005). Nanoparticles should be restricted to 0.1 to 100 nanometers. The recent technology can produce as smaller as particle called nanoparticle. The term nanoparticle has been evolved from "Greek" Word which means "dwarf". The nanoparticles can produce by means of chemical process, by electrical process and also by means of engineering process. This engineering is generally described as involving either a 'top-down' or a 'bottom-up' technique. Naturally, nanotechnology is the process through which the design, characterization, production and application of particle structures, devices, systems by controlling shape and size at nanometer scale. This technology may introduce in a variety of field like space systems, medical diagnostic equipments and drug delivery system (Moghimi et al., 2005 ; Rawat, 2006). Thus the technology is applicable to biochemistry, biotechnology, molecular biology, chemistry, physics and also in all branches of life sciences

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(Liu, 2006). It also can apply in the field of energy storage, production and conversion, agricultural productivity enrichment. It is related with water treatment and remediation, disease diagnosis and screening, food processing and storage. This technology acts as remediation of air pollution (Duebendorf, 2008). Nanotechnology has the ability to vector and pest detection and can control the host insect pest attraction (Bhattacharyya et al., 2009) It is an important phenomenon of molecular modeling tool. The area of nanotechnology is as broad as the area of science itself. This technology can range from an invisible sunscreen or stain resistant clothing to more efficient cancer treatments and the potential for repairing damaged spinal cords. The element to nanotechnological system is in nanometer. Nanoparticle compositions and methods are disclosed for the sustained release of small molecules to the particle tissues. The ideal nanoparticles helps to prevent self-aggregation of the molecules, and the consequent loss of effectiveness on the basis of their functions.. The particle system employs layer-by-layer self-assembly of biocompatible polyelectrolyte layers, and layers of charged small molecules, as for example, drug molecules, to form a multilayer nanoparticle. Thus the small drug molecule itself acts as one of the alternating charged molecules in the multilayer assembly for execution its functions (Moghimi et al., 2006). .

IMPORTANT PROPERTIES OF NANOPARTICLES :-

The most important thing is going to emerge from the above study that a targeted nanoparticles should have to develop the following essential properties, which are as follows:-

- Targeted nanoparticles possess high catalytic activity.
- It exhibits high mechanical property.
- It can expose electrical conductivity.
- Moreover, has the ability to show hardness and

strength of metals.

All above characteristics of small nanoparticles possess a beauty for exposed its function on the tissue receptor surface (Bhattacharyya, 2009).

BEHAVIOR OF NANOPARTICLES IN THE NATURE :-

Nano science is the younger science and their age is so young. With this phenomena it exhibits a novel behavior in the nature. Nanoparticles in the nature with their important properties they can expose the hydrogen storage systems based on carbon nanotubes. Carbon nanotubes (0.1 m) is required for solar cells preparation. Quantum dots helps to prepare) Photovoltaic cells and organic light-emitting devices. In agricultural sector where nanoporous zeolites and nanomembranes can purify agricultural ground water and also fertilizer for proper penetration of these components in plant host. Now a days soil quality , plant health , detection of contaminants and pathogens of particular host can be monitored by nanosensors and also by nanomagnets . Moreover, nanocapsulation helps in delivering herbicides to the specific plant host. As we know water is essential to give strength of the life process. Human civilization has been developed from sea water. Recently, it has been observed that drinking water quality is going to be change due to use of several chemicals in the agricultural fields and also due to bio-contaminants . Nanoparticles are being used to control water pollution. Thus TiO₂ and other nanoparticles helps in catalytic degradation of water pollutants. (Bürgi and Pradeep, 2006; Maliyekkal, et al., 2009 ; Pradeep, 2009).

It is undoubtedly to considered today that nanoparticle has the ability to take part in disease diagnosis and screening, drug delivery systems, food processing and storage, health monitoring like; nanotubes and nanoparticles for glucose, CO₂, and cholesterol sensors and for in-site monitoring of homeostasis of the physiological system. Lastly it can take part in vector and insect pest detection and also take part in control insect-host interactions. It is also important to propose that not all nano materials exhibits novel execution in nature (Maliyekkal , et al., 2009).

APPLICATION OF NANOPARTICLES FROM ELECTRONICS TO ENVIRONMENT.

Engineered nanomaterials may apply in different sector like, electronic devise, information technology and communications (IT Sectors), packaging processes, logistics phenomenon, food and agribased products, automotive power processes, energy environment monitoring system and maintenance mining systems , mineral exploration and mineral processing being saved by scientific instruments , defence sector , cosmetics industry , clothing system and to built eco-friendly environment. Moreover, recently - A* STAR Institute of Microelectronics and the Institute of

Materials Research has been develop one core-shell structure which develops one silicon-germanium core with a silicon outer layer to form the nanowire. As we know that silicon combined with germanium expose more charge carrier ability than only silicon. Naturally, conjugated silica made nanowires helps to manufacture transistor structures. (Jiang et al., 2009 ; Kwong., 2010) Nanoscience has the potential to play an enormous role in enhancing a range of products, including sensors, photovoltaics and consumer electronics. Scientists in this field have created a multitude of nano scale materials, such as metal nanocrystals, carbon nanotubes and semiconducting nanowires..However, Jen Cha, a UC San Diego nanoengineering professor, and her team of researchers, have discovered recently one biomolecules, such as Lithographically Confined DNA Origami, and proteins (Hung et al., 2009). It is very known that Lithography (ward derived from Greek ἑλίϑιον - lithos, 'stone' + γράφω - graphō, 'to write') is a method fo r writing on lithographic lime stone and that Lithographically Confined DNA Origami can introduce in computer as tiny computer chips. This computer chips has the ability to create more speed and power of a specific computer. The size of the above DNA nanostructures varies from 5 and 100 nanometers, with this size of DNA exhibits a unique functional nanochips (Hung , et al., 2009). More recently , IBM researchers in collaborator with Paul W.K. Rothemund, of the California Institute of Technology, have made a tiny circuit boards by using nanoscale folding of DNA, also called as DNA origami . This targeted nanoscale folding of DNA or two-dimensional shapes of DNA (smaller than 22 nm) developed through lithographic technology and top down methods (Piner et al., 1999 ; . Rothemund et al., 2004 ; Rothemund, 2009) . As we all know Watson-Crick model of DNA which is made up of 'A', 'G', 'C', 'T' binds strongly with its perfect complementary base pairs. This complementary base pairs of DNA posses all genetic information's of the life processes. Due to the above features of DNA , nanotechnologist started to use this DNA origami for production of nanoscale circuits in the present century (Rothemund, 2009). Thus discovery of nanoengineering tools will explore different new technology in the field of electronic engineering. This technology integrates electrical and optical devices on the same piece of silicon, enabling computer chips to communicate using pulses of light (instead of electrical signals), resulting in smaller, faster and more power-efficient chips than is possible with conventional technologies (This week in nanotechnology - December 3, 2010) A group of Beckman Institute researchers have discovered a practical method for direct writing of metal lines less than five nanometers (5 nm) wide, a big step in creating contacts to and interconnects between nanoscale device structures like carbon nanotubes and graphene that have potential

uses in electronics applications. More recently researchers at Delft University of Technology and Oxford University announce new types of nanopore devices that could help in developing fast and cheap genetic analysis. According to them this novel method can combines man-made and biological materials to result in a tiny hole on a chip, which is able to measure and analyze single DNA molecules.

IMPORTANT NANOPARTICLES ENGINEERED FOR BENEFIT OF HUMAN BEING.

Targeted nanoparticles have been prepared for the benefit of social life. There are several nanoparticles like, copper, gold, quantum dots and mesoporous silica are essential in several sectors. Moreover, recently metal nanocolloids may prepared from silk fibroin for production of carbon nanotubes (Wenxing et al., 2003) In the recent decade nanotechnology develops a semiconductor nanocrystals superpara-magnetic iron oxide nanoparticles which helps to track stem cells for new life process (Huang et al., 2005). Biological and nonbiological conjugation in a tiny process helps to detect biosensors in the physiological system. This conjugation such as lipasemolecules covalently attached with PEGylate legated shell of a gold nanoparticle can take part in drug , gene delivery, and tissue engineering manipulation in physiological process (Brennan et al., 2006). Recently carbon nanotube helps to detect toxin in drinking water. Thus carbon nanotube can be introduced to maintain the water quality in nature. Naturally , the use of single-walled carbon nanotubes (SWNTs) will be act as future environmental sensors (Wang et al., 2009) . Short RNA or nano RNA can regulate the target specific genes. This method is very important in the field of apoptotic cell division

(Feng and Yu., 2010). " Nanodragster" is the recent contribution of nanotechnology. This technology is applicable to computer circuits, in "nanocar with wheels made of buckyballs and also in several molecular scientific components in the future (Vives et al., 2009). Paper battery or supercapacitor is the useful applications in electric or hybrid cars, where quick transfer of electricity may exhibits. The paper supercapacitor posses high surface area and also posses high volume which exposed in its rapid functions (Cui, 2009) . Nanocapsules are the important process through we can deliver several materials like, proteins, DNA, RNA and other different drugs to the targete tissues in a physiological system. Naturally, a novel protein may deliver through nanocapsules in some specific target tissue to activate the gene functions (Yan et al., 2009). Proteins can bind the surfaces of nanoparticles, and biological materials in general, immediately upon introduction of the materials into a physiological environment (Aggarwal et al ., 2009). Moreover, protein therapies can be introduced through

nanoencapsulation (Winkle, 2010). Protein nanotube has attracted consideration in the present century, as because, this technology is applicable to enzymatic nanocatalysts, bioseparation through nanofilters, and targeting nanocarriers. In a wide nanospheres, protein nanotubes where one end of the tube is open which helps to release the desired micromolecules to the target specific tissue without its structural change (Komatsu and Qu, 2010)

In the present century several neural diseases are observed, one of the disease known as Alzheimer's disease (AD). This disease will increase more than 100 millions by 2050. Due to development of nanotechnology Alzheimer's disease (AD) can control by means of gold nanoparticles which are also called as "colloidal gold" or sometimes "nano-gold". This technology has the ability to boost up the lifespan of medical implants in the physiological process. Nano-gold now command a great deal of attention for biomedical applications (Neely *et al.*, 2009; Perez, 2010).

NANOTECHNOLOGY IN AGRICULTURE.

Agriculture is the backbone of most developing countries where several recent technology needs to develop to protect the host plants in relation to its crop protection. One of the new technology recently develop with nanoparticles which may consider as nanotechnology. Nanotechnology has the potential role in agricultural field, as because, this technology relates with new processes. These new tools are entangled with molecular detection of host plant diseases, types of viral detection and also can detect crop pathogens. This technology can improve our ideas on the biological aspects of different crops which helps to enhance the yields or nutritional values of crops. Moreover, a tremendous loss of crops due to attack of insect pests. Thus several strong insecticides have been used to control insect pests. In the present century several new formulations like, eco-friendly pesticides, allelochemicals etc. have been introduced in the agricultural field to control pests. But our intention is to control insect pests as early as possible. To combat this situation new technology is inviting by several agricultural scientists in the agricultural field. In this context, one of the most recent technique nano encapsulation process have been introduced in the field. Naturally, the question is what is nanoencapsulation? Nanocapsule is a process through which micronanoparticles (mNPs) can be used to deliver the characteristics in the particular tissues. In the near future nanoencapsulation will be the forefront technique to control several insect pests (Bhattacharyya *et al.*, 2010). Moreover, naturally occurring nano-structures are not being taken account usually, though they are a potentially rich source of products that meet certain specifications (Watson and Watson, 2004). The emerging industries based on nanotechnology have so far made

little use of 'free' technology available in nature (Bhattacharyya and Debnath, 2008; Ehrlich *et al.*, 2008). If we would like to observe several insects (either beneficial or destructive) most of the insect possess nanoparticles on their surface. Here we can cite some examples of insects like, the wings of cicada e.g., *Pflatoda claripennis* (Psaltoda claripennis Ashton) and termite e.g., family Rhinotermitidae (Zhang and Liu, 2006), other insects are *Solenopsis substitute* (Fabricius), *Solenopsis invicta* Buren,, *Schwarziana quadripunctata* (Lepelletier), *Pachycondyla marginata* (Roger), species *Neocapritermes opacus* (Hagen), honeybee *Apis mellifera* Linnaeus, etc. where mNPs are on the surface for execution of different functions (Gorb and Gorb, 2009). The above information's leads to produce effective nano-pesticides by leading chemical companies, they are now formulating pesticides at nano scale like aluminosilicate nanotubes on plant surface which are easily accepted by insect-setae and thus mortality of insect pest may achieved. Biologically more active and environmentally-safe pesticides as nanoemulsions may use in the agricultural field. Nanosensors techniques are being used in the agricultural field for monitoring the soil conditions and crop production (Sunandan and Joydeep, 2009). Now a days Single stranded DNA tagged with gold nanoparticles are introducing as nanosensors to control insect pests. The nanosensor technology and software micromolecules are introducing for detection of insect and plant pathogens which are highly significant biosecurity threats in relation to public health. More recent application of nanoparticles loaded with garlic essential oil may consider as proper insecticides of adult *Tribolium castaneum* in the stored house (Yang *et al.*, 2009). Antimicrobial particles like gram-negative bacteria binding proteins (GNBPs) have the ability to hit the several peptidoglycan recognition proteins of insects which helps to control insect pests (Bulmer *et al.*, 2009; Bhattacharyya, *et al.*, 2010). Now it is clear that nano-sized materials are usually being used in agricultural field to create more effective insecticides, herbicides and fungicides. We are intended to propose that advance nanotechnological methods boost up agricultural production through use of more effective nanomaterials.

PERSPECTIVE OF NANOTOXICOLOGY.

In the present century nanoparticles become more widely used in the field of medical science and other several sectors. Moreover, the beginning of nano technology starts from the center of the spiral are C60, a carbon nanotube, a CdSe quantum dot, an array of semiconducting nanorods, a metal-organic framework, a peptide amphiphile, and other gold nanoparticles have the ability to react with several cellular receptors. Naturally, now it is in the process to observe how nanoparticles manipulate the molecular level of physiology? It is clear that nanoparticles can cross

the barrier of cell membrane and can be tagged in the specific acceptor site of DNA for execution of its functions. It has been notified that the tremendous development of nanotechnology in several essential sectors in the present century will explore some harmful interactions with biological systems (El-Ansary and Al-Daihan, 2009). Naturally, it is very essential to look after either this nanoparticle has any toxic effect in the physiological process or not (Oberdörster et al., 2007; Murphy et al., 2008; Odom, 2008). Several advanced researches on nanoparticles clearly denote that nanoparticles exposed its toxicity in the rigid environmental system (Lewinski et al., 2007). Naturally, the nanotechnology industry is expected to produce large quantities of nanoparticles in the near future, researchers have been worried about the environmental impact of the global nanotechnological revolution. A new method has been developed that could replace nearly all of the toxic chemicals required to make gold nanoparticles (This week in nanotechnology - December 3, 2010).

Contribution of nanotechnology in the present century-

From all above scenario it has been established that magnetic nanoparticles exposed its multitask duties and this technology has come from the lab to the land for nano-bio solutions, The green nanotechnology will create a safe sustainable development of the nation. Thus this technology will lead towards better food quality, better agricultural production, better air, better water resource management and also in other several medical sectors. Therefore, consumable nanotechnology with their nanomaterials and products will create an immense advancement in different sectors of the modern world. Lastly we can quote one very important statement of Professor Herzl, he stated "If you will it, it is no dream", and, one of the long-lasting wills of our common history as humankind has been the manipulation of Nature's inner components. Thus, now a days his wards are the unique one to uplift the new technology as 'Nanotechnology' in each every sectors of life.

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