Nanotechnology and its application in various domain

Gyandeep Kushwaha

Department of Information TechnologyDronacharya College Of Engineering,Farrukhnagar, Gurgaon, IndiaEmail-gyandeepkushwah102@gmail.com

Ashwani Kumar

Faculty of Computer Science and Information technology

Dronacharya College Of EngineeringFarrukhnagar, Gurgaon, India

Abstract - this review paper look into the present aspects of "Nanotechnology". It gives a brief description about Nanotechnology Nanotechnology is a multidisciplinary field that covers a vast and diverse array of devices derived from engineering, physics, chemistry, and biology. The burgeoning new field of nanotechnology, opened up by rapid advances in science and technology, creates myriad new opportunities for advancing medical science and disease treatment in human health care. Applications of nanotechnology to medicine and physiology imply materials and devices designed to interact with the body at subcellular (i.e., molecular) scales with a high degree of specificity. This can be potentially translated into targeted cellular and tissue-specific clinical applications designed to achieve maximal therapeutic efficacy with minimal side effects. In this review the chief scientific and technical aspects of nanotechnology are introduced, and some of its potential clinical applications are discussed.

---

1 . Introduction

Nanotechnology, often shortened to "nanotech," is the study of the control of matter on an atomic and molecular scale. Generally, nanotechnology deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials or devices within that size. Nanotechnology is very diverse, encompassing numerous fields in the natural sciences.

There has been much debate on the future implications of nanotechnology. Nanotechnology has the potential to create many new materials and devices with a vast range of applications, such as in medicine, electronics and energy production. On the other hand, nanotechnology raises many of the same issues as with any introduction of new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.

- **what is nanotechnology?**

Nanotechnology refers to the branch of science and engineering devoted to designing, producing, and using structures, devices, and systems by manipulating atoms and molecules at nanoscale, i.e. having one or more dimensions of the order of 100 nanometres (100 millionth of a millimetre) or less.

In the natural world, there are many examples of structures with one or more nanometre dimensions, and many technologies have incidentally involved such nanostructures for many years, but only recently has it been possible to do it intentionally.

Many of the applications of nanotechnology involve new materials that have very different properties and new effects compared to the same materials made at larger sizes. This is due to the very high surface to volume ratio of nanoparticles compared to larger particles, and to effects that appear at that small scale but are not observed at larger scales.

The applications of nanotechnology can be very beneficial and have the potential to make a significant impact on society. Nanotechnology has already been embraced by industrial sectors, such as the information and communications sectors, but is also used in food technology, energy technology, as well as in some medical products and medicines. Nanomaterials may also offer new opportunities for the reduction of environmental pollution.

- **How it Stareted**

The ideas and concepts behind nanoscience and nanotechnology started with a talk entitled "There's Plenty of Room at the Bottom" by physicist Richard Feynman at an American Physical Society meeting at the California Institute of Technology (CalTech) on December 29, 1959, long before the term nanotechnology was used. In his talk, Feynman described a process in which scientists would be able to manipulate and control individual atoms and molecules. Over a decade later, in his explorations of ultraprecision machining, Professor Norio Taniguchi coined the term nanotechnology. It wasn't until 1981, with the development of the scanning tunneling microscope that could "see" individual atoms, that modern nanotechnology began.

- **The Past of Nanotechnology**

Nanoparticles and structures have been used by humans in fourth century AD, by the Roman, which demonstrated one of the most interesting examples of nanotechnology in the ancient world. The Lycurgus cup, from the British Museum collection, represents one of the most outstanding achievements in ancient glass industry.

In 1990, the scientists analyzed the cup using a transmission electron microscopy (TEM) to explain the phenomenon of dichroism . The observed dichroism (two colors) is due to the presence of nanoparticles with 50–100 nm in diameter. X-ray analysis showed that these nanoparticles are silver-gold (Ag-Au) alloy, with a ratio of Ag:Au of about 7:3, containing in addition about 10% copper (Cu) dispersed in a glass matrix . The Au nanoparticles produce a red color as result of light absorption (~520 nm). The red-purple color is due to the absorption by the bigger particles while the green color is attributed to the light scattering by colloidal dispersions of Ag nanoparticles with a size > 40 nm. The Lycurgus cup is recognized as one of the oldest synthetic nanomaterials . A similar effect is seen in late medieval church windows, shining a luminous red and yellow colors due to the fusion of Au and Ag nanoparticles into the glass. Figure 4 shows an example of the effect of these nanoparticles with different sizes to the stained glass windows .

- **The Future of nanotechnology**

Nanotechnology is often referred to as "the future technology" that can solve many problems. Some even talk about a nanotechnology revolution. Nanotechnology definitely brings tremendous benefits and potential, but the fact that even the youngest technology has its dangers, and much less explored, should be well known to everyone.

It is claimed that environmental problems such as pollution and climate change could also be solved. However, there are also negative properties that nanotechnology entails. For example, the development of usable nanoparticles requires enormous energy and water consumption as well as the use of toxic solvents and chemicals. In addition, the use of nano packaging promotes longer shelf life of food, which in turn means that the food continues to be transported over long distances. Everyone knows that global transport is a major environmental burden. For humans, dangers arise when such nano-pesticides are ingested via food, as research cannot yet foresee how the human body absorbs and degrades these substances

- **Fundamental Concepts in Nanoscience and Nanotechnology ?**

It's hard to imagine just how small nanotechnology is. One nanometer is a billionth of a meter, or 10-9 of a meter. Here are a few illustrative examples:

There are 25,400,000 nanometers in an inch
A sheet of newspaper is about 100,000 nanometers thick

On a comparative scale, if a marble were a nanometer, then one meter would be the size of the Earth Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules. Everything on Earth is made up of atoms—the food we eat, the clothes we wear, the buildings and houses we live in, and our own bodies.

But something as small as an atom is impossible to see with the naked eye. In fact, it's impossible to see with the microscopes typically used in a high school science classes. The microscopes needed to see things at the nanoscale were invented in the early 1980s.

Once scientists had the right tools, such as the scanning tunneling microscope (STM) and the atomic force microscope (AFM), the age of nanotechnology was born.

Although modern nanoscience and nanotechnology are quite new, nanoscale materials were used for centuries. Alternate-sized gold and silver particles created colors in the stained glass windows of medieval churches hundreds of years ago. The artists back then just didn't know that the process they used to create these beautiful works of art actually led to changes in the composition of the materials they were working with.

Today's scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

- **A perspective on Nanotechnology**

One of the first uses of nanotechnology was in the Middle Ages. It was done by using gold nanoparticles to make red pigments in stained glass showing that nanotechnology has been around for centuries. The gold when clumped together appears gold, but certain sized particles when spread out appear different colors. Reference: The Nanotech Pioneers Where are they taking us? By Steven A Edwards

In the year 1974 at the Tokyo Science University, Professor Norio Taniigrichi came up with the term nanotechnology.

Nanotechnology was first used to describe the extension of traditional silicon machining down into regions smaller than one micron (one millionth of a meter) by Tokyo Science University Professor Norio Taniguchi in 1974. It is now commonly used to describe the engineering and fabrication of objects with features smaller than 100 nanometers (one tenth of a micron).

Nanotechnology has been used for thousands of years, although people did not know what they were doing. For example, stained glass was the product of nanofabrication of gold. Medieval forgers were the first nanotecnologists in a sense, because they, by accident, found out a way to make stained glass.

- **A vision**

Richard Feynman was a man of great importance to the field of nanotechnology. He was a man with a vision. He believed that with research we could change things on a small scale. In his famous speech There's Plenty of Room at the Bottom in 1959, Richard Feynman discussed the possibility of manipulating and controlling things on a molecular scale in order to achieve electronic and mechanical systems with atomic sized components. He concluded that the development of technologies to construct such small systems would be interdisciplinary, combining fields such as physics, chemistry and biology, and would offer a new world of possibilities that could radically change the technology around us.

- **Technological development and limits**

The impact on society and our lives of the continuous downscaling of systems is profound, and continues to open up new frontiers and possibilities. However, no exponential growth can continue forever, and the semiconductor industry will eventually reach the atomic limit for downsizing the transistor. Atoms in solid matter are typically one or two hundred picometers apart so nanotechnology involves manipulating individual structures which are between ten and ten thousand atoms across; for example, the gate length of a 45 nm transistor is about 180 silicon atoms long. Such very small structures are vulnerable to molecular level damage by cosmic rays, thermal activity, and so forth. The way in which they are assembled, designed and used is different from prior microelectronics

Example:

Trends in Nanotechnology

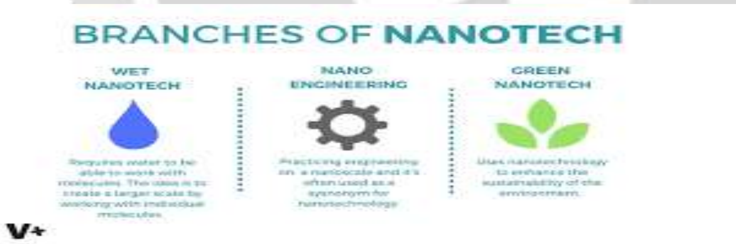
Nanotechnology opens up an almost unlimited field of research activity. Especially in medicine, nanotechnology offers exciting opportunities. Novel diagnostic procedures and therapies promise wide-ranging development potential. For example, novel drugs can be developed. Supported by the progressive miniaturization in the electronics industry, interdisciplinary research teams are researching so-called nanobots. Prototypes already available today should continue to shrink below the size of blood cells and be able to move in the human organism. These nanobots could then transport drugs and dose them specifically to the disease centers.

The development of long fibrous devices that can be introduced into the human organism would be the consequent continuation of minimally invasive surgery. Substances could be more specifically administered and, for example, tissue samples.

Classic mechanical and plant engineering also wants to benefit from innovative materials whose structures show improved properties during machining and in use. So today the rotors of wind turbines are designed with a special coating, which has a positive effect on efficiency.

- **Branches of Nanotechnolog**

a brief overview like how we can describe the branches of nanotechnology. A number of Nanotechnology products are available and still a formidable amount of researches are going on in research laboratories and universities. Nanotechnology branches are being developed that could bang the global market for mineral, non-fuel commodities and agricultural. Presently, Nanotechnology is characterized as revolutionary discipline in terms of its influence on industrial applications. Nanotechnology offers probable solutions to several problems using emanating nano techniques. Depending on the strong inter panel character of nanotechnology there are several research fields and various potential applications that involves nanotechnology. Here are some branches where nanotechnology has been implemented



- **1 . Green Nanotechnolog**

Green nanotechnology is the branch of nanotechnology that enhances the environmental sustainability of processes producing negative facet. It includes manufacturing green Nano-products and then using these Nano-products in support of sustainability . The goal of green nanotechnology is to minimize future environmental and human health risks associated with the use of nanotechnology products, and to boost the replacement of existing products with nano-products that are more environmentally friendly. Solar cells , Nano remediation and water treatment all applications are based on green nanotechnology .

2 . Nano engineering

Nano engineering is the branch nanotechnology practice on the nanoscale. The name 'Nano-engineering' is derived from the nanometer, a unit of measurement equaling one billionth meters. This branch accentuates the engineering rather than the applied science aspect of the field. Scanning tunneling microscope (STM) and molecular self- assembly are two techniques of Nano engineering.STM is used to employ structures as small as a single atom whereas with Molecular selfassembly, an arbitrary sequence of DNA can synthesized and used to create custom proteins or regular patterns of amino acids

3.Wet Nanotechnology

Wet nanotechnology refers to working up with large masses from small ones . W. Eric Drexler put forth the idea of Nano-assemblers working dry. The wet nanotechnology comes out to be the first area in which a Nano-assembler attains the trading results. Pharmaceuticals and bioscience are main features of wet nanotechnology . R.A.L. Jones puts the bits of natural nanotechnology into a synthetic structure biokleptic nanotechnology. Using the guiding principles of biomimetic nanotechnology, trillions of nanotech robots are designed that resemble bacteria in structural properties, entering a person's blood stream to do medical treatments like cancer [

- **Applications of Nanotechnology**

After more than 20 years of basic nanoscience research and more than fifteen years of focused R&D under the NNI, applications of nanotechnology are delivering in both expected and unexpected ways on nanotechnology's promise to benefit society.

Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors: information technology, homeland security, medicine, transportation, energy, food safety, and environmental science, among many others. Described below is a sampling of the rapidly growing list of benefits and applications of nanotechnology.

- **1.Electronics and IT Applications**

Nanotechnology has greatly contributed to major advances in computing and electronics, leading to faster, smaller, and more portable systems that can manage and store larger and larger amounts of information. These continuously evolving applications include:

Transistors, the basic switches that enable all modern computing, have gotten smaller and smaller through nanotechnology. At the turn of the century, a typical transistor was 130 to 250 nanometers in size. In 2014, Intel created a 14 nanometer transistor, then IBM created the first seven nanometer transistor in 2015, and then Lawrence Berkeley National Lab demonstrated a one nanometer transistor in 2016! Smaller, faster, and better transistors may mean that soon your computer's entire memory may be stored on a single tiny chip.
Using magnetic random access memory (MRAM), computers will be able to "boot" almost instantly. MRAM is enabled by nanometer-scale magnetic tunnel junctions and can quickly and effectively save data during a system shutdown or enable resume-play features.
Ultra-high definition displays and televisions are now being sold that use quantum dots to produce more vibrant colors while being more energy efficient.

Flexible, bendable, foldable, rollable, and stretchable electronics are reaching into various sectors and are being integrated into a variety of products, including wearables, medical applications, aerospace applications, and the Internet of Things. Flexible electronics have been developed using, for example, semiconductor nanomembranes for applications in smartphone and e-reader displays. Other nanomaterials like graphene and cellulosic nanomaterials are being used for various types of flexible electronics to enable wearable and "tattoo" sensors, photovoltaics that can be sewn onto clothing, and electronic paper that can be rolled up. Making flat, flexible, lightweight, non-brittle, highly efficient electronics opens the door to countless smart products.

Other computing and electronic products include Flash memory chips for smart phones and thumb drives; ultra-responsive hearing aids; antimicrobial/antibacterial coatings on keyboards and cell phone casings; conductive inks for printed electronics for RFID/smart cards/smart packaging; and flexible displays for e-book readers. Nanoparticle copper suspensions have been developed as a safer, cheaper, and more reliable alternative to lead-based solder and other hazardous materials commonly used to fuse electronics in the assembly process.

- **Nanotechnology In Artificial Inteligence**

AI and nanotechnology are working together to solve real-world problems

Artificial intelligence (AI) and nanotechnology are among the most hyped emerging technologies today. But in many ways, they are also the least understood. While unusual use cases of either technology—such as the ability to fake your own voice with AI—grab the headlines, the truth is that both AI and nanotech are already with us and being used in mundane, everyday circumstances.

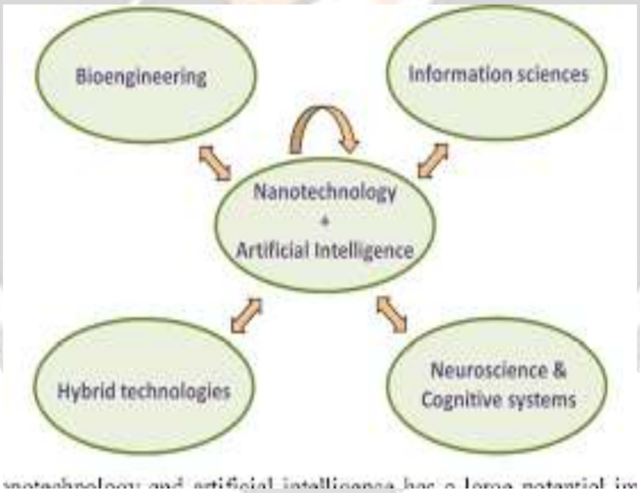
In this article, we want to get beyond the hype. Here, we won't dwell on speculative, far-future use cases. Instead, we'll look at real-world, actually-existing situations in which AI and nanotech are already being used. And by doing that, we'll immediately see that there is a natural overlap between the technologies, and one that can drive the development of both.

1. What AI and nanotech

First, a word about what AI and nanotech are and what they are not. The novelty of both technologies today is such that many people still think of them as science fiction. This impression isn't helped by high-profile scientists claiming that AIs could eventually destroy humanity or nanotechnology could take our bodies away from us.

These are exciting, spectacular scenarios, but the reality of both technologies is much less spectacular and closely tied to the needs of the contemporary economy. In fact, the most widespread use of AI has been in the form of chatbots; rather than taking over the world, at the moment AIs are mainly focused on customer service.

Similarly, though the term "nanotechnology" still sounds like one from science fiction, for researchers working in the field, it has a precise and somewhat less sensational definition—ANT technology—that makes use of the nanometer scale. And today, this is actually pretty common. More than 300 products are already nano-based, according to a database maintained by the Woodrow Wilson International Center, in Washington, D.C



- **Nanocomputing**

This is arguably the area in which there is the closest correspondence between the two technologies, and potentially the most productive overlap.

The central promise of nanocomputing is that it can greatly increase the computing power available to researchers and engineers alike. In recent years, some have worried that Moore's Law—that transistors per chip and therefore computing power doubles over a predictable timeframe—is no longer holding true, because as we build ever smaller computers, we are encountering strange quantum effects that limit our ability to work at this scale.

Nanocomputing is one approach to overcoming this problem. Nanocomputers use a variety of novel media to perform calculations—anything from organic chemical reactions to nano-MOSFETs. However, most of these devices depend on intricate physical systems to allow for intricate computational algorithms and machine learning procedures that can be used to generate novel information representations for a broad range of uses.

In simple terms, AIs can help us to understand the ways in which materials work at the nanoscale. This might allow us to build computers at this scale that are not dependent on the transistor-based architecture that most computers today are based on. This, in turn, will allow the creation of ever more sophisticated AIs, which will allow us to probe this behavior still further. In the same way that neural networks could help computers code themselves, nanocomputing technologies could allow computers to build themselves.

The future of Nanotechnology in AI

Of course, both AI and nanotechnology are emerging technologies, and it remains to be seen how each will develop. However, the ways in which these technologies are already being used mean that it's possible to see an emerging syncretism. Advances in AI are allowing us to understand the behavior of materials at the nano scale, and this is turn might allow us to create ever more powerful AIs. In this sense, the two technologies are closely intertwined.

2.Medical and Healthcare Applications

Nanotechnology is already broadening the medical tools, knowledge, and therapies currently available to clinicians. Nanomedicine, the application of nanotechnology in medicine, draws on the natural scale of biological phenomena to produce precise solutions for disease prevention, diagnosis, and treatment. Below are some examples of recent advances in this area:

Commercial applications have adapted gold nanoparticles as probes for the detection of targeted sequences of nucleic acids, and gold nanoparticles are also being clinically investigated as potential treatments for cancer and other diseases.
Better imaging and diagnostic tools enabled by nanotechnology are paving the way for earlier diagnosis, more individualized treatment options, and better therapeutic success rates.
Nanotechnology is being studied for both the diagnosis and treatment of atherosclerosis, or the buildup of plaque in arteries. In one technique, researchers created a nanoparticle that mimics the body's "good" cholesterol, known as HDL (high-density lipoprotein), which helps to shrink plaque.
The design and engineering of advanced solid-state nanopore materials could allow for the development of novel gene sequencing technologies that enable single-molecule detection at low cost and high speed with minimal sample preparation and instrumentation.
Nanotechnology researchers are working on a number of different therapeutics where a nanoparticle can encapsulate or otherwise help to deliver medication directly to cancer cells and minimize the risk of damage to healthy tissue. This has the potential to change the way doctors treat cancer and dramatically reduce the toxic effects of chemotherapy.
Research in the use of nanotechnology for regenerative medicine spans several application areas, including bone and neural tissue engineering. For instance, novel materials can be engineered to mimic the crystal mineral structure of human bone or used as a restorative resin for dental applications. Researchers are looking for ways to grow complex tissues with the goal of one day growing human organs for transplant. Researchers are also studying ways to use graphene nanoribbons to help repair spinal cord injuries; preliminary research shows that neurons grow well on the conductive graphene surface.
Nanomedicine researchers are looking at ways that nanotechnology can improve vaccines, including vaccine delivery without the use of needles. Researchers also are working to create a universal vaccine scaffold for the annual flu vaccine that would cover more strains and require fewer resources to develop each year.

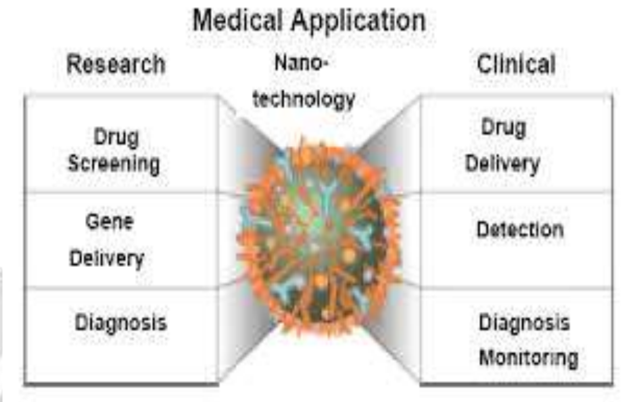
2.Nanotechnology in Medicine Application:

One application of nanotechnology in medicine currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer cells). Particles are engineered so that they are attracted to diseased cells, which allows direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease.

For example researchers at North Carolina State University are developing a method to deliver cardiac stem cells to damaged heart tissue. They attach nanovesicles that are attracted to an injury to the stem cells to increase the amount of stem cells delivered to an injured tissue

Researchers at the University of Houston are developing a technique to kill bacteria using gold nanoparticles and infrared light. This method may lead to improved cleaning of instruments in hospital settings.

Researchers at the University of Colorado Boulder are investigating the use of quantum dots to treat antibiotic resistant infections.



2.1 What Are The Risks?

Manuplating DNA

Therapies that involve the manipulation of individual genes, or the molecular pathways that influence their expression, are increasingly being investigated as an option for treating diseases. One highly sought goal in this field is the ability to tailor treatments according to the genetic make-up of individual patients.

This creates a need for tools that help scientists experiment and develop such treatments.

Imagine, for example, being able to stretch out a section of DNA like a strand of spaghetti, so you can examine or operate on it, or building nanorobots that can "walk" and carry out repairs inside cell components. Nanotechnology is bringing that scientific dream closer to reality.

For instance, scientists at the Australian National University have managed to attach coated latex beads to the ends of modified DNA, and then using an "optical trap" comprising a focused beam of light to hold the beads in place, they have stretched out the DNA strand in order to study the interactions of specific binding proteins.

- **3.Energy Applications**

- Nanotechnology is finding application in traditional energy sources and is greatly enhancing alternative energy approaches to help meet the world's increasing energy demands. Many scientists are looking into ways to develop clean, affordable, and renewable energy sources, along with means to reduce energy consumption and lessen toxicity burdens on the environment:
- Nanotechnology is improving the efficiency of fuel production from raw petroleum materials through better catalysis. It is also enabling reduced fuel consumption in vehicles and power plants through higher-efficiency combustion and decreased friction.
- Nanotechnology is also being applied to oil and gas extraction through, for example, the use of nanotechnology-enabled gas lift valves in offshore operations or the use of nanoparticles to detect microscopic down-well oil pipeline fractures.
- Researchers are investigating carbon nanotube "scrubbers" and membranes to separate carbon dioxide from power plant exhaust.

- Researchers are developing wires containing carbon nanotubes that will have much lower resistance than the high-tension wires currently used in the electric grid, thus reducing transmission power loss.
- Nanotechnology can be incorporated into solar panels to convert sunlight to electricity more efficiently, promising inexpensive solar power in the future. Nanostructured solar cells could be cheaper to manufacture and easier to install, since they can use print-like manufacturing processes and can be made in flexible rolls rather than discrete panels. Newer research suggests that future solar converters might even be "paintable."

Nanotechnology is already being used to develop many new kinds of batteries that are quicker-charging, more efficient, lighter weight, have a higher power density, and hold electrical charge longer.

- An epoxy containing carbon nanotubes is being used to make windmill blades that are longer, stronger, and lighter-weight than other blades to increase the amount of electricity that windmills can generate.
- In the area of energy harvesting, researchers are developing thin-film solar electric panels that can be fitted onto computer cases and flexible piezoelectric nanowires woven into clothing to generate usable energy on the go from light, friction, and/or body heat to power mobile electronic devices. Similarly, various nanoscience-based options are being pursued to convert waste heat in computers, automobiles, homes, power plants, etc., to usable electrical power.

- Energy efficiency and energy saving products are increasing in number and types of application. In addition to those noted above, nanotechnology is enabling more efficient lighting systems; lighter and stronger vehicle chassis materials for the transportation sector; lower energy consumption in advanced electronics; and light-responsive smart coatings for glass.

4.Nanotechnological applications in food industry

Nanotechnology has been reported as the new industrial revolution, both developed, and developing countries are investing in this technology to secure a market share. At present, the USA leads with a 4-year, 3.7-billion USD investment through its National Nanotechnology Initiative (NNI). The USA is followed by Japan and the European Union, which have both committed substantial funds (750 million and 1.2 billion, including individual country contributions, respectively, per year). Others such as India, South Korea, Iran, and Thailand are also catching up with a focus on applications specific to the economic growth and needs of their countries (Kour et al. 2015). Food processing approaches that involve nanomaterials include integration of nutraceuticals, gelation and viscosifying agents, nutrient propagation, mineral and vitamin fortification, and nano-encapsulation of flavors (Huang et al. 2010). Thus, systems with physical structures in the nanometer distance range could affect features from food safety to molecular synthesis. Nanotechnology may also have the potential to enhance food quality and safety. Many studies are assessing the ability of nanosensors to improve pathogen detection in food systems. Nanofoods are products that were grown processed or packaged with the aid of nanotechnology or materials produced with nanotechnology . In this review, we discuss some current nanotechnology research in food technology and agriculture, including processing, packaging, nano-additives, cleaning, and sensors for the detection of contaminants, and propose future developments in the developing field of agrifood nanotechnology

Nano-encapsulation

 Nanotechnology can also facilitate encapsulation of drugs or other components for protection against environmental factors and can be used in the plan of food ingredients, e.g., flavors and antioxidants (Ravichandran 2010). Micro-encapsulation is used to increase bioavailability, control release kinetics, minimize drug side effects, and cover the bitter taste of medicinal substances in the pharmaceutical industry.

 Currently, numerous techniques of nano-encapsulation are progressively rising with their own merits and demerits. Techniques including emulsification, coacervation, inclusion complexation, nanoprecipitation, solvent evaporation, and supercritical fluid technique are enduring techniques for nano-encapsulation of food substances

Packaging of food items

Nanocomposites Nanocomposites are mostly exploited in the area of food packaging, as they are eco-friendly and biodegradable. Nanocomposites exhibit extremely multipurpose chemical functionality and are therefore used for the growth of high obstacle properties (Pandey et al. 2013). A nanocomposite-based commercialized fertilizer, Guard IN Fresh, helps fruits and vegetables to ripen by scavenging ethylene gas (Gupta and Moulik 2008). Nanoclays are made of aluminum silicates, commonly mentioned to as phyllosilicates, and are low-cost, constant, and eco-friendly

- **Nanosensors** : Nanosensors in conjunction with polymers are used to screen food pathogens and chemicals during storage and transit processes in smart packaging. Additionally, smart packaging confirms the integrity of the food package and authenticity of the food product.

- **Food packaging :** The biodegradability of a packaging material can be augmented by integrating inorganic elements, for example, mud, into the biopolymeric medium and can be measured with surfactants that are utilized for the alteration of the layered silicate**.**

4.Nanotechnological applications in Agriculture.

Abstract

- Nanotechnology has gained intense attention in the recent years due to its wide applications in several areas like medicine, medical drugs, catalysis, energy and materials. Those nanoparticles with small size to large surface area (1–100 nm) have several potential functions. These days, sustainable agriculture is needed. The development of nanochemicals has appeared as promising agents for the plant growth, fertilizers and pesticides. In recent years, the use of nanomaterials has been considered as an alternative solution to control plant pests including insects, fungi and weeds. Several nanomaterials are used as antimicrobial agents in food packing in which several nanoparticles such as silver nanomaterials are in great interest. Many nanoparticles (Ag, Fe, Cu, Si, Al, Zn, ZnO, TiO_2, CeO_2, Al_2O_3 and carbon nanotubes) have been reported to have some adverse effects on plant growth apart from the antimicrobial properties. In food industries, nanoparticles are leading in forming the food with high quality and good nutritive value.

1**. Introduction**

l Nanotechnology has gained intense attention in recent years due to its wide applications in several areas like medicine, medical drugs, catalysis, energy and materials. Those nanoparticles with small size to large surface area (1–100 nm) have potential medical, industrial and agricultural applications. Scientists have carried out significant efforts toward the synthesis of nanoparticles by different means, including physical, chemical and biological methods [1]. These methods have many disadvantages due to the difficulty of scale-up of the process, separation and purification of nanoparticles from the micro-emulsion (oil, surfactant, co-surfactant and aqueous phase) and consuming large amount of surfactants [2]. Green methods for synthesizing nanoparticles with plant extracts are advantageous as it is simple, convenient, eco-friendly and require less reaction time. Nanomaterials prepared by eco-friendly and green methods could increase agriculture potential for improving the fertilization process, plant growth regulators and pesticides [3]. In addition, they minimize the amount of harmful chemicals that pollutes the environment. Hence, this technology helps in reducing the environmental pollutants [4], and nanotechnology has recently gained attention due to its wide applications in different fields such as in medicine, environment and agriculture [5]. Particularly, the large surface area offered by the tiny nanoparticles, which have high surface area, makes them attractive to address challenges not met by physical, chemical pesticides and biological control methods.

l Nanotechnology in agriculture has gained good momentum in the last decade with an abundance of public funding, but the stage of development is good, even though many methods became under the umbrella of agriculture. This might be attributed to a unique nature of farm production, which functions as an open system whereby energy and matter are exchanged freely. The scale of demand of input materials is always being large in contrast with industrial nanoproducts with the absence of control over the input of the nanomaterials in contrast with industrial nanoproducts [6]. Nanotechnology provides new agrochemical agents and new delivery mechanisms to improve crop productivity, and it promises to reduce pesticide applications. Nanotechnology can increase agricultural production, and its applications include: (1) nanoformulations of agrochemicals for applying pesticides and fertilizers for crop improvement; (2) the application of nanosensors in crop protection for the identification of diseases and residues of agrochemicals; (3) nanodevices for the genetic engineering of plants; (4) plant disease diagnostics; (5) animal health, animal breeding, poultry production; and (6) postharvest management. Precision farming techniques might be used to further improve the crop yields but not damage soil and water. In addition, it can reduce nitrogen loss due to leaching and emissions, and soil microorganisms. Nanotechnology applications include nanoparticle-mediated gene or DNA transfer in plants for the development of insect-resistant varieties, food processing and storage and increased product shelf life. Nanotechnology may increase the development of biomass-to-fuel production.

2. **Nanotechnology in pesticides and fertilizers**

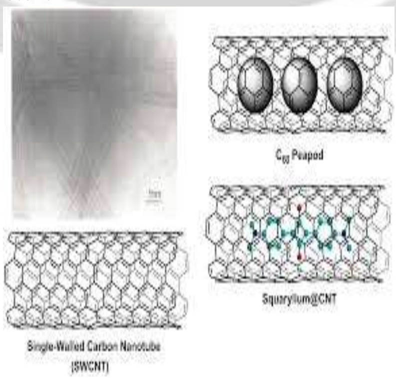
These days, sustainable agriculture is needed. It may be understood to present a good approach of ecosystem for long run. Practices that can cause long-term damage to soil include excessive tilling of the soil which leads to erosion and irrigation without needed drainage. This will lead to salinization. This is to satisfy human being food, animal feed and fiber needs.

Uses of Nanotechnology

from the past two decades, scientists and engineers have mastered the complexities of working with nonmaterial and research is still going on. Nowadays most of the products are manufactured by nanoscale materials. Sunscreens containing nanoscale zinc Oxide or titanium dioxide that reflects ultraviolet light to avert sunburns. A nanoscale dry powder can neutralize gas. So, the nanoscale materials are being used to manufacture the batteries for tools in order to deliver more power, more promptly and dissipating less heat. The dressing of anti bacterial wound use nanoscale silver [11]. Other uses of nanotechnology includes sports equipment, vehicle parts, storage of power in batteries, moisturizing effectiveness of cosmetics, drug delivery and other numerous techniques and products based on nanoscale material are described in brusque

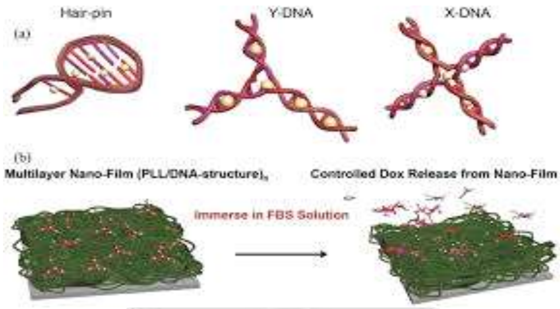
- **1. Carbon Nano Tubes (CNT)**

Carbon nanotubes are allotropes of carbon having a cylindrical nanostructure. Nanotubes have been constructed with length-to-diameter ratio of up to 2, 80, 00,000:1 that is much larger than any other material. These cylindrical carbon molecules possess extraordinary strength and unique electrical properties. These novel properties make them substantially useful in various applications in electronics, nanotechnology, optics, materials science, as well as in architectural



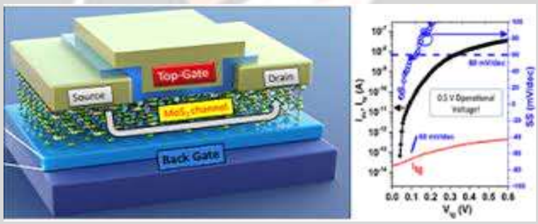
- **2.Thin Nano Films:**

Various nanoscale materials can be used in thin films to make them water repellent, UV or IR- resistant, anti reflective, anti-microbial , self-cleaning, anti-fog, Scratch resistant or electrically conductive. Applications of Nano films include computer display, cameras and eyeglasses



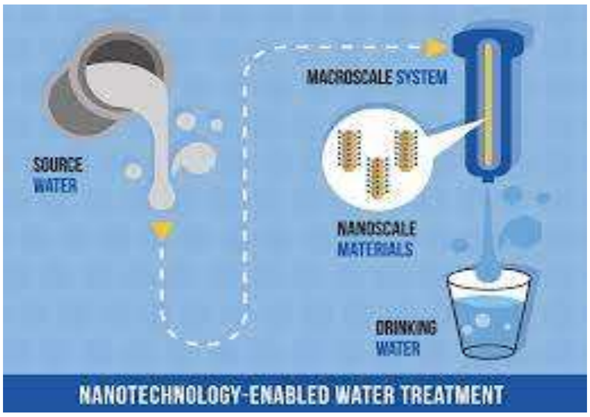
3.Thin Nano scale Transistors:

A transistor is a semiconductor electronic device used to amplify or switch electronic signals and electrical power. In transistors, a small amount of electricity is used as a gate to control the flow of larger amount of electricity. More the number of transistors are embedded in the computer, the greater will be power. Transistors sizes have been decreasing day by day, so computer have become more powerful. Upto now, the industry's best trading technology produced computer chips with transistors having 45-nanometer features. Recent announcements indicate that even more small size of transistors is possible with the help of nanotechnology



4. **Drug-Delivery Technique using DendrimersDendrimers** :are highly branched, star-shaped macromolecules with nanometer-scale dimensions shown in figure 5. Dendrimers are specially designed and manufactured for a vast variety of applications, including the treatment of cancer, drug delivery, catalysis, gene transfixion, and energy harvesting and photo activity. Dendrimers carrying different materials and their branches can do several things at one time, such as perceiving diseased cells, diagnosing diseased states (including cell death), drug delivery, describing location and reporting events of therapy

5. Water Filtration techniqueCarbon nanotubes based membranes are used for water desalination and nanoscale sensors to diagnose contaminants in water system. The process of water filtration using carbon nanotubes is shown in figure 6.Nanoscale titanium dioxide is the other nanoscale material that has great potential to filter and purify water system and it is also used in sunscreen to neutralize bacteri



Nanotechnology for Environmental Protection

- Nanotechnology for Environmental Protection In the last few decades, highly toxic organic compounds have been synthesized and released into the environment in order to be used directly or indirectly over a long period. Among some of these elements are pesticides, fuels, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) (Jones, 2007). Some combined chemical compounds resist highly against biodegradation via native flora in comparison with organic substances easily degraded through introduction into the environment. Thus, dangerous chemical compounds have been one of the most serious issues in the contemporary world. The management of contaminated soil and ground water is a major environmental concern.

- The presence of elevated concentrations of a wide range of contaminants in soils, sediments and surface-and ground waters, affects the health of millions of people worldwide (Pereira et al., 2003). Current clean up technology is not significantly and economically adequate to solve all of today‟s clean up needs. Nanotechnology is one of the most important trends in science and perceived as one of the key technologies of the present century (Zhang and Elliot, 2006). Nanotechnology could be a powerful tool in dealing with pollution remediation. Several studies indicate that combining nanoparticles with conventional treatment could increase the efficiency of contaminants removal, such as organic materials. In Zhang‟s report (Rickerby and Morrison, 2007), nano scale iron particles are very effective for the transformation and detoxification of a wide variety of common environmental contaminants, such as chlorinated organic solvents, organochlorine pesticides, and PCBs. Nanoparticles remain reactive towards contaminants in soil and water for extended periods of time and rapid in situ reactions have been observed with TCE reduction up to 99% in a few days after the nanoparticle injection. Many researchers have shown that engineered nanoparticles such as TiO
- ZnO, carbon nanotube, metallic nanoparticles (e.g., iron, nickel) magnetic nanoparticles and amphiphilic polyurethane nanoparticles could be useful for remediation and treatment of contaminated water, soil or air.

- **Effects of Nanotechnology**

How will nanotechnology affect our lives - this part will not look in terms of the technological impact such as faster and cheaper computers, but at the very important health and environmental effects that necessarily must be considered.

When will it help cure cancer or and when might it cause it? Will the apparent ecological benefit of a nanoparticle that improves catalytic reactions be futile when we consider the ecological footprint of the nanoaparticles' life cycle? There are many open questions where the search for answers has only just begun!

Nanotechnology has been proclaimed to imply a wealth of potential benefits for society many of which will have direct or indirect positive effects on the environment. Of specific environmental importance is the potential improved efficiency of energy production, reduced energy use of products, reduced use of chemicals due to e.g. functionalization of surfaces, remediation of soil pollution, improved sensoring and monitoring of the environment and improved functionality of materials.

Additionally, principles of green engineering and chemistry are beginning to be integrated into the development of nanomaterials, meaning that nanotechnology may also lead to more environmental beneficial production methods .

There are a lot of opportunities but as with many other nanotechnologies there is still a large gap from the research labs to manufacturing and real life use of nanotechnological products and solutions.

The focus here will however be at the potential health and environmental impacts.

1.Health effects of nanotechnology

The environmental impacts of nanotechnology have become an increasingly active area of research.

Until recently the potential negative impacts of nanomaterials on human health and the environment have been rather speculative and unsubstantiated[1].

However, within the past number of years several studies have indicated that exposure to specific nanomaterials, e.g. nanoparticles, can lead to a gamut of adverse effects in humans and animals .

This has made some people very concerned drawing specific parallels to past negative experiences with small particles .

Some types of nanoparticles are expected to be benign and are FDA approved and used for making paints and sunscreen lotion etc. However, there are also dangerous nanosized particles and chemicals that are known to accumulate in the food chain and have been known for many years:

2.Potential environmental impacts of nanotechnology

The topics of understanding and assessing the environmental impacts and benefits of nanotechnology throughout the life cycle from extraction of raw materials to the final disposal have only been addressed in a couple of stautomobiles [2] , respectively, and one project was sponsored by the German government udies. The U.S. EPA, NCER have sponsored a few projects to investigate Life Cycle Assessment methodologies.

2007 special issue of Journal of Cleaner Production puts focus on sustainable development of nanotechnology and includes a recent LCA study in Switzerland .

The potential environmental impact of nanomaterials could be more far-reaching than the potential impact on personal health of free nanoparticles. Numerous international and national organizations have recommended that evaluations of nanomaterials be done in a life-cycle perspective

This is also one conclusion from a recent series of workshops in the US on “green nanotechnology” (Schmidt, 2007)[7] .

A workshop co-organised by US EPA/Woodrow Wilson Center and EU Commission DG Research put focus on the topic of Life Cycle Assessments of Nanotechnologies (Klöpffer et al., 2007) .

Nanotechnology in India

- Research and work on nanotechnology in India started in 2001 with the formation of the NanoScience and Technology Initiative with initial funding of Rs. 60 crores.

- In 2007, the GOI launched a 5-year program called Nano Mission, it was allocated a budget of Rs 1,000 crores. It had a wider scope of objectives and much larger funding. Fields involved in the mission were: basic research in nanotechnology, infrastructure development, human resources development, and global collaboration.
- Many institutions and departments were roped in for the work such as the Department of IT, DRDO, Department of Biotechnology, Council of Scientific and Industrial Research (CSIR), etc. In both IIT Bombay and IISC Bangalore, National Centers for Nanofabrication and Nanoelectronics were established.

- **Concerns**

  - India spends only a fraction of the amount spent by countries such as the USA, China, Japan, etc. on nanotechnology.
  - The quality of research is also to be improved significantly. Only a small percentage of the papers from India figures in the top 1% of publications.
  - Only 0.2% of the patents filed in the US Patent Office are from India in this field.
  - There are very few students who take up this field.
  - The target number of PhDs in nanotechnology is 10000 per year by the Ministry of HRD.
  - The contribution of the private sector is minimal in this domain. Even though there is a lot of potential, the private sector is yet to show tremendous enthusiasm.

Scope for potential:

- A team from IIT Madras used nanotechnology to decontaminate arsenic from water.
- A team from IIT Delhi has engineered a self-cleaning technology to be used in the textile industry.

- **Steps by Government**

- Nanotechnology regulatory board to regulate industrial nano products.
- Nano technology institutes like Indian Institute of Nano sciences at Bangalore,Mumbai,kolkata
- Nano technology initiatives program by Department of Information technology and for nano electronic products
- Department of Science and Tech-Nanomission (nano-biotechnology activities) through DBT, ICMR, and CoE in Nanoelectronics by MeitY support nanoscience, nanotechnology, nanobiotechnology, and nanoelectronics activities.
- Eighteen sophisticated analytical instruments facilities (SAIFs) established by DST across India play a major role in the advanced characterization and synthesis of nanomaterials for various applications.
- The Center of Excellence in Nanoscience and Nanotechnology established by DSTNanomission helps research and PG students in various thrust areas.
- Thematic Units of Excellence (TUEs) for various areas of nanoscience and nanotechnology play a major role in product-based research to support nanotechnology.

Visvesvaraya PhD Scheme

- It was initiated by the Ministry of Electronics and Information Technology (MeitY) in 2014 with the approval of the Cabinet Committee on Economic Affairs (CCEA) with an objective to enhance the number of PhDs in ESDM and IT/IT Enabled Services sectors in the country.
- PhD seats were allocated to 97 institutions (IITs, NITs, Central & State Universities etc.) in 25 states and 4 Union Territories.
- The scheme is a manifestation of the Prime Minister's vision of providing world-class education and opportunities for research and development to the students at the bottom of the pyramid in society.
- Salient features of the PhD Scheme are as follows:
- It provides 25% more fellowship amount than most of the other PhD Schemes.
- Part-time PhD candidates get a one-time incentive on completion of the PhD.

- The scheme also supports 200 Young Faculty Research Fellowships in the areas of ESDM and IT/ITES with the objective to retain and attract bright young faculty members in these sectors.
- Objectives:
- Give thrust to R&D, create an innovative ecosystem and enhance India's competitiveness in these knowledge-intensive sectors.
- To fulfil the commitments made in National Policy on Electronics (NPE 2012) and National Policy on Information Technology (NPIT 2012)
- They recommend giving special thrust on significantly increasing the number of PhDs in the country to enable India to compete globally in the coming decades, to develop an ecosystem of research, development and IP creation in these knowledge-intensive sectors.

INSPIRE Scheme

- Innovation in Science Pursuit for Inspired Research (INSPIRE) is an innovative programme sponsored and managed by the Department of Science & Technology for attraction of talent to Science.
- The basic objective of INSPIRE is to communicate to the youth of the country the excitements of creative pursuit of science, attract talent to the study of science at an early age and thus build the required critical human resource pool for strengthening and expanding the Science & Technology system and R&D base.
- A striking feature of the programme is that it does not believe in conducting competitive exams for identification of talent at any level. It believes in and relies on the efficacy of the existing educational structure for identification of talent.
- Nanomission
- It is an umbrella programme aims for the overall development of research in the field of nanotechnology and to make use of its applied potential for economic development.
- It strives to promote basic research through funding to individual or group of scientists and create centres for excellence for promoting skills and education in this field.
- Infrastructure development is vital in this field and requires expensive equipment like Optical Tweezers, Nano Indenter, Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM) etc. For the optimum use of these expensive infrastructures and technologies, it has proposed to establish a nationwide chain of shared facilities.

- **How should exposure to nanotechnology be controlled?**

Based on the above analysis and observations we can highlight some insights for future developments :

- Elimination (including substitution)
- Engineering controls
- Administrative controls
- Personal Protective equipment

What are examples of elimination and substitution controls for nanomaterials

- **First, determine if you can eliminate or substitute the nanomaterial. For example, determine if it is possible to:**
-
- **not use the nanomaterial at all (eliminate)**
- **replace the nanomaterial with a "normal" sized particle that has known information about its hazards and risks (substitute)**
- **use another form of the nanomaterial, such as a liquid instead of dry powder (substitute) that may not become airborne as easily**

What are examples of engineering controls for nanomaterials?

- **enclosures, which can be small for weigh scales or large enough to enclose the entire nanomaterial reactor**
- **local exhaust ventilation**
- **isolation devices, such as glove boxes**
- **use of air locks and sealed containers**

8.Conclusions

Nanotechnology is the science of tiny particles. The nanotechnology envisions a world in which new products are designed at the atomic and molecular level; provide realistic, cost-effective methods for strapping renewable energy sources and keeping the environment clean. Nowadays, many of scientists and engineers are finding new ways to use nanotechnology to improve the world. There are numerous applications of nanotechnology including electronics, biology, chemical engineering and robotics electronics. By the help of nanotechnology, doctors detecting disease at its earliest stages and treating illness such as heart disease, cancer and diabetes with more effective and safer medicines. Researchers also picture new technologies for protecting both the civilians and military forces from conventional and chemical weapons. Although there are many research challenges ahead, nanotechnology already is producing a vast range of favorable materials and pointing to development in many fields. It has opened scientific Inquiry to the level of nanoparticles and gives a world of new opportunities

New and future innovation is nanotechnology that has exceptionally extraordinary property in food source chain (precision farming techniques, smart feed, enhancement of food texture and quality, bioavailability/nutrient values, packaging, labeling, crop production and use of agrochemicals such as nano-pesticides, nano-fertilizers, and nano-herbicides) round the world agricultural sector. Nanofood packaging resources may widen nourishment life, upgrade food safety, prepared customers that food is sullied or destroyed, repair tears in packaging, and uniform release added substances to grow the life of the food in the package. To maintain leadership in food and food-processing industry, one must work with nanotechnology and nanobio-info in the future. The future belongs to new products and new processes with the goal to customize and personalize the products

References:

https://www.nano.gov/

Alfadul SM, Elneshwy AA. Use of nanotechnology in food processing, packaging and safety review. Afr J Food Agric Nutr Dev. 2010;10(6):2719–2739. [Google Scholar]

Amaral DMF, Bhargava K. Essential oil nanoemulsions and food applications. Adv Food Technol Nutr Sci Open J. 2015;1:84–87. doi: 10.17140/AFTNSOJ-1-115. [CrossRef] [Google Scholar]

http://www.nottingham.ac.uk/physics/research/nano/pdfs/N15ND05.pdf Nanotechnology.[12] Nanoelectronics:Nanotechnology in electronics. http://www.understandingnano.com

https://en.wikibooks.org/wiki/Nanotechnology