Trends in Commerce, Economics & Life Sciencess

कला, वाणिज्य व विज्ञान
कनिष्ठ व वरिष्ठ महाविद्यालय

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Dr. B. M. Dhoot

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Applications and Challenges of Nanotechnology

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Abstract:

This study gives a general review of this contemporary technology and assesses the possible benefits and predicted risks of its use. Engineered systems, gadgets, and structures are referred to as nanotechnology. The foundation of new technology is the study, creation, and application of these qualities. The technique promises to enhance science in a variety of fields, including medical, consumer goods, energy, materials, and production. Nanotechnology is the process of modifying matter at a size close to the atomic level to create novel structures, materials, and gadgets.

Keywords:
Nanometre, components, Renewable Resources, Nano-sphere, nanotechnology.

I. INTRODUCTION

A nanometre is one billionth of a metre, or 10 times the diameter of an atom of hydrogen. Building "objects" on the size of atoms and molecules is the focus of the study and innovation area of nanotechnology. These "things" are often materials and gadgets.

The present scientific knowledge at the nanometre scale comes from a variety of fields, starting with the atomic and molecular notions in physics and chemistry and progressing to include molecular biotechnology, medicine, and engineering. The scope of modern molecular biomedical research as a result includes molecular motors and other functional elements.[1] The capacity to regulate and selectively alter the characteristics of increasingly smaller amounts of matter in a functional fashion followed the observation and comprehension of atomic and molecular behaviour from basic principles. These early developments in self-assembly provide examples.[2] This resulted in the creation of modern synthetic and supramolecular chemicals,[3] Biomedical applications relate to man-made micro & nanoscale sensor devices that come from other fields of microscopy and device engineering. biomolecular and medical engineering, as well as the recently-emerging discipline of systems biology[4]

Surface effects, such as catalytic properties and moisture behaviour, were sometimes unexpectedly significant in materials made up of nanosized entities, such as nanoparticles, nanocomposite, and colloids because of the deviation of surface and interface properties from the bulk properties of larger amounts of materials.[5] The characteristics of surfaces of clusters of very tiny particles, notably those on the order of 1000 atoms or molecules and smaller, exhibit quantum mechanical principles with the creation of materials with novel and improved physical and/or chemical characteristics was made possible by the ever decreasing characteristic sizes of the domains or phases.[6] Gate oxides in devices are typically 25 nm thick in electronic engineering, and device downsizing has advanced well into the nanometer range. The availability of the initial real space pictures of atomic and molecular processes at surfaces through the development of electron microscopy microscopes has significantly improved public awareness of nanoscience in recent years.[7]

As nanotechnology advances, the potential for bottom-up manufacturing of nanoscale materials may lead to some form of self-assembly of structures that resemble biological membranes, such the self-assembly of phospholipid bilayers. The spontaneous generation of artificial life systems by modification and analogous processes, as postulated by several well-known commentators, is, nevertheless, thought to be exceedingly implausible based on present understanding. On the basis of present scientific understanding, it is highly challenging to attain self replication and self perpetuation in a designed nano-system.

II. The design and components of the nanosystem unit

Quantum dots:

Quantum dots are large atomic size structures that contain thousands of atoms. Nanotechnology was first developed using quantum mechanics. Quantum dots are semiconductor crystals that are so small they are nanoscale. Nanoscale materials behave in accordance with quantum rules. The most favoured quantum points because of their electrical, optical, and semiconducting characteristics are InGeAS, CdTe, PbS, PbSe, ZnS, CdSe, InAs, CdS, GaN. The excellent optical and electrical capabilities of quantum dots result from their tunable size, which also affects the wavelength and colour of their emission. The activation of electrons reveals the existence of quantum points.[8]

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• Nanospheres:

The term "nanospheres" refers to matrices with a particle size of 10–100 nm that are made of natural or synthetic polymers and contain the active chemical. The two types of polymeric nanoparticles are nanocapsules and nanospheres. The nanospheres' structure is seen in Figure 1. Nanospheres might be both crystalline and amorphous.[9] Due to its capabilities of incarceration, injection, and dispersion, it is highly beneficial.[10]

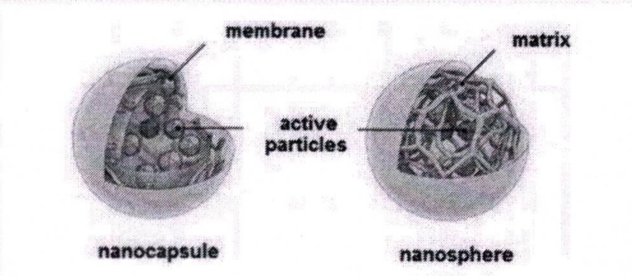

Fig1: structure of nano particle.

• Properties of Nanoscale Materials:

Due to the effectiveness of this strategy, which was first introduced decades ago with steel alloys, many technical materials are now composites with micro to nanoscale domain sizes. Material attributes depend on structure and composition, and they may often be designed or adjusted by altering the relative weights of macroscopic bulk qualities and interfacial or interphase properties by modifying the typical sizes and dimensions of components and domains. This behaviour is controlled by intricate procedures, which is directly related to the release of nanoparticles into the environment. Nanomaterials frequently exhibit selective chemical stability, which creates the possibility of the material disintegrating into one or more components. There is a complicated relationship between the structure and the composition of the material, depending on the physical or chemical characteristics of each domain, which may relate to the bulk and surface properties of each component as well as newly developing qualities localised at the interface.

• Engineered nanostructures and materials applications:

Nanotopographies offer significantly diverse adhesion, tribology, optics, and electrical behaviour features in surface science and surface engineering. New surface and size dependent chemistry, such as enantioselective catalysis at surfaces, has been made

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possible by supramolecular chemistry and catalysis. In materials science, nanomaterials with nanoscale dispersed phases and nanocrystalline materials are already in use.

These materials' very small grain sizes give them mechanical characteristics that are considerably different from those of normal microstructures. Advances in drug design and targeting in the biological sciences can be attributed to a basic knowledge of molecular motors and other molecular functional entities at the nanoscale. For analytical and instrumental applications in Engineering, biology, and medicine, among other fields, nanoscale functionalized entities and devices are currently being developed.

The fields of science and technology where nanoscale structures are being actively developed or are currently in use are listed below.

• **Medicine**

Drug delivery by functionalized nanostructures may lead to enhanced pharmacokinetic and targeting features, and medical research is leading to a better knowledge of the origin of illnesses on the nanometer scale.

• **Sustainable Energy from Renewable Resources**

The use of nanotechnology in the production of sustainable and renewable energy sources (like fuel cells and solar energy) may result in the development of more affordable and clean energy sources. As a result, both environmental and human health would be enhanced.

• **Electrical components of today**

Digital, electrical, and electronic instruments are the application fields where these nanoscience advancements are having the most of an influence. Fluorescence labelling, scanning electron microscopy, and confocal microscopy, for example, have enhanced characteristics and resolution as a result of the switch from semiconductor (conventional and organic) technologies to nanoscale devices. Nanostructure-based data storage devices offer more compact, quick, and energy-efficient systems.

• **Commercial Goods**

Consumer goods including cosmetics and sunscreens, fibres and textiles, dyes, fillers, paints, emulsions, and colloids all employ a range of functional nanoscale materials and useful nanoscale surfaces.

• **Pollution prevention**

For instance, tiny wastewater filters might sift pollutants from industrial plants, removing even the tiniest contaminants before they are discharged into the environment. Emissions from industrial combustion facilities might be cleaned using similar filters. Nanoparticles might also be used to clean up oil spills by separating the oil from sand, pebbles, and bird feathers that have been captured in the spill.

• Agriculture

The prospect of tracking infections on crops and animals as well as evaluating agricultural yield is made possible by tiny sensors. They are achieving this by modifying the genetic makeup of the crops, using biological molecules at the nanoscale. Researchers in both developed and developing nations are working to create crops that can thrive in "hostile" environments like fields with high salt content soil (often caused by climate change and increasing sea levels) or low water content soil. Nanoparticles may also increase the effectiveness of fertilisers.

• Hazards and Issues Regarding Potential Negative Impacts on Human and Environmental Health

Given that nanomaterials and other nanostructured materials have been produced by naturally occurring events, including volcanoes and fires, in the environment for a very long period, it would seem that there is no inherent risk connected with the nanoscale per itself for the population in its entirety. The use of the desired properties with nanoscale is based on a few discrete differences between those of the nanoscale and features of more conventional sizes, specifically the significantly higher surface area of nanoparticles compared to larger particles of the same volume or mass, and also quantum effects. It is reasonable to wonder whether these characteristics present any inherent risks to people or the environment. Since engineered nanostructures are being produced and generated in ever-increasing quantities in new materials, the increased exposure levels of both humans and environmental species, as well as the possible new routes by which awareness may occur with the current and anticipated applications, are the real concerns facing the assessment of risks associated with the nanoscale. Increased risk assessments are being demanded by a number of non-governmental entities, therefore the following features of nanotechnology have sparked concern:

- They could build up in the food chain.

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- "Grey goo": Nanotechnology-produced tiny robots could be able to reproduce themselves.
- Research into nanotechnology may advance faster than measures can be put in place to control its applications and uses if prompt action is not taken.
- It is impossible to anticipate the toxicity of a substance's nanoparticles from its bulk toxicity, such as the carcinogenicity of solid silver.
- It is possible for nanoparticles to linger and gather in the environment.
- The public hasn't participated enough in discussions on the regulation, usage, and uses of nanotechnology.
- Applications for developing nations will be ignored if the wealthy nations are the major proponents of nanotechnology development.

CONCLUSION:

Nanotechnology is touted as having the ability to improve energy efficiency, aid in environmental cleanup, and address significant health issues. It is said to be able to drastically cut expenses while greatly increasing industrial output. Nanotechnology will enable the creation of products that are more useful while also being smaller, cheaper, lighter, and using less energy and raw resources to produce.

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