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Innovation The Research Concept

Introduction to Nanotechnology & Its Applications

Abstract

Nanoscience is an interdisciplinary filed that seeks to bring about mature nanotechnology. Focusing on the nanoscale intersection of fields such as Physics, Biology, Engineering, Chemistry, Computer Science and more, nanoscience is rapidly expanding.

Nanotechnology is currently the subject of much interest and study. Many potential application have already been indentified such as in the field of Material Sciences, Cosmetics, Biomedical application, Agriculture, House cleaning products, Military technology, Chemicals and basic materials, Miniaturized super computers, Energy capture and storage technology, Pharmaceuticals and medical products, Bioelectronics, Nanoelectronics equipments, security system, Nano medicine, Food processing and storage, Environment and Nano sensing etc.

Thus Nanotechnology is expected to be one of the most important technologies of the century because it offers solutions to a variety of health and environmental problems.

Keywords: Nanotechnology Applications, Nanoscience, Nanomaterials, Nanoelectronics.

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Introduction

Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced. By convention nanotechnology is taken as the scale range 1 to 100nm.

One nanometer is one billion or 10^{-9} of a meter. By comparison typical Carbon-Carbon bond lengths or the spacing between there atoms in a molecule, are in the range 0.12-0.15 nm and a DNA double helix has a diameter around 2nm. Areas of physics such as nanoelectronics, nanomechanics, nanophotonics and nanoionics have evolved during the law few decades to provide a basic scientific foundation of nanotechnology.

Aim of the Study

Aim of present study on Nanotechnology is as follows:

1. Develop the National Capacity to identify, define and responsibly address concepts and challenges specific to the ethical, legal and societal implication of nanotechnology.
2. Promote awareness of and education about ELSI among relevant stackholders, including manufacturer, regulations, nongovernmental organizations, workers and the public.
3. Incorporate sustainability in the responsible development of nanotechnology.
4. Encourage the development of engineered and nanomaterials that are safer and more sustainable alternative is materials.
5. Promote the design and development of safe and environmentally begin manufacturing and end of life processes for engineered nanomaterials and nanotechnology enabled products.

Review of Literature

The concept that seeded nanotechnology were first discussed in 1959 by renowned physicist "Richard Fetnman". The term 'nanotechnology' was first used by Nario Taniguchi in 1974. Inpired by Feynman's concept K. Eric Drexier used the term 'nanotechnology' in his book 'Engines of creation: The coming Era of nanotechnology, in 1986.

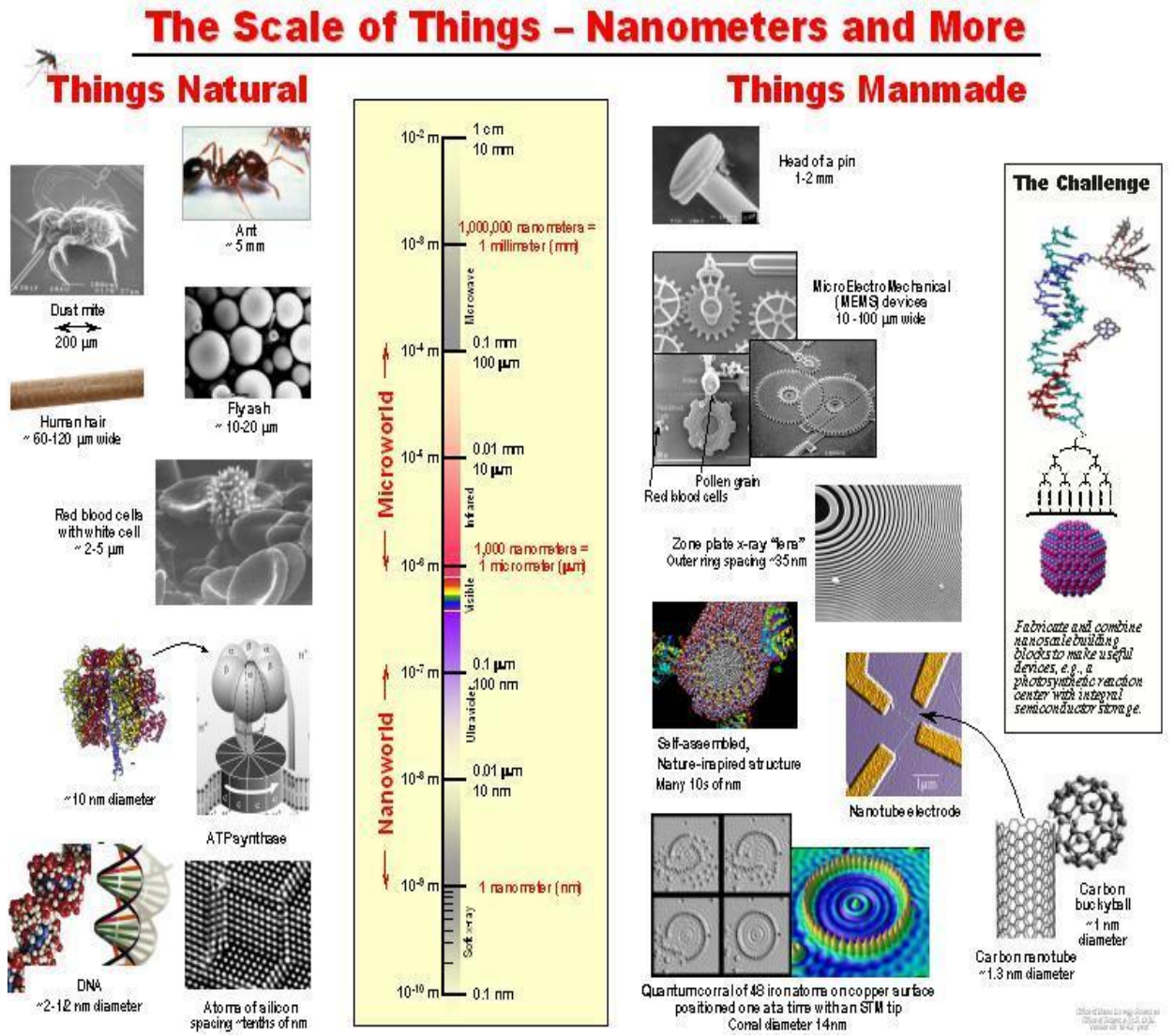
Two major breakthrough sparked the growth of nanotechnology in modern era.

First the invention of the scanning tunneling microscope in 1981 and was successfully used to manipulate individual atoms in 1989. Second, Fullerence were discovered in 1985 by Harvy Kroto. In the early 2000s the field garnered increased scientific, political and commercial attention that led to both controversy and progress. Mean while, commercialization of

products based on advancements in nano scale technologies began emerging. Government moved to promote the fund research into nanotechnology such as in the U.S. with the National Nanotechnology initiative. By the mid 2000s new and serious scientific attention began to flourish. Projects emerged to produce nanotechnology road maps which center on automatically precise manipulation of matter and discuss existing and projected capabilities, goals and applications.

Core Concept of Nanotechnology

Nanotechnology means, a technology that operates at the atomic, molecular or macro moleculars levels, in a length scale of 1-100 nanometers. As things approach the nanoscale, new properties emerge due to size confinement, quantum phenomenon and coulomb blockage. These new properties can be controlled to give us materials with new applications.



Nanoscale

Nanotechnology is the area of science and technology where very small structures play a critical role. Nanotechnology occurs at the order of nanometer (nm), that is from 0.1 nm to around 100nm . 1 Nanometer = $1x10^{-9}$m.

To put it another way a nanometer is about as wide as DNA molecule; 1/80,000 the diameter of an average human hair.

Nano Science

We define nanoscience as the study of phenomenon and manipulation of materials at atomic, molecular and macro molecular scales, where properties differ significantly from those at a largerscale; and nanotechnologies as the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanometer scale.

Nanoscience is a convergence of physics, chemistry, material science and biology, which deals with the manipulation and characterization of matter on length scales between the molecular and micron size Nanotechnology is an emerging engineering discipline that applies methods from nanoscience to create products.

What is Special about Nanoscience?

The laws of physics operate in unfamiliar ways on these length scales and this is important to

appreciate for two reasons. The peculiarities in behaviour imposed by nanoscale impose strong constraints on what is possible to design and make on this scale, But the very different behaviour of matter on the nanoscale also offers opportunities for structures and devices that operate on radically different principles.

For example- The importance of *quantum effects* could lead to highly novel computer architectures, quantum computing while the importance of *Brownian motion* and *surface forces* lead to an entirely different principles for constructing structure and devices.

Physics Operates at The Nanoscale Include

Quantum Mechanics

Quantum mechanics is essential to understand the behaviour of systems at atomic length scales and smaller. For Example: If Newtonian mechanics governed the working for an atoms, electrons would rapidly travel towards and collide with the nucleus, making stable atoms impossible. However, in the natural world the electrons normally remain in an unknown orbital path around the molecules, defying classical electromagnetism.

The quantum theory of the atom was developed as an explanation for the electrons staying in its orbital, which could not be explained by Newton's Laws of motion and by Maxwelles laws of classical electromagnetism.

Quantum mechanics is important for understanding how individual atoms combine covalently to form chemicals or molecules. The application of quantum mechanics to chemistry is known as quantum chemistry. Quantum mechanics can provide quantitative insight into ionic and covalent bonding processes by explicitly showing which molecules are energetically favorable to which others, and by approximately how much. Most of the calculations performed in computation chemistry rely on quantum mechanics.

Much of modern technology operates at a scale where quantum effects are significant. Examples include the laser, the transistors. The electromicroscope and magnetic resonance imaging. The study of semiconductors led to the invention of the diode and the transistors which are indispensable for modern electronics.

Nanomaterials

Material that consists of or contain nanoparticles and can offer improved properties such as lower weight or higher strength.

Nanomaterials can be classified as-

One Dimensional Nanomaterials

Such as thin films and engineered surfaces have been developed and used for decades in fields such as electronics devices manufacturing, chemistry and engineering.

Two Dimensional Nanomaterials

Two dimensional nanomaterials such as tubes and wires have generated considerable interest among the scientific community in recent years.

Three Dimensional Nanomaterials

For ex. Fullerence (carbon 60), Dendrimers, Quantum Dot etc.

Construction

There are two types of constructions-

1. Top-down
2. Bottom-up

Top-down

From top to down, mechanism and structures are miniaturized to a nanometric scale. This has been the most frequent application of nanotechnology up to this point, in particular in the domain of electronics where miniaturization is dominant.

Bottom-up

From bottom to top, we begin with a nanometric structure as a molecule and through a process of assembly we create mechanism longer than that with which we began. There is less wastage with this technique however this technique is limited in how big the structures can be made.

Application of Nanotechnology

In the Field Medicine

1. Nano decvices are small enough to enter cells.
2. Nano devices can make cancer tests faster and more efficient.
3. Nano devices can improve sensitivity.

Energy

1. Cost competitive fuel cells for automotive applications.
2. Thin film photovoltaics for cost effective solar energy.
3. Higher power: Super Capacitors.

Chemicals and Basic Materials

1. Nano-composite polymers for structural and electronic applications.
2. High efficiency and Novel catalysis.

In the Field of Security

1. Emerging nanotechnologies are expected to play a critical role in helping to maintain national security.
2. Another one of great importance to national security is that of protecting information systems from attack.
3. The other area of great importance to national security is that of protecting our troops.

Some Other Applications

1. Cosmetics
2. Food processing and storage
3. Air pollution and control
4. Water treatment and Remediation
5. Cosmetics
6. Agricultural productivity enrichment
7. Ambient sensor systems
8. Bullet Proof
9. Blind sight

Conclusion

Nanotechnology is one of the most important technologies of this century. Moreover new nanomaterials and nanodevices will have major impact in different fields of development of century. This has great potential for producing improvement and innovations in many areas of life, not least of which would be new and improved health treatments, reduced use of some harmful or scare resources cleaner, faster and safer manufacturing, quicker and smaller devices, increased life cycle of products etc.

This would help in the field of health, IT and communication and consumer goods.

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