Nanotechnology and Its Importance In The Present Day Technologies

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ABSTRACT:

Nanotechnology means creating or developing small, compatible compounds which can practically exist anywhere. The two methods Top-down approach and Bottom-up approaches are very interesting. Also, the applications of nanotechnology in the field of Electronics, Food, Fuel cells, Solar cells, Better air quality, Cleaner water, Chemical sensors, Sporting goods, Fabric and Nano medicine also proof to us that a better scientific world is just ahead of us and we just need to extend our struggle a little bit to understand it. There's an unprecedented multidisciplinary convergence of scientists dedicated to the study of a world so small, we can't see it even with a light microscope. That world is the field of nanotechnology, the realm of atoms and nanostructures. Nanotechnology is so new; no one is really sure what will come of it. Even so, predictions range from the ability to reproduce things like diamonds and food to the world being devoured by self-replicating nanorobots.

Key words: Nanotechnology Top-down approach Bottom-up approaches applications of nanotechnology

I. INTRODUCTION:

Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced.

In order to understand the unusual world of nanotechnology, we need to get an idea of the units of measure involved. A centimeter is one-hundredth of a meter, a millimeter is one-thousandth of a meter, and a micrometer is one-millionth of a meter, but all of these are still huge compared to the nanoscale. A nanometer (nm) is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the width of a human hair. As small as a nanometer is, it's still large compared to the atomic scale. An atom has a diameter of about 0.1 nm. An atom's nucleus is much smaller -- about 0.00001 nm. Atoms are the building blocks for all matter in our universe. You and everything around you are made of atoms. Nature has perfected the science of manufacturing matter molecularly. For instance, our bodies are assembled in a specific manner from millions of living cells. Cells are nature's nanomachines. At the atomic scale, elements are at their most basic level. On the nanoscale, we can potentially put these atoms together to make almost anything.

In its original sense, 'nanotechnology' refers to the projected ability to construct items *from the bottom up*, using techniques and tools being developed today to make complete, high performance products.

II. FOUR GENERATIONS PRODUCTS:

Mihail (Mike) Roco of the U.S. National Nanotechnology Initiative has described *four generations* of nanotechnology development. The current era, as Roco depicts it, is that of passive nanostructures, materials designed to perform one task. The second phase, which we are just entering, introduces active nanostructures for multitasking; for example, actuators, drug delivery devices, and sensors. The third generation is expected to begin emerging around 2010 and will feature nanosystems with thousands of interacting components. A few years after that, the first integrated nanosystems, functioning (according to Roco) much like a mammalian cell with hierarchical systems within systems, are expected to be developed.

- Ist generation products:

These are the Passive nanostructures like

a. Dispersed and contact nanostructures. Ex: aerosols, colloids

b. Products incorporating nanostructures. Ex: coatings, nanoparticle reinforced composites, nanostructured metals, polymers, ceramics.

- 2nd generation products:

These are the Active nanostructures like

a. Bio-active, health effects. Ex: targeted drugs, biodevices

b. Physico-chemical active Ex: 3D transistors, amplifiers, actuators, adaptive structures.

- 3rd generation products:

These are the Systems of nanosystems like Guided assembling; 3D networking and new hierarchical architectures, robotics, evolutionary.

- 4th generation products:

These are the Molecular nanosystems like molecular devices by design, atomic design, emerging functions.

Nanotechnology is sometimes referred to as a *general-purpose technology*. That's because in its advanced form it will have significant impact on almost all industries and all areas of society. It will offer better built, longer lasting, cleaner, safer, and smarter products for the home, for communications, for medicine, for transportation, for agriculture, and for industry in general. Nanotechnology is the engineering of functional systems at the molecular scale. In its original sense, 'nanotechnology' refers to the projected ability to construct items from the

 ISBN : 978-93-87793-30-2

bottom up, using techniques and tools being developed today to make complete, high performance products. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macro scale products, also now referred to as molecular nanotechnology. A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. This definition reflects the fact that quantum mechanical effects are important at this quantum-realm scale, and so the definition shifted from a particular technological goal to a research category inclusive of all types of research and technologies that deal with the special properties of matter that occur below the given size threshold. It is therefore common to see the plural form "nanotechnologies" as well as "nanoscale technologies" to refer to the broad range of research and applications whose common trait is size.

Small is Good because:

- Faster
- Lighter
- Can get into small spaces
- Cheaper
- More energy efficient
- Different properties for very small structures

For Example:The melting point of gold decreases rapidly as the particle dimension
reaches the nanometer scale.
The properties of materials/structures be different at the nanoscale
Two of the reasons:
1. Ratio of surface area-to-volume of structure increases (most atoms are at or near the surface, which make them more weakly bonded and more reactive)
2. Quantum mechanical effects are important (size of structure is on same scale as the wavelengths of electrons, and quantum confinement occurs resulting in changes in electronic and optical properties)
To build something so small
-“Top-down” – building something by starting with a larger component and carving away material (like a sculpture). In nanotechnology: patterning (using photolithography) and etching away material, as in building integrated circuits.
-“Bottom-up” – building something by assembling smaller components (like building a car engine). In nanotechnology: self-assembly of atoms and molecules, as in chemical and biological systems.

Bottom-up approaches:

These seek to arrange smaller components into more complex assemblies.

- DNA nanotechnology utilizes the specificity of Watson–Crick basepairing to construct well-defined structures out of DNA and other nucleic.
- Approaches from the field of "classical" chemical synthesis (inorganic and organic synthesis) also aim at designing molecules with well-defined shape (e.g. bis-peptides).
- More generally, molecular self-assembly seeks to use concepts of supramolecular chemistry, and molecular recognition in particular, to cause single-molecule components to automatically arrange themselves into some useful conformation.
- Atomic force microscope tips can be used as a nanoscale "write head" to deposit a chemical upon a surface in a desired pattern in a process called dip pen nanolithography. This technique fits into the larger subfield of nanolithography.

Top-down approaches:

These seek to create smaller devices by using larger ones to direct their assembly.

- Many technologies that descended from conventional solid-state silicon methods for fabricating microprocessors are now capable of creating features smaller than 100 nm, falling under the definition of nanotechnology. Giant magneto resistance-based hard drives already on the market fit this description, as do atomic layer deposition (ALD) techniques. Peter Grünberg and Albert Fert received the Nobel Prize in Physics in 2007 for their discovery of Giant magnetoresistance and contributions to the field of spintronics.
- Solid-state techniques can also be used to create devices known as nanoelectromechanical systems or NEMS, which are related tomicroelectromechanical systems or MEMS.
- Focused ion beams can directly remove material, or even deposit material when suitable pre-cursor gasses are applied at the same time. For example, this technique is used routinely to create sub-100 nm sections of material for analysis in Transmission electron microscopy.
- Atomic force microscope tips can be used as a nanoscale "write head" to deposit a resist, which is then followed by an etching process to remove material in a top-down method.

III. APPLICATIONS OF NANOTECHNOLOGY:

- ❖ Supercomputer in your palm, perhaps made from silicon nanowires, carbon nanotubes, or organic materials such as DNA.
- ❖ Very tiny motors, pumps, gyroscopes, and accelerometers; helicopters the size of flies or smaller.
- ❖ Tiny bio- and chemical-sensors; nanoparticles that track and destroy cancer cells; artificial body parts and implantable drug delivery systems.

- Energy storage (batteries) and conversion (solar cells) using nanowires and nanotubes.
- Enhanced consumer products using nano- whiskers, nanoparticles, and nanotubes for stain and wrinkle resistant clothes, transparent zinc oxide sunscreen, fast-absorbing drugs and nutrients, extra-strong tennis racquets, and scratch-resistant paint.

- Electronics

Nanotechnology holds some answers for how we might increase the capabilities of electronics devices while we reduce their weight and power consumption. Check out our Nanotechnology Applications in Electronics page to see how nanotechnology is being used in electronics.

- Food

Nanotechnology is having an impact on several aspects of food science, from how food is grown to how it is packaged. Companies are developing nanomaterials that will make a difference not only in the taste of food, but also in food safety, and the health benefits that food delivers

- ***Fuel Cells***

Nanotechnology is being used to reduce the cost of catalysts used in fuel cells to produce hydrogen ions from fuel such as methanol and to improve the efficiency of membranes used in fuel cells to separate hydrogen ions from other gases such as oxygen.

- ***Solar Cells***

Companies have developed nanotech solar cells that can be manufactured at significantly lower cost than conventional solar cells.

- ***Batteries***

Companies are currently developing batteries using nanomaterials. One such battery will be a good as new after sitting on the shelf for decades. Another battery can be recharged significantly faster than conventional batteries.

- ***Space***

Nanotechnology may hold the key to making space-flight more practical. Advancements in nanomaterials make lightweight spacecraft and a cable for the space elevator possible. By significantly reducing the amount of rocket fuel required, these advances could lower the cost of reaching orbit and traveling in space.

➢ ***Fuels***

Nanotechnology can address the shortage of fossil fuels such as diesel and gasoline by making the production of fuels from low grade raw materials economical, increasing the mileage of engines, and making the production of fuels from normal raw materials more efficient.

➢ ***Better Air Quality***

Nanotechnology can improve the performance of catalysts used to transform vapors escaping from cars or industrial plants into harmless gasses. That's because catalysts made from nanoparticles have a greater surface area to interact with the reacting chemicals than catalysts made from larger particles. The larger surface area allows more chemicals to interact with the catalyst simultaneously, which makes the catalyst more effective.

➢ Cleaner Water

Nanotechnology is being used to develop solutions to three very different problems in water quality. One challenge is the removal of industrial wastes, such as a cleaning solvent called TCE, from groundwater. Nanoparticles can be used to convert the contaminating chemical through a chemical reaction to make it harmless. Studies have shown that this method can be used successfully to reach contaminates dispersed in underground ponds and at much lower cost than methods which require pumping the water out of the ground for treatment.

➢ ***Chemical Sensors***

Nanotechnology can enable sensors to detect very small amounts of chemical vapors. Various types of detecting elements, such as carbon nanotubes, zinc oxide nanowires or palladium nanoparticles can be used in nanotechnology-based sensors. Because of the small size of nanotubes, nanowires, or nanoparticles, a few gas molecules are sufficient to change the electrical properties of the sensing elements. This allows the detection of a very low concentration of chemical vapors.

➢ ***Sporting Goods***

If you're a tennis or golf fan, you'll be glad to hear that even sporting goods has wandered into the nano realm. Current nanotechnology applications in the sports arena include increasing the strength of tennis racquets, filling any imperfections in club shaft materials and reducing the rate at which air leaks from tennis balls.

➢ ***Fabric***

Making composite fabric with nano-sized particles or fibers allows improvement of fabric properties without a significant increase in weight, thickness, or stiffness as might have been the case with previously-used techniques.

 ISBN : 978-93-87793-30-2

➢ **NANOTECHNOLOGY IN MEDICINE - NANOMEDICINE**

The use of nanotechnology in medicine offers some exciting possibilities. Some techniques are only imagined, while others are at various stages of testing, or actually being used today. Nanotechnology in medicine involves applications of nanoparticles currently under development, as well as longer range research that involves the use of manufactured nano-robots to make repairs at the cellular level, sometimes referred to as nanomedicine

IV. CONCLUSION:

Though all these advantages, applications and many other interesting features are appearing to be possible with this Nanotechnology, yet scientists are trying to find a safe way so that, this technology will not be harmful to the environment in which we live. This still needs to be developed, but once developed this will definitely rule out the others.

The key features in this field are:

- combining different sciences and technologies
- enhanced or new properties
- new applications
- all at very small dimensions.
- And we now have sophisticated tools to build, characterize and utilize structures at the nanoscale, across a breadth of disciplines.
- But we must also be aware of possible consequences