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NANO TECHNOLOGY & ITS APPLICATIONS

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ABSTRACT

A basic definition of Nanotechnology is the study manipulation and manufacture of extremely minute machines or devices. These devices are so small to the point of manipulating the atoms themselves to form materials. By this Nanotechnology we can make computers billions of times more full than today's and new medical capabilities that will heal and cure in cases that are now viewed as utterly hopelessly. The properties of manufactured products depend on how those atoms are arranged. Self replication make a effective route to truly low cost manufacturing. Artificial systems able to make a wide range of nonbiological products like diamond under programmatic control are likely to be more brittle and less adaptable in their response to changes in their environment than biological systems. At the same time they should be simpler and easier to design. Thus the progress of technology around the world has already given us more precise, less expensive manufacturing technologies that can make an unprecedented diversity of new products. Everything requires the computer is a major reason why people should research and develop Nanotechnology.

I. INTRODUCTION

The emerging fields of nanoscience and nanoengineering are leading to unprecedented understanding and control over the fundamental building blocks of all physical matter. This is likely to change the way almost everything from vaccines to computers to automobile tires to objects not yet imagined is designed and made.

The word "Nano" means dwarf in Greek language. Use it as a prefix for any unit like a second or a meter and it means a billionth of that unit. A nanosecond is one billionth of a second. And a nanometer is one billionth of a meter about the length of a few atoms lined up shoulder to shoulder. A world of things is built up from the tiny scale of nanometers. The thousands of cellular proteins and enzymes that constitute eg., The human bodies are a few nanometers thick. Enzymes typically are constructions of thousands of atoms in precise molecular structures that span some tens of nanometers. That kind of natural nanotechnology is about ten times smaller than some of the smallest synthetic nanotechnology that has been prepared until now. The individual components of an Intel Pentium III microprocessor span about 200 nanometers. This is the reason that computing is so powerful and easy these days. Nanotechnology makes microelectronics to be mere hints of what will come from engineering that begins on the even smaller scales of nanostructures.

II. NANOTECHNOLOGY

Nanotechnology, or, as it is sometimes called, *molecular manufacturing* , is a branch of engineering that deals with the design and manufacture of extremely small electronic circuits and mechanical devices built at the molecular level of matter. The Institute of Nanotechnology in the U.K. expresses it as "science and technology where dimensions and tolerances in the range of 0.1 nanometer (nm) to 100 nm play a critical role." Nanotechnology is often discussed together with micro-electromechanical systems (MEMS), a subject that usually includes nanotechnology but may also include technologies higher than the molecular level.

There is a limit to the number of components that can be fabricated onto a semiconductor wafer or "chip.". Traditionally, circuits have been etched onto chips by removing material in small regions. However, it is also possible in theory to build chips up, one atom at a time, to obtain devices much smaller than those that can be manufactured by etching. With this approach, there would be no superfluous atoms; every particle would have a purpose. Electrical conductors, called nanowire s, would be only one atom thick. A logic gate would require only a few atoms. A data bit could be represented by the presence or absence of a single electron.

Two concepts associated with nanotechnology are positional assembly and self-replication. Positional assembly deals with the mechanics of moving molecular pieces into their proper relational places and keeping them there. *Molecular robots* are devices that do the positional assembly. Self-replication deals with the problem of multiplying the positional arrangements in some automatic way, both in building the manufacturing device and in building the manufactured product.

2.1 Nanoparticles

A nanoparticle (or nanopowder or nanocluster or nanocrystal) is a microscopic particle with at least one dimension less than 100 nm. Nanoparticle research is currently an area of intense scientific research, due to a wide variety of potential applications in biomedical, optical, and electronic fields.

Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale this is often not the case. Size-dependent properties are observed such as quantum confinement in semiconductor particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials. The properties of materials change as their size approaches the nanoscale and as the percentage of atoms at the surface of a material becomes significant.

For bulk materials larger than one micrometre the percentage of atoms at the surface is minuscule relative to the total number of atoms of the material. The interesting and sometimes unexpected properties of nanoparticles are not partly due to the aspects of the surface of the material dominating the properties in lieu of the bulk properties. Nanoparticles exhibit a number of special properties relative to bulk material.

For example, the bending of bulk copper (wire, ribbon, etc.) occurs with movement of copper atoms/clusters at about the 50 nm scale. Copper nanoparticles smaller than 50 nm are considered super hard materials that do not exhibit the same malleability and ductility as bulk copper.The change in properties is not always desirable. Ferroelectric materials smaller than 10 nm can switch their magnetisation direction using room temperature thermal energy, thus making them useless for memory storage.

Suspensions of nanoparticles are possible because the interaction of the particle surface with the solvent is strong enough to overcome differences in density, which usually result in a material either sinking or floating in a liquid. Nanoparticles often have unexpected visible properties because they are small enough to confine their electrons and produce quantum effects.

For example gold nanoparticles appear deep red to black in solution. Nanoparticles have a very high surface area to volume ratio. This provides a tremendous driving force for diffusion, especially at elevated temperatures. Sintering can take place at lower temperatures, over shorter time scales than for larger particles. This theoretically does not affect the density of the final product, though flow difficulties and the tendency of nanoparticles to agglomerate complicates matters. The large surface area to volume ratio also reduces the incipient melting temperature of nanoparticles.

2.2 Properties of Nanoparticles

Nanoparticles are important scientific tools that have been and are being explored in various biotechnological, pharmacological and pure technological uses. They are a link between bulk materials and atomic or molecular structures.

While bulk materials have constant physical properties regardless of its size, among nanoparticles the size often dictates the physical and chemical properties. Thus, the properties of materials change as their size approaches the nanoscale and as the percentage of atoms at the surface of a material becomes significant.

For bulk materials, those larger than one micrometer (or micron), the percentage of atoms at the surface is insignificant in relation to the number of atoms in the bulk of the material.

2.3 Physical Properties of Nanoparticles

Nanoparticles are unique because of their large surface area and this dominates the contributions made by the small bulk of the material. Zinc oxide particles have been found to have superior UV blocking properties compared to its bulk substitute. This is one of the reasons why it is often used in the preparation of sunscreen lotions.

2.3.1 Other Examples of the Physical Properties of Nanoparticles

- Color – Nanoparticles of yellow gold and gray silicon are red in color
- Gold nanoparticles melt at much lower temperatures (~300 °C for 2.5 nm size) than the gold slabs (1064 °C)
- Absorption of solar radiation in photovoltaic cells is much higher in nanoparticles than it is in thin films of continuous sheets of bulk material - since the particles are smaller, they absorb greater amount of solar radiation

2.4. Optical Properties of Nanoparticles

Nanoparticles also often possess unexpected optical properties as they are small enough to confine their electrons and produce quantum effects. One example of this is that gold nanoparticles appear deep red to black in solution.

2.4.1 Formation of Suspensions

An important physical property of nanoparticles is their ability to form suspensions. This is possible since the interaction of the particle surface with the solvent is strong enough to overcome density differences. In bulk materials this interactions usually result in a material either sinking or floating in a liquid.

2.4.2 Magnetization and Other Properties of Nanoparticles

Other properties unique among nanoparticles are quantum confinement in semiconductor particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials.

2.4.3 Related Stories

- Researchers demonstrate new way to reduce preterm birth using nanoparticles.
- New molecular delivery system could help ensure delivery of chemotherapy drugs into tumours.
- Experimental nanoparticle therapy shows promise for fighting primary liver cancer.

For example, ferroelectric materials smaller than 10 nm can switch their magnetisation direction using room temperature thermal energy, thus making them unsuitable for memory storage. Thus this property is not always desired in nanoparticles.

2.5 Diffusion Properties of Nanoparticles

At elevated temperatures especially, nanoparticles possess the property of diffusion. Sintering can take place at lower temperatures, over shorter time scales than for larger particles. Although this does not affect the density of the final product but there is a chance of agglomeration.

2.5.1 Hard Nano Particles

Clay nano particles, when incorporated into polymer matrices, increase reinforcement, leading to stronger plastics. These nano particles are hard, and impart their properties to the polymer (plastic). Nano particles have also been attached to textile fibers in order to create smart and functional clothing.

2.5.2 Semisolid Or Soft Nanoparticles

Semi-solid and soft nanoparticles have been manufactured. Of these notable is the liposome. Various types of liposome nanoparticles are currently used clinically as delivery systems for anticancer drugs, antibiotics and antifungal drugs and vaccines.

2.5.3 Dimensionality

Nanoparticles are generally classified based on their dimensionality, morphology, composition, uniformity, and agglomeration.

- 1D nanomaterials

These are one dimensional in the nanometer scale are typically thin films or surface coatings, and include the circuitry of computer chips and the antireflection and hard coatings on eyeglasses. These have been used in electronics, chemistry, and engineering.

- 2D nanomaterials

Two-dimensional nanomaterials have two dimensions in the nanometer scale. These include 2D nanostructured films, with nanostructures firmly attached to a substrate, or nanopore filters used for small particle separation and filtration. Asbestos fibers are an example of 2D nanoparticles.

- 3D nanomaterials

Materials that are nanoscaled in all three dimensions are considered 3D nanomaterials. These include thin films deposited under conditions that generate atomic-scale porosity, colloids, and free nanoparticles with various morphologies.

III. NANOTECHNOLOGY APPLICATIONS

The Understanding Nanotechnology is dedicated to providing clear and concise explanations of nanotechnology applications. Scan the listings below to find an application of interest, or use the navigation bar above to go directly to the page discussing an application of interest.

3.1 Medicine

Researchers are developing customized nanoparticles the size of molecules that can deliver drugs directly to diseased cells in your body. When it's perfected, this method should greatly reduce the damage treatment such as chemotherapy does to a patient's healthy cells.

3.2 Electronics

Nanotechnology holds some answers for how we might increase the capabilities of electronics devices while we reduce their weight and power consumption.

3.3 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.

3.4 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.

3.5 Solar Cells

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

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14. Application of Nano in Human

Diseases such as diabetes, cancer, multiple sclerosis and Alzheimer's pose a **tremendous challenge to modern medicine.** Societies are ageing around the world, yet today's elders wish to remain active and healthy, and live useful lives for as long as possible.

Nanomedicine, the application of nanotechnology to human healthcare, offers numerous potential pathways to improving medical diagnosis and therapy and even to regenerate tissues and organs. It can provide personalised yet more affordable healthcare while at the same time offering an improved quality of life for everyone.

3.14.1. Future Application

Nanotechnology is the technology of the 21st century. It is similar to the time when the semiconductor industry began many years back in our history. It is also similar to time when biotechnology started during the last century. In the case of nanotechnology, its potential applications is a combination of both semiconductor and biotechnology. Nanotechnology is not an independent technology just like molecular biology. Nanomaterials are independently synthesized using the basic sciences such as chemistry, physics and, for some nanoparticles, biology (with the use of bacteria and plants). Nanotechnology which involves the applications of nanomaterials, involves basic and applied sciences and engineering. For instance, some nanomaterials are now and will in the future be used in the semiconductor industry; they are being used and will be use to improve IC manufacturing. Some are now being used and in the future more nanomaterials will be used for medicine, molecular biology, food monitoring, bar coding, threat agents monitoring, counterfeit money monitoring, disinfection, environmental monitoring, paints and coating, catalysts for various reactions, agriculture improvements, etc. There are currently and enormous amount of work before we can harness the good things that can come out of nanotechnology which is still in its infancy stages of development. Give it five more years and a lot more of its commercial products will be available in the market for commercial use.

In the future, we could imagine a world where medical nanodevices are routinely implanted or even injected into the bloodstream to monitor health and to automatically participate in the repair of systems that deviate from the normal pattern. The continued advancement in the field of biomedical nanotechnology is the establishment and collaboration of research groups in complementary fields. Such collaborations have to be maintained not only on specialty field level but also internationally. The successful development and implementation of international collaborations fosters a global perspective on research and brings together the benefits to mankind in general. However, nanotechnology in medicine faces enormous technical hurdles in that long delays and numerous failures are inevitable. This is because the effort needed to produce nanoscale biomedical or therapeutic devices is highly interdisciplinary. As we have seen, it touches on numerous established disciplines, encompassing elements of physiology, biotechnology, chemistry, electrical engineering, and materials science, to name just a few of the fields involved. Obviously, this broad sweep of knowledge is difficult for any one investigator to master fully. The breadth of the effort constitutes just one of the major barriers to entry in the field. Other challenges include inadequate funding, the raw complexity of biology, the fashion in which biologists hold and distribute information, and cultural differences between engineers and biological scientists. Likewise, it should not be taken for granted the dangers and negative consequences of nanobiotechnology when applied in warfare, in the hands of terrorists and disasters associated with its application in energy generation when and wherever it strikes, or the risks associated with nanoparticles in blood circulation. It should be appreciated that nanotechnology is not in itself a single emerging scientific discipline but rather a meeting point of traditional sciences like chemistry, physics, biology, and materials science to bring together the required collective knowledge and expertise required for the development of these novel technologies.

3.14.2 Advantages & Disadvantages of Nanotechnology

Understanding, shaping and combining matter at the atomic and molecular scale is called nanotechnology. Nanotechnology encompasses science, medicine, engineering, computing and robotics at this scale, called the nanoscale. Nanotechnology offers the potential for new and faster kinds of computers, more efficient power sources and life-saving medical treatments. Potential disadvantages include economic disruption and possible threats to security, privacy, health and the environment.

3.14.2.1 Manufacturing Advantages

Nanotechnology is already making new materials available that could revolutionize many areas of manufacturing. For example, nanotubes and nano particles, which are tubes and particles only a few atoms across, and aerogels, materials composed of very light and strong materials with remarkable insulating properties, could pave the way for new techniques and superior products. In addition, robots that are only a few nanometers in length, called nanobots, and nanofactories could help construct novel materials and objects.

3.14.2.2 Energy Advantages

Nanotechnology may transform the ways in which we obtain and use energy. In particular, it's likely that nanotechnology will make solar power more economical by reducing the cost of constructing solar panels and related equipment. Energy storage devices will become more efficient as a result. Nanotechnology will also open up new methods of generating and storing energy.

3.14.2.3 Advantages in Electronics and Computing

The field of electronics is set to be revolutionized by nanotechnology. Quantum dots, for example, are tiny light-producing cells that could be used for illumination or for purposes such as display screens. Silicon chips can already contain millions of components, but the technology is reaching its limit; at a certain point, circuits become so small that if a molecule is out of place the circuit won't work properly. Nanotechnology will allow circuits to be constructed very accurately on an atomic level.

3.14.2.4 Medical Advantages

Nanotechnology has the potential to bring major advances in medicine. Nanobots could be sent into a patient's arteries to clear away blockages. Surgeries could become much faster and more accurate. Injuries could be repaired cell-by-cell. It may even become possible to heal genetic conditions by fixing the damaged genes. Nanotechnology could also be used to refine drug production, tailoring drugs at a molecular level to make them more effective and reduce side effects.

3.14.2.5 Environmental Effects

Some of the more extravagant negative future scenarios have been debunked by experts in nanotechnology. For example: the so-called "gray goo" scenario, where self-replicating nanobots consume everything around them to make copies of themselves, was once widely discussed but is no longer considered to be a credible threat. It is possible, however, that there will be some negative effects on the environment as potential new toxins and pollutants may be created by nanotechnology.

3.14.2.6 Economic Upheaval

It is likely that nanotechnology, like other technologies before it, will cause major changes in many economic areas. Although products made possible by nanotechnology will initially be expensive luxury or specialist items, once availability increases, more and more markets will feel the impact. Some technologies and materials may become obsolete, leading to companies specializing in those areas going out of business. Changes in manufacturing processes brought about by nanotechnology may result in job losses.

3.14.2.7. Privacy and Security

Nanotechnology raises the possibility of microscopic recording devices, which would be virtually undetectable. More seriously, it is possible that nanotechnology could be weaponized. Atomic weapons would be easier to create and novel weapons might also be developed. One possibility is the so-called "smart bullet," a computerized bullet that could be controlled and aimed very accurately. These developments may prove a boon for the military; but if they fell into the wrong hands, the consequences would be dire.

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IV. FIGURES AND TABLES

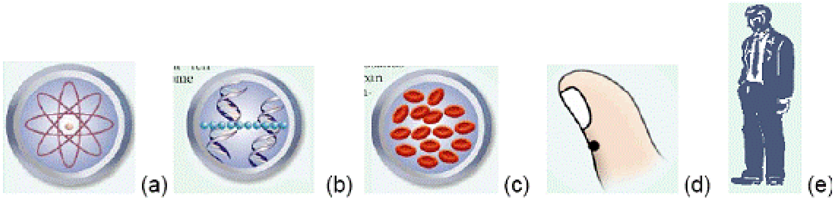

Figure 4.1: The whole size issue; (a) Less than a nanometre- individual atoms are up to a few angstroms, or upto a few tenths of a nanometer in diameter; (b) Nanometer- Ten shoulder-to-shoulder hydrogen atoms (blue balls) span 1 nm. DNA molecules are about 2.5 nm wide; (c) Thousands of nanometers- Biological cells, like these red blood cells, have diameters in the range of thousands of nm; (d) a million nanometers- A pinhead sized patch of this thumb (black point) is a million nanometers across; (e) Billions of nanometers-a two meter tall person is two billion nanometers tall.

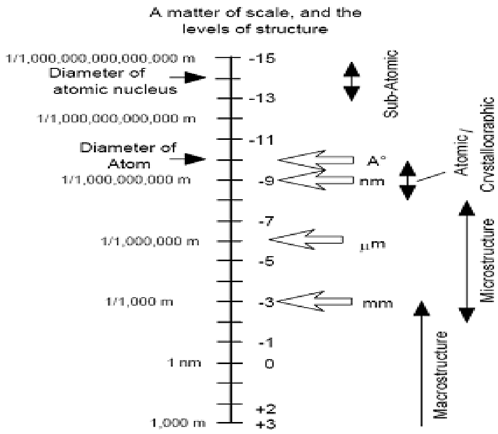

Figure 4.2 Logarithmic Length

Nanostructure science and technology is a broad and interdisciplinary area of research and development activity that has been growing explosively worldwide in the past few years. It has the potential for revolutionizing the ways in which materials and products are created and the range and nature of functionalities that can be accessed. It is already having a significant commercial impact, which will assuredly increase in the future.

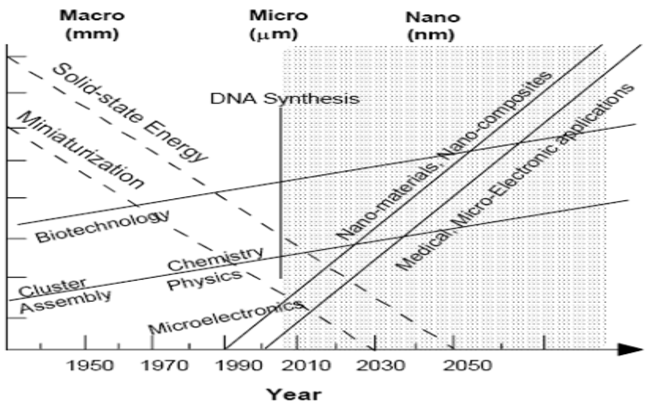

Figure 4.3: Evolution of science & technology and the future.

When used as a prefix for something other than a unit of measure (as in "nanoscience"), **nano** refers to nanotechnology, or on a scale of nanometres. See nanoscopic scale.

SI prefixes							
Prefix		**1000^m**	**10^n**	**Decimal**	**English word**		**Adoption** [nb 1]
Name	**Symbol**				**Short scale**	**Long scale**	
micro	μ	1000^{-2}	10^{-6}	0.000001	millionth	1960 (1873)	micro
nano	n	1000^{-3}	10^{-9}	0.000000001	billionth	thousand millionth	**nano**
pico	p	1000^{-4}	10^{-12}	0.000000000001	trillionth	billionth	pico

Table 4.1 Nanoscopic Scale

V. CONCLUSION

As a conclusion to this topic that, Nanotechnology is a brand new technology that has just began, it is a revolutionary science that will change all what we knew before. The future that we were watching just in science fiction movies will in the near future be real. This new technology will first of all, keep us healthy because of nanorobots that will repair every damage that we have in our body. Secondly it will give scientists the ability to manipulate the combination of atoms in an object and to turn it into a lighter, stronger, and more durable object than before, just by using carbon nanotubes that are known to be a hundred times stronger than steel and in addition to that they are very flexible. Thirdly, Nanotechnology will give us an abundant energy because it will transform energy more effectively, for example windmills which are known to have the ability to transform wind energy into electrical energy, well new windmills that will use Nanotechnology will have lighter and stronger blades (using carbon nanotubes) that will transform a lot more energy than before. Nanotechnology covers a lot of domains today and will cover a lot more in the near future.

REFERENCES

(1) Wong, H.S. Philip (2006, March). *Nanoelectronics – Opportunities and Challenges. International Journal of High Speed Electronics and Systems. Vol. 16, Issue 1, p. 83, 12p.*

(2) Yamaguchi, Tomohiko; Epstein, Irving; Shimomura, Masatsugu; & Kunitake, *Toyoki (2005, December). Vol. 15, Issue 4, p. N, 3 p.*

(3) Nanotechnology at UT Austin (2007). *Graduate Portfolio Program. Retrieved 6/27/2007 from http://www.cnm.utexas.edu/graduateportfolio.html*