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NANO TECHNOLOGY

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ABSTRACT

A nano meter is a unit of length in the metric system, equal to one billionth of a meter (10^{-9}). A nanometer is a billionth of a meter, that is, about 1/80,000 of the diameter of a human hair, or 10 times the diameter of a hydrogen atom. Nanotechnology is now used in precision engineering, new materials development as well as in electronics; electromechanical systems as well as mainstream biomedical applications in areas such as gene therapy, drug delivery and novel drug discovery techniques. This book presents carefully selected abstracts of the last 5 years in this frontier field. Special access is providing by author, title and subject indexes.

1. INTRODUCTION

Nanotechnology is engineering and not a science, the main feature of nanotechnology is that it can build any chemically stable structure that is allowed by the laws of physics. The theoretical models and computational models point out the possibility of molecular producing systems and they do not break the existing physical laws, the nanotechnology is generally called as the science of small and it is related to the manipulation of the particles at the atomic level. At the time of designing the Nano device, the scientist should know the parameters like size, shape and power, force, motion and also other features and really understand all these parameters is really a challenge for the scientist.

The materials of Nano scale furnish various chemical properties than the materials that have the great size and all these chemical properties and physical properties form the foundation of new applied sciences.

2. HISTORY OF NANOTECHNOLOGY

The developed researchers normally have natural risks but when coming to the nanotechnology it suffers a unique burden. In the year of 1959, Richard Feynman who was a noble prize winner initially designed the idea of molecular manufacturing in his speech “that there is plenty of room at the bottom.” The Richard Feynman was the foremost scientist who suggested that the machines and materials could someday need atomic description. In the year of 1986, Gird Binning and Heinrich Rohrer invented the scanning tunneling microscope and because of this invention, they were awarded the noble prize.

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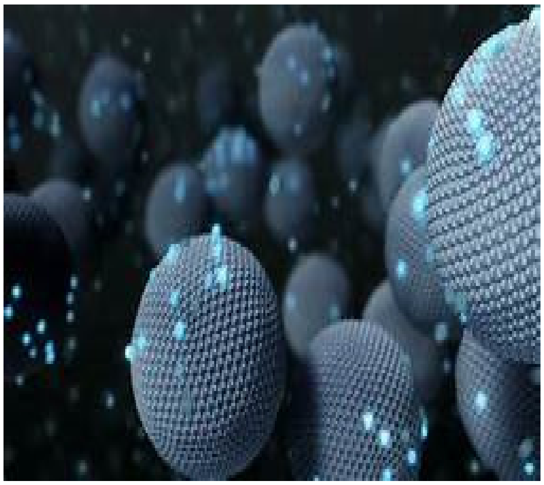

TOOLS OF NANOTECHNOLOGY

The tools of the nanotechnology are as follows:

- Positional control
- Self-assembly
- The positional devices and positional controlled reactions
- Stiffness
- Scanning tunneling microscope

1. Positional control:

   The positional control is the most important principle of nanotechnology and in the year of 1959, Richard Feynman who was the noble prize winner said that in the laws of physics nothing stopped the people from arranging the atoms in the way that people want.

2. Self-assembly:

   The self-assembly is a good setup and strong method of synthesizing intricate molecular structures.

3. Positional devices and positional controlled reactions:

   The positional control and positional devices aids in making the things which become little complex if we don't use the positional control.

4. Stiffness:

   The stiffness is a measure of the capacity that how far a particular thing moves when we push it, if the particular thing moves more with a little push then it is not stiff and if it does not moves more though we apply much pressure on it then it is said to be very stiff.

5. Scanning tunneling microscope:

   A scanning tunneling microscope is a machine that can position a tip to atomic accuracy near a surface and also can be moved around.

FUNDAMENDAL CONCEPTS

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

One nanometer (nm) is one billionth, or 10^{-9}, of a meter. By comparison, typical carbon-

carbon bond lengths, or the spacing between these atoms in a molecule, are in the range 0.12–0.15 nm, and a DNA double-helix has a diameter around 2 nm. On the other hand, the smallest cellular life-forms, the bacteria of the genus *Mycoplasma*, are around 200 nm in length. By convention, nanotechnology is taken as the scale range 1 to 100 nm following the definition used by the National Nanotechnology Initiative in the US. The lower limit is set by the size of atoms (hydrogen has the smallest atoms, which are approximately a quarter of an nm diameter) since nanotechnology must build its devices from atoms and molecules. The upper limit is more or less arbitrary but is around the size below which phenomena not observed in larger structures start to become apparent and can be made use of in the Nano device. These new phenomena make nanotechnology distinct from devices which are merely miniaturized versions of an equivalent macroscopic device; such devices are on a larger scale and come under the description of micro technology.

To put that scale in another context, the comparative size of a nanometer to a meter is the same as that of a marble to the size of the earth. Or another way of putting it: a nanometer is the amount an average man's beard grows in the time it takes him to raise the razor to his face.

Two main approaches are used in nanotechnology. In the "bottom-up" approach, materials and devices are built from molecular components which assemble themselves chemically by principles of molecular recognition. In the "top-down" approach, Nano-objects are constructed from larger entities without atomic-level control.

Areas of physics such.as nanoelectronics, nanomechanics, nanophoton ics and nanoionics have evolved during the last few decades to provide a basic scientific foundation of nanotechnology

LARGER TO SMALLER :A MATERIALS PERSPECTIVE

Image of reconstruction on a clean Gold(100) surface, as visualized using scanning tunneling microscopy. The positions of the individual atoms composing the surface are visible.Several phenomena become pronounced as the size of the system decreases. These include statistical mechanical effects, as well as quantum mechanical effects, for example the "quantum size effect" where the electronic properties of solids are altered with great reductions in particle size. This effect does not come into play by going from macro to micro dimensions. However, quantum effects can become significant when the nanometer size range is reached, typically at distances of 100 nanometers or less, the so-called quantum realm. Additionally, a number of physical (mechanical, electrical, optical, etc.) properties change when compared to macroscopic systems. One example is the increase in surface area to volume ratio altering mechanical, thermal and catalytic properties of materials. Diffusion and reactions at Nano scale, nanostructures materials and Nano devices with fast ion transport are

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generally referred to nonionic. *Mechanical* properties of Nano systems are of interest in the Nano mechanics research. The catalytic activity of nanomaterial's also opens potential risks in their interaction with biomaterials.

Materials reduced to the Nano scale can show different properties compared to what they exhibit on a macro scale, enabling unique applications. For instance, opaque substances can become transparent (copper); stable materials can turn combustible (aluminum); insoluble materials may become soluble (gold). A material such as gold, which is chemically inert at normal scales, can serve as a potent chemical catalyst at Nano scales. Much of the fascination with nanotechnology stems from these quantum and surface phenomena that matter exhibits at the Nano scale.

SIMPLE TO COMPLEX: A MOLECULAR PERSPECTIVE

Modern synthetic chemistry has reached the point where it is possible to prepare small molecules to almost any structure. These methods are used today to manufacture a wide variety of useful chemicals such as pharmaceuticals or commercial polymers. This ability raises the question of extending this kind of control to the next-larger level, seeking methods to assemble these single molecules into supramolecular assemblies consisting of many molecules arranged in a well-defined manner.

These approaches utilize the concepts of molecular self-assembly and/or supramolecular chemistry to automatically arrange themselves into some useful conformation through a bottom-up approach. The concept of molecular recognition is especially important: molecules can be designed so that a specific configuration or arrangement is favored due to non-covalent intermolecular forces. The Watson–Crick base pairing rules are a direct result of this, as is the specificity of an enzyme being targeted to a single substrate, or the specific folding of the protein itself. Thus, two or more components can be designed to be complementary and mutually attractive so that they make a more complex and useful whole.

Such bottom-up approaches should be capable of producing devices in parallel and be much cheaper than top-down methods, but could potentially be overwhelmed as the size and complexity of the desired assembly increases. Most useful structures require complex and thermodynamically unlikely arrangements of atoms. Nevertheless, there are many examples of self-assembly based on molecular recognition in biology, most notably Watson–Crick base pairing and enzyme-substrate interactions. The challenge for nanotechnology is whether these principles can be used to engineer new constructs in addition to natural ones.

An experiment indicating that positional molecular assembly is possible was performed by Ho and Lee at Cornell University in 1999. They used a scanning tunneling microscope to move an individual carbon

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monoxide molecule (CO) to an individual iron atom (Fe) sitting on a flat silver crystal, and chemically bound the CO to the Fe by applying a voltage.

HEALTH AND ENVIRONMENT CONCERNS

Nano fibers are used in several areas and in different products, in everything from aircraft wings to tennis rackets. Inhaling airborne nanoparticles and Nano fibers may lead to a number of pulmonary diseases, e.g. fibrosis. Researchers have found that when rats breathed in nanoparticles, the particles settled in the brain and lungs, which led to significant increases in biomarkers for inflammation and stress response and those nanoparticles induce skin aging through oxidative stress in hairless mice.

A two-year study at UCLA's School of Public Health found lab mice consuming Nano-titanium dioxide showed DNA and chromosome damage to a degree "linked to all the big killers of man, namely cancer, heart disease, neurological disease and aging".

A major study published more recently in Nature Nanotechnology suggests some forms of carbon nanotubes – a poster child for the "nanotechnology revolution" – could be as harmful as asbestos if inhaled in sufficient quantities. Anthony Seaton of the Institute of Occupational Medicine in Edinburgh, Scotland, who contributed to the article on carbon nanotubes said "We know that some of them probably have the potential to cause mesothelioma. So those sorts of materials need to be handled very carefully." In the absence of specific regulation forthcoming from governments, Paul and Lyons (2008) have called for an exclusion of engineered nanoparticles in food a newspaper article reports that workers in a paint factory developed serious lung disease and nanoparticles were found in their lungs.

IMPLICATION

The implications of the nanotechnology in the health and safety issues, political and social issues are as follows:

1. Health and safety issues:

The nanoparticles can cause severe illness and are hazardous to the human body.

They have untraceable destructive weapons of mass damage.

2. Political and social issues:

It creates social strife through enhancing the wealth gap.

The advisability of enhancing the scope of the applied science makes political dilemma.

3. ADVANTAGES

The advantages of the nanotechnology are as follows:

- The nanotechnology is suitable for the low cast and high volume production.
- It has the reduced size, mass and power consumption along with the high functionality.
- It has the advanced features like the reliability and robustness

4. DISADVANTAGES

Well, all the great developments come with the associated problems and few of them are as follows:

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The nanotechnology cannot solve all our present issues.

- There is a problem in testing a billion molecules electronic circuit.
- The computing of Nano scale is amorphous.
- It has the “price of programmability.”

5. APPLICATIONS

The nanotechnology has the applications in the following fields:

- In the improved transportation like the intelligent cars
- In Nano composites
- In the atom computers
- In the memories that have the high storage capacity
- In the molecular electronics
- In the military
- In the smart furniture
- In solar energy
- In the medical uses

These are some of the applications of the nanotechnology and there are many fields in which the nanotechnology is applied.

6. CONCLUSION

1. By taking advantage of quantum-level properties, Molecular Nanotechnology MNT allows for unprecedented control of the material world, at the nanoscale, providing the means by which systems and materials can be built with exacting specifications and characteristics.
2. The use of Nanotechnology is continuously transforming daily use products, making consumer goods plentiful, inexpensive and highlydurable.
3. The medicine will take a quantum leap forward, with the use ofnanotechnology.
4. Single molecule transistor technology has got scope in chemical and biological sensing. DNA-based logic gates that could carry out calculations inside the body have been constructed for the firsttime.
5. Space travel and colonization will become safe and affordable with the advances that nanotechnology is bringing in aerospacematerials.

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