International Journal of Education and Science Research Review
ISSN 2348-6457
www.ijesrr.org April- 2017, Volume-4, Issue-2 Email- editor@ijesrr.org

NANOTECHNOLOGY: BIG THINGS FROM A MINIATURE GLOBE

RITU RANI
Assistant Professor
CRM Jat College
Hisar Haryana

ABSTRACT

Nanotechnology ("nanotech") is manipulation of matter on an atomic, molecular, and supramolecular scale. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale 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 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 which 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. Because of the variety of potential applications (including industrial and military), governments have invested billions of dollars in nanotechnology research.

KEYWORDS*:* Nanotubes, NanoFilms, Grey Goo, Nanoelectronics, Nanomedicine.

HISTORY OF NANOTECHNOLOGY

The concepts that seeded nanotechnology were first discussed in 1959 by renowned physicist Richard Feynman in his talk *There's Plenty of Room at the Bottom*, in which he described the possibility of synthesis via direct manipulation of atoms. The term "nano-technology" was first used by Norio Taniguchi in 1974, though it was not widely known.

Inspired by Feynman's concepts, K. Eric Drexler used the term "nanotechnology" in his 1986 book *Engines of Creation: The Coming Era of Nanotechnology*, which proposed the idea of a nanoscale "assembler" which would be able to build a copy of itself and of other items of arbitrary complexity with atomic control. Also in 1986, Drexler co-founded The Foresight Institute (with which he is no longer affiliated) to help increase public awareness and understanding of nanotechnology concepts and implications.

Thus, emergence of nanotechnology as a field in the 1980s occurred through convergence of Drexler's theoretical and public work, which developed and popularized a conceptual framework for nanotechnology, and high-visibility experimental advances that drew additional wide-scale attention to the prospects of atomic control of matter. In the 1980s, two major breakthroughs sparked the growth of nanotechnology in modern era.

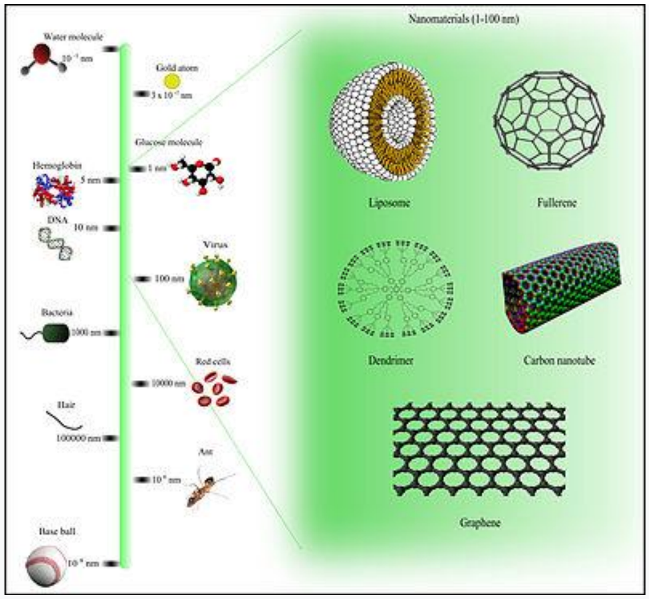

Fig. 1: Comparison of Nanomaterials Sizes

First, the invention of the scanning tunneling microscope in 1981 which provided unprecedented visualization of individual atoms and bonds, and was successfully used to manipulate individual atoms in 1989.The microscope's developers Gerd Binnig and Heinrich Rohrer at IBM Zurich Research Laboratory received a Nobel Prize in Physics in 1986. Binnig, Quate and Gerber also invented the analogous atomic force microscope that year.

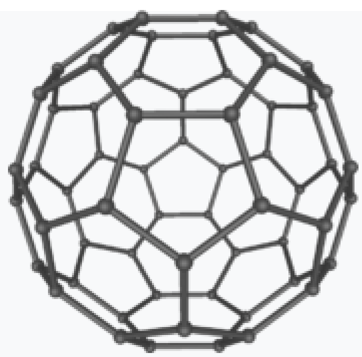

Fig. 2: Buckminsterfullerene C_{60}, also known as the bucky ball, is a representative member of the carbon structures known as fullerenes.

Second, Fullerenes were discovered in 1985 by Harry Kroto, Richard Smalley, and Robert Curl, who together won the 1996 Nobel Prize in Chemistry. C_{60} was not initially described as nanotechnology; the term was used regarding subsequent work with related graphene tubes (called carbon nanotubes and sometimes called Bucky tubes) which suggested potential applications for nanoscale electronics and devices.

In the early 2000s, the field garnered increased scientific, political, and commercial attention that led to both controversy and progress. Controversies emerged regarding the definitions and potential implications of nanotechnologies, exemplified by the Royal Society's report on nanotechnology. Challenges were raised regarding the feasibility of applications envisioned by advocates of molecular nanotechnology, which culminated in a public debate between Drexler and Smalley in 2001 and 2003.

Meanwhile, commercialization of products based on advancements in nanoscale technologies began emerging. These products are limited to bulk applications of nanomaterials and do not involve atomic control of matter. Some examples include the Silver Nano platform for using silver nanoparticles as an antibacterial agent, nanoparticle-based transparent sunscreens, carbon fiber strengthening using silica nanoparticles, and carbon nanotubes for stain-resistant textiles.

Governments moved to promote and fund research into nanotechnology, such as in the U.S. with theNational Nanotechnology Initiative, which formalized a size-based definition of nanotechnology and established funding for research on the nanoscale, and in Europe via the European Framework Programmes for Research and Technological Development.

By the mid-2000s new and serious scientific attention began to flourish. Projects emerged to produce nanotechnology roadmaps which center on atomically precise manipulation of matter and discuss existing and projected capabilities, goals, and applications.

FUNDAMENTAL 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 theseatoms 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 smallestcellular 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 a 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 miniaturised versions of an equivalent macroscopic device; such devices are on a larger scale and come under the description of microtechnology.

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.

PUTTING NANOTECHNOLOGY TO USE

Over the past two decades, scientists and engineers have been mastering the intricacies of working with nanoscale materials. Now researchers have a clearer picture of how to create nanoscale materials with properties never envisioned before. Products using nanoscale materials and process are now available. Anti bacterial wound dressings use nanoscale silver. A nanoscale dry powder can neutralize gas. Batteries for tools are being manufactured with nanoscale materials in order to deliver more power, more quickly with less heat. Sunscreens containing nanoscale titanium dioxide or Zinc Oxide are transparent and reflect ultraviolet light to prevent sunburns. Various techniques and products based on nanoscale particles are described in brief.

Drug-Delivery Technique

Dendrimers are a type of nanostructure that can be precisely designed and manufactured for a wide variety of applications, including the treatment of cancer and other diseases. Dendrimers carrying different materials an their branches can do several things at one time, such as recognising diseased cells, diagnosing diseased states (including cell death), drug delivery, reporting location, and reporting outcomes of therapy.

Nano films

Different nanoscale materials can be used in thin films to make them water repellent, anti reflective, self-cleaning, Ultraviolet or infrared-resistant, anti-fog, anti-microbial, Scratch- resistant, or electrically conductive. Nano films are used now on eyeglasses, computer display and cameras to protect or treat the surfaces. Nano film is shown in figure 2.

Water Filtration technique

Researchers are experimenting with carbon nanotubes based membranes for water desalination and nanoscale sensors to identify contaminants in water system. Other nanoscale materials that have great potential to filter and purify water include nanoscale titanium dioxide, which is used in sunscreen and which has been shown to neutralize bacteria.

Nano Tubes

Carbon nanotubes (CNTs) are allotropes of carbon with a cylindrical nanostructure. Nanotubes have been constructed with length-to-diameter ratio of up to 28,000,000:1, which is significantly larger than any other material. These cylindrical carbon molecules have novel properties that make them potentially useful in many applications in nanotechnology, electronics, optics and other fields of materials science, as well as potential uses in architectural fields. They exhibit extraordinary strength and unique electrical properties, and are efficient conductors of heat. Their final usage, however, may be limited by their potential toxicity. Nano tubes is shown in figure 3.

Nanoscale Transistors

Transistors are electronic switching devices where a small amount of electricity is used like a gate to control the flow of larger amount of electricity. In computers, the more transistors, the greater the power. Transistors sizes have been decreasing, so computer have become more powerful. Until recently, the industry's best commercial technology produced computer chips with transistors having 45-nanometer features. Recent announcements indicate that 32 nanometer feature technology soon will be here.

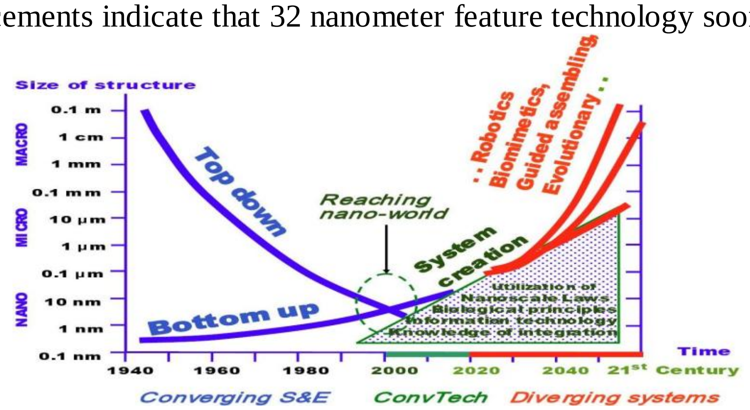

Figure 3. Reaching at the nanoworld (about 2000) and "converging technologies" approach for system creation from the nanoscale (2000-2020) towards new paradigms for nanosystem architectures in applications (after 2020).

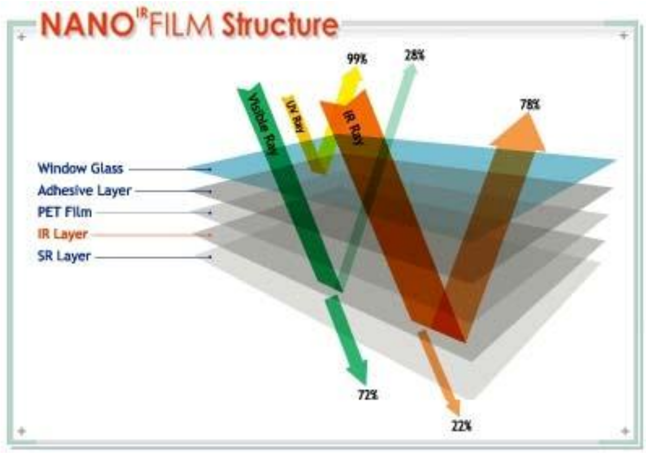

Figure 4. Nano Films.

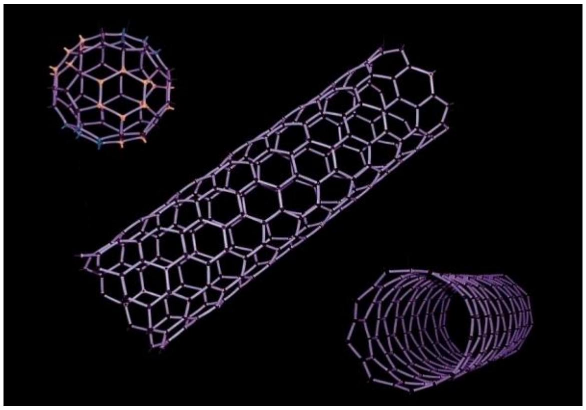

Figure 5. Nano Tubes.

NANOTECHNOLOGY APPLICATIONS

A number of Nanotechnology products are available and a tremendous amount of researches are still going on in universities, government and research laboratories. Nanotechnology applications are being developed that could impact the global market for agricultural, mineral, and other non-fuel commodities. Currently, Nanotechnology is described as revolutionary discipline in terms of its possible impact on industrial applications. Nanotechnology offers potential solutions to many problems using emerging nanotechniques.
Depending on the strong inter disciplinary character of nanotechnology there are many research fields and several potential applications that involves nanotechnology. In this section we provide a brief overview about some nanotechnology and nanoscience current developments. Obviously it can’t provide an exhaustive report of the developments in nanoscience and nanotechnology an all scientific and engineering fields. Here are some fields where nanotechnology has been implemented.

Nanorobot Development for Defense

The defense industry should remarkably benefit from achievements and trends on current nanobiotechnology systems integration. Such trends on technology have also resulted in a recent growing interest from the international scientific community, including medical and pharmaceutical sectors, towards the research and development of molecular machines.

Medical Nanorobots

The research and development of nanorobots with embedded nanobiosensors and actuators is considered a new possibility to provide new medical devices for doctors . As integrated control mechanisms at microscopic environments differ from conventional control techniques, approaches using event-based feed forward control are sought to effectively advance new medical technologies. In the same way the development of microelectronics in the 1980s has led to new tools for biomedical instrumentation, the manufacturing of nanoelectronics , will similarly permit further miniaturization towards integrated medical systems, providing efficient methodologies for pathological prognosis.

The use of microdevices in surgery and medical treatments is a reality which has brought many improvements in clinical procedures in recent years. For example, among other biomedical instrumentation, catheterization has been successfully used as an important methodology for heart and intracranial surgery. Now the advent of biomolecular science and new manufacturing techniques is helping to advance the miniaturization of devices from micro to nanoelectronics. Sensors for biomedical applications are advancing through tele operated surgery and pervasive medicine, and this same technology provides the basis for manufacturing biomolecular actuators. A first series of nanotechnology prototypes for molecular machines are being investigated in different ways, and some interesting devices for propulsion and sensing have been presented. More complex molecular machines, or nanorobots, having embedded nanoscopic features represent new tools for medical procedures.

RISKS OF NANOTECHNOLOGY

These days it seems you need the prefix “nano” for products or applications if you want to be either very trendy or incredibly scary. Molecular manufacturing operations could be carried out with failure rates less than one in quadrillion. As soon as molecular manufacturing was proposed risks associated with it began to be identified. Engines of Creation described one hazard possible: grey goo. A small nanomachine capable of replication could in theory copy itself too many times. If it were capable of surviving outdoors, and using biomass as raw material, it could severely damage the environment.

Sufficiently powerful products would either hostile governments or angry individual, to wreak havoc. Destructive nanomachines could do immense damage to unprotected people and objects. If the wrong people gained the ability to manufacture any desired product, they could rule the world, or cause massive destruction in the attempt. Certain products such as powerful aerospace weapons, and microscopic antipersonnel devices, provide special cause of concern. Grey goo is relevant here as well. Clearly, the unrestricted availability of nanotechnology poses grave risks, which may well outweigh the benefits of clean, cheap, convenient, self contained manufacturing.

Development of nanotechnology must be undertaken with care to avoid accidents. Once a nanotechnology-based manufacturing technology is created, it must be administered with even more care. Irresponsible use of molecular manufacturing could lead to black markets, unstable arms races ending in immense destruction, and possibly a release of grey goo.

Another important aspect of the nanoscale is that the smaller a nanoparticle gets, the larger its relative surface area becomes. Its electronic structure changes dramatically, too. Both effects lead to greatly improved catalytic activity but can also lead to aggressive chemical reactivity. There are tremendous differences in particle number concentration and particle surface area.

To understand the effect of particle size on surface area, consider a U.S. silver dollar. The silver dollar contains 26.96 grams of coin silver, has a diameter of about 40 mm, and has a total surface area of approximately 27.70 square centimeters. If the same amount of coin silver were divided into tiny particles say 1 nanometer in diameter the total surface area of those particles would be 11,400 square meters. When the amount of coin silver contained in a silver dollar is rendered into 1 nm particles, the surface area of those particles is 4.115 million times greater than the surface area of the silver dollar!.

CONCLUSION

Today, many of our nation's most creative scientists and engineers are finding new ways to use nanotechnology to improve the world in which we live. These researchers envision a world in which new materials, designed at the atomic and molecular level, provide realistic, cost-effective methods for harnessing renewable energy sources and keeping our environment clean. They see doctors detecting disease at its earliest stages and treating illness such as cancer, heart disease, and diabetes with more effective and safer medicines. They picture new technologies for protecting both our military forces and civilians from conventional, biological, and chemical weapons. Although there are many research challenges ahead, nanotechnology already is producing a wide range of beneficial materials and pointing to breakthrough in many fields. It has opened scientific Inquiry to the level of molecules-and a world of new opportunities.

REFERENCES

1. Handbook on Nanoscience, Engineeering and Technology, 2nd Ed., Taylor and Francis, 2007.
2. National Nanotechnology Initiative. http://www.nano.gov
3. Nanotechnology: A Brief Literature Review M.Ellin Doyle, Ph.D Food Research Institute, University of Wisconsin–Madison, Madison, WI 53706.
4. NASA Institute for Advanced Concepts report: The Space Elevator. http://www.nanotech-now.com
5. Chris Phoenix and Mike Treder, "Safe Utilization Of Advanced Nanotechnology", Center for Responsible
6. Nanotechnology (CRN), January 2003, Revised on December 2003. http://www.crnano.org/safe.htm
7. Laura Wright. "Nanotech Safety: More on How Little We Know" , OnEarth Magazine, December 12, 2007.
8. Nanotechnology Risks-the real issues. http://www.nanowerk.com
9. Research Strategies for Safety Evaluation of Nanomaterials, Part IV: Risk Assessment of Nanoparticles.
10. Bhattacharyya Debnath, Singh Shashank and Satnalika N. (2009). Nanotechnology, Big Thing from a Tiny World : A Review, International Journal u and e service, Science & Technology, Vol. 2, No. 3.