Nanotechnology: present & future scenario for healthcare, Genetic Engineering & smart material

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Abstract:

"Nanotechnology deals with natural and artificial structures on the nanometer scale, i.e.in the range from 1 µm down to 10 A. One nanometer, 1 nm = 10 ˚ −9m, is roughly the distance from one end to the other of a line of five neighboring atoms in an ordinary solid." In the nanometer scale if the size of a soccer ball(~ 30 cm = 3×10^{-1}m) is reduced 10.000 times we reach the width of a thin human hair(~ 30 µm = 3×10^{-5}m). If we reduce the size of the hair with the same factor, we reach the width of a carbon nanotube (~ 3 nm = 3×10^{-9}m).It is quite remarkable, and very exciting indeed, that we today have a technology that involves manipulation of the ultimate building blocks of that seep into many different markets. Nanotechnology has been applied to photo voltaic, MEMS and NEMS, molecular electronics data, ordinary matter: single atom sand molecules.

Introduction:

Nanotechnology is the science of the very small and involves the manipulation of matter at the atomic or molecular level. A nanometer is 100,000 times thinner than a strand of hair. Nanotechnology has three important aspects: size, structure, and resulting novel properties. Today Nanotechnology produces surprising result for new development in the field of electronics & Medicine. Since the invention of the integrated circuit more than half a century ago in 1958, there has been an exponential growth in the number of transistors per micro chip and an associated decrease in the smallest width of the wires in the electronic circuits. Nanotechnology is made possible by a variety of nanofabrication techniques. Some of the techniques include :electrospinning, sol-gel processing, molecular self-assembly, atomic layer deposition and physical vapor deposition. Nanotechnology touches all aspects of high-technology

Size:

It takes about 3-10 atoms to span the length of a nanometer. In comparison, the diameter of a human being.

Structure:

Nanotechnology is not just about the size of looking at very small things, it is about structure, or how things are put together, arranged, or assembled. It is the ability to work – observe, manipulate, and build – at the atomic or molecular level.

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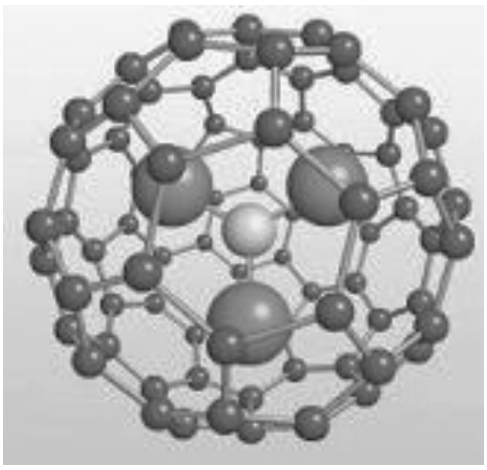
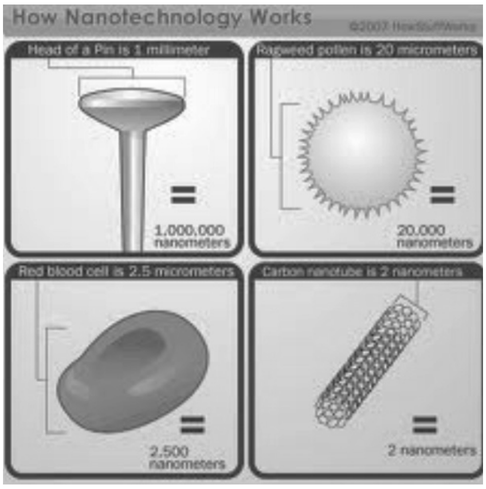
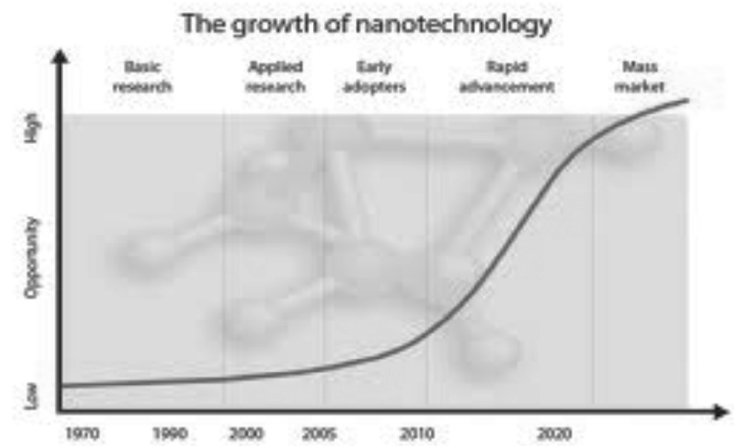
Novel Properties:

Nanotechnology produces materials and systems that exhibit novel and significantly changed physical, chemical, and biological properties because of their size and structure. When a substance consists only of clusters of a few hundred atoms, the laws of quantum mechanics influence dramatic changes in its mechanical, optical, and electronic properties. Hair is about 20,000 nanometers wide and a smoke particle is about 1,000 nanometers wide. These properties include improved catalysts, tunable photo activity, and increased strength.

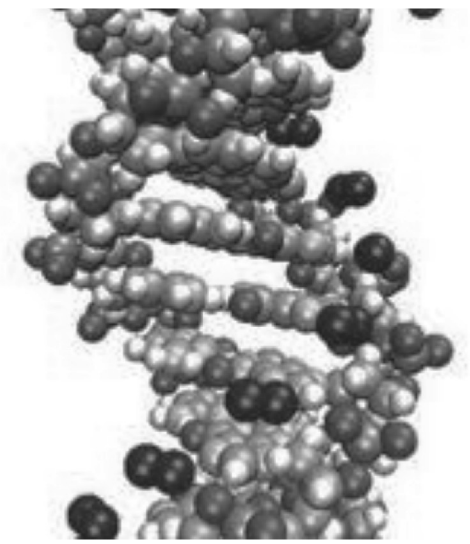
The enhanced ability to control and characterize materials at the molecular level has fuelled the rapidly growing science of nanotechnology. Research in chemistry is the forefront of this new and exciting field. At







the nanometer length scale, certain materials demonstrate novel properties quite different from their macroscopic behavior. Recently semiconductor technologies are developed reaching design dimensions of a single nanometer, exploiting materials that are both inexpensive and mechanically flexible. Researchers study biological phenomena at the molecular level (rather than the cellular level) to further understand mechanisms of drug delivery and metabolism. Characterizing and designing polymers at the nanoscale has led to the development of new materials with unique structure, properties, and functions.



Nanotechnology research includes:

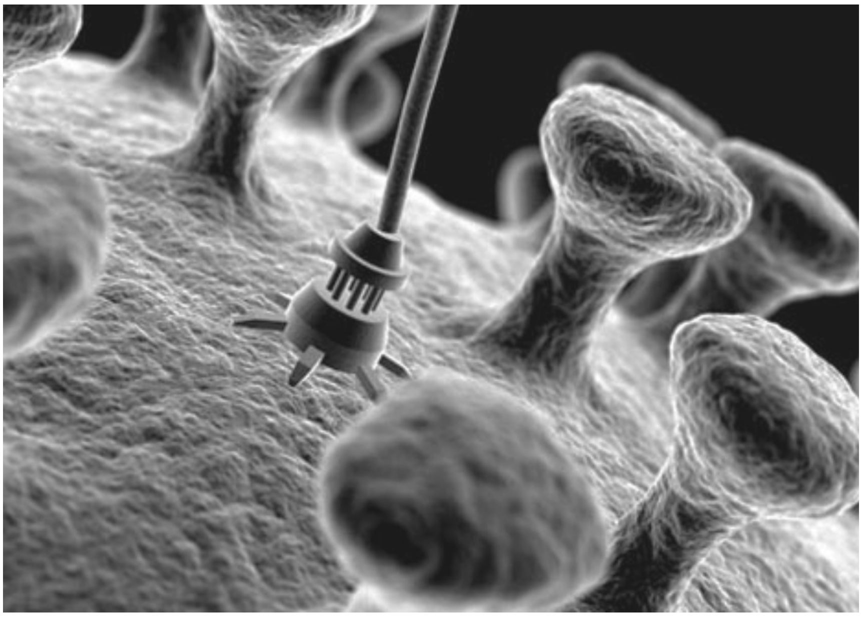
- Understanding charge transport in organic semiconductors
- Single molecule devices
- Carbon nanotube sorting, purification, assembly and devices
- Development of organic rather than the traditional inorganic materials as chemical barriers in computer chips
- Exploration of the microdynamics of polymer molecules, including DNA, to enable separation processes based on reading nano-barcodes rather than the traditional electrophoresis techniques
- Flow characterization of complex fluids to reduce drag in turbulent flows and to control cellular transport in drug delivery applications
- Manipulating polymeric and other complex materials to examine interfacial dynamics and rheological properties
- Using complex fluid dynamics to alter the orientation of molecules for applications in the electronics and biological industries
- Design and characterization of high-strength interpenetrating network hydrogels for biomaterial functions including wound healing, tissue replacement, and an artificial cornea
- Analysis of the structure and function of proteins and macromolecules at interfaces
- Development of bio renewable polymer composites and foams for green building materials

- Theoretical modeling of the self assembly of clustering proteins into nano scale structures
- Developing virus-like particle based nanoparticles as imaging agents for metastatic cancer .

Molecular Nanotechnology (MNT) is nanotechnology using "molecular manufacturing", an anticipated technology based on positionally-controlled mechano synthesis is controlled by molecular machine systems. It involves combining physical principles demonstrated by chemistry, other nanotechnologies, and the molecular machinery of life with the systems engineering principles found in modern macro scale factories. Conventional chemistry has no tools that allow us to place a particular molecule in a particular place (so that it bonds in a predictable way), after the reaction with a physical filtering process to extract the species we actually wanted, with the other species discarded as waste. Nanotechnology could therefore offer much cleaner manufacturing processes than today's bulk technology offers.

Applications and capabilities Smart Materials and Nanosensors

One application of nanotechnology is the development of so-called smart materials. This term refers to any sort of material designed and engineered at the nanometre scale to perform a specific task, and encompasses a wide variety of possible commercial applications. One example is materials designed to respond differently to various molecules; such a capability could lead, for example, to artificial drugs which would recognize and render inert specific viruses. Another is the idea of self-healing structures, which would repair small tears in a surface naturally in the same way as self-sealing tires or human skin; and while this technology is relatively new, it is already seeing commercial application in various engineering plastics. A nano sensor would resemble a smart material, involving a small component within a larger machine that would react to its environment and change in some fundamental, intentional way. As a very simple example: a photo sensor could passively measure the incident light and discharge its absorbed energy as electricity when the light passes above or below a specified threshold, sending a signal to a larger machine. Such a sensor would cost less and use less power than a conventional sensor, and yet function usefully in all the same applications — for example, turning on parking lot lights when it gets dark. While smart materials and nano sensors both exemplify useful applications of nanotechnology, they pale in comparison with the complexity of the technology most popularly associated with the term: the replicating nano robot.



Replicating Nanorobots

Replicating Nanorobots critics doubt the feasibility of controllable self-replicating nanorobots: they cite the possibility of mutations removing any control and favoring reproduction of mutant pathogenic variations. Advocates counter that bacteria are (of necessity) evolved to evolve, while nanorobot mutation can be actively prevented by common error-correcting techniques. Recent technical proposals for nanofactories do not include self-replicating nanorobots, and recent ethical guidelines prohibit self-replication.

Nanorobots

Smart Materials

Medical Nanorobots

One of the most important applications of molecular nanotechnology will be medical nanorobotics or nanomedicine. The ability to design, build, and deploy large numbers of medical nanorobots will make possible the rapid elimination of disease and the reliable and relatively painless recovery from physical trauma. Medical nanorobots will also make possible the convenient correction of genetic defects, and can help to ensure a greatly expanded healthspan. More controversially, medical nanorobots could be used to augment natural human capabilities. However, mechanical medical nano devices will not be allowed (or designed) to self-replicate inside the human body, nor will medical nanorobots have any need for self-replication themselves. They will be manufactured exclusively in carefully regulated nanofactories.

Conclusion:

Scientists & Engineers have applied the term "nanotechnology" to micro scale technologies like MEMS. This prompted to use the term "molecular nanotechnology". Recently, the term "nanotechnology" is applied to the currently available fine-scale chemistry or materials science or molecular engineering. That would include "nanotech" suntan lotion and "nanotech" stain-resistant paints. To refer to molecular manufacturing if the number of atoms in macro-sized product, unlike the 'Nano' prefix for the number of subdivisions of a

meter. Such a product is likely to have around a sextillion (10^{21}) distinct atomic parts. However Nanotechnology is not a single technology, but a set of technologies which yield a set of technical breakthroughs-storage, catalysis and biotechnology. Conventional microtechnology is a top-down technology. This means that the microstructures are fabricated by manipulating a large piece of material, typically a silicon crystal, using processes like lithography, etching, and metallization. However, such an approach is not the only possibility. There is other remarkable consequences of the development of micro and nanotechnology.