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UNDERSTANDING, PROSPECTS AND COSTRAINTS OF EMERGING NANOTECHNOLOGY

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ABSTRACT

Nanotechnology deals with the design, characterization, production and application of structures, devices and systems by controlling their size and shape at nanometre scale. It focuses on manipulating the most basic components of all matter (atoms and molecules) with great precision and exploiting the novel properties or phenomena observed at that length scale as compared to their bulk-scale counterparts. Thus size effects become predominant at the nano scale. Most of the observed effects at this nano scale could be explained by surface and quantum confinement phenomena. It is an emerging interdisciplinary technology and promises significant advances in various technological applications. Nanotechnology is the new industrial revolution as it has the potential to revolutionise various sectors of the society. Still the potential of this technology has not been fully exploited as many questions still remain to be answered. Notwithstanding these advantages, it is a challenge to the government and industries as yet there are no specific regulations for assessing the toxicity or environmental impact of nanoparticles.

KEYWORDS:Atomic force microscopy, Scanning Tunneling microscope, Fullerene, Carbon Nanotubes.

I.UNDERSTANDING

Nanotechnology is a manipulation of matter on an atomic, molecular and super molecular scale. The earliest widespread description of nanotechnology referred to the particular technology goal of precisely manipulating atom and molecules for fabrication of macroscale products are now referred to as molecular nanotechnology.

The manipulation of matter with at least one dimension sized from 1 to 100nm.

As defined by size, nanotechnology is naturally very broad including fields of science, organic chemistry molecular engineering etc.

It becomes a matter of debate regarding future implications of nanotechnology. Nanotechnology may able to create many new materials and devices with a vast range of applications. On the other hand nanotechnology raises many of the same issues as any new technology, including concerns about toxicity and environmental impact of nano materials and their potential effects on global economics.

II.PROSPECTS

The major breakthroughs sparked the growth of nanotechnology in modern era.

First , the invention of scanning tunneling microscope in 1981 which provided visualization of individual atoms and bonds and is successfully used to manipulate individual atoms. The developers received the Nobel Prize in Physics(Gerd Binning and Heinrich Rohrer).

Second, Fullerenes were discovered. C80 was not initial described as nanotechnology ,the term was used regarding subsequent work with related graphene tubes(carbon nano tubes and sometimes called Bucky tubes)which suggested potential application for nano scale electronics and devices.

Controversies emerged regarding the feasibility of applications envisioned by advocates of molecular nanotechnology which culminated in a public debate.

III.CURRENT RESEARCHS

NANOMATERIALS

*Interface and colloid science has given rise to many materials which may be useful in nanotechnology such as carbon nanotubes and fullerenes and various nanoparticles and nanorods.

*Nanoscale materials can also be used for bulk applications, most present commercial applications of nanotechnology are of this flavor.

*Progress has been made in using these materials for medicine applications.

*Nanoscale materials such as nano pillars are sometimes used in solar cells which combats the cost of traditional silicon solar cells.

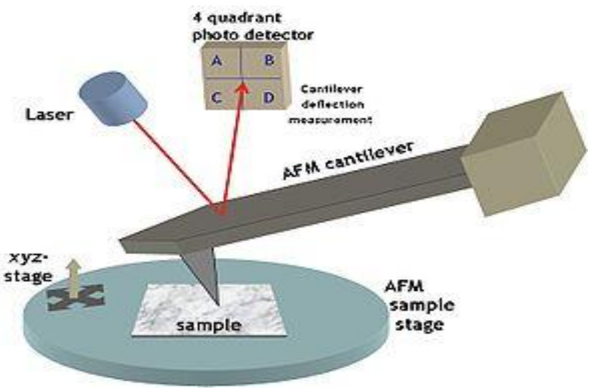
*Development of applications incorporating semiconductor nanoparticles to be used in the next generation of products such as display technology, lighting, solar cells and biological imaging.

*Recent application of nanomaterials includes a range of biomedical applications such as a tissue engineering, drug delivery and biosensors.

*Atomic force microscope(AFM) tips can be used as a nanoscale to deposit a chemical upon a surface in desired pattern.

TOOLS AND TECHNIQUES

There are several important modern developments. The AFM and STM Scanning Tunneling microscope are two early versions of scanning probes that launched nanotechnology.



Typical AFM setup. A micro fabricated cantilever with a sharp tip is deflected by features on a sample surface, much like in a phonograph but on a much smaller scale. A laser beam reflects off the backside of the cantilever into a set of photo detectors, allowing the deflection to be measured and assembled into an image of the surface.
Various techniques of nanolithography such as optical lithography, x- ray lithography, electron beam lithography were also developed. Lithography is a top down fabrication technique where bulk material is reduced in size to nanoscale pattern.

Another group of nanotechnological techniques include those used for fabrication of nanotubes and nanowires, those used in semiconductor fabrication such as deep ultravoilet lithography, electron beam lithography, focused ion beam machining ,atomic layer deposition and further include molecular self assembly techniques such as those employing d-block copolymers.

IV.ATOMIC FORCE MICROSCOPY

Atomic force microscopy (AFM) or Scanning force microscopy (SFM) is very high resolution type of scanning probe microscope (SPM) with demonstrated resolution in order of fractions of nanometers, more than 1000 times better than a optical diffraction light.
The information is gathered by ‘feeling’ or ’touching’ the surface with a mechanical probe Piezoelectric elements that facilitate tiny but accurate and precise movements on command enable precise scanning.
The AFM has three major abilities
*force measurement
*imaging
*manipulation
In force measurement ,AFM,s can be used to measure the forces between the probe and the sample as a function of their mutual separation ,This can be applied to perform force spectroscopy, to measure the mechanical properties of the sample such as the sample’s Young’s modulus ,a measure of stiffness.
For imaging, the reaction of the probe to the forces that the sample imposes on it can be used to form an image of the 3-dimensional shape(topography) of a sample surface at a high resolution.
In manipulation, the forces between tip and sample can also be used to change the properties of a sample in a controlled way. Examples of this include atomic manipulation ,scanning probe lithography and local stimulation of cells.

V.APPLICATIONS

The AFM has been applied to problems in a wide range of disciplines of the natural sciences, including solid state physics, semiconductor science and technology.
Applications in the field of solid state physics includes
(a) The identification of atoms at a surface

(b) The evaluation of interactions between a specific atom and its neighboring atoms.

(c) The study of changes in physical properties arising from changes in an atomic arrangement through atomic manipulation.

In molecular biology, AFM can be used to study the structure and mechanical properties of protein complexes and assemblies.

In cellular biology, AFM can be used to attempt to distinguish cancer cells and normal cells based on hardness of cells.

VI.SCANNING TUNELLING MICROSCOPE

STM is an instrument for imaging surfaces at atomic level. For a STM, good resolution is considered to be 0.1 nm lateral resolution and 0.01 nm depth resolution. With this resolution, individual atoms within materials are routinely imaged and manipulated .The STM can be used not only in ultra high vaccum but also in air, water and various other liquid or gas ambient and the temperatures ranging from near zero Kelvin to over 1000 degree centigrade.

A close-up of a simple scanning tunneling microscope head using a platinum–iridium tip.

VIII.HAZARDS OF NANOTECHNOLOGY

Health and safety hazards of nonmaterial’s

It includes the potential toxicity of various types of nonmaterial’s, as well as fire and dust explosion hazards, inhalation exposure appears to present the most concern .Skin contact and ingestion exposure and dust explosion hazards are also a concern.

Inhalation exposure is most common route of exposure to airborne particles in the workplace. The deposition of nano particles in the respiratory tract is determined by shape and size of particles and they are deposited in lungs to a greater extent than larger respirable particles. Nanoparticles may enter the blood stream from the lungs and translocate to other organs , including the brain.

DERMAL

Nanomaterials could potentially enter the body through intact skin during occupational exposure. Nanoparticles may enter the body through wounds, with particles migrating into the blood and lymph nodes.

GASTROINTESTINAL

Ingestion can occur from unintentional hand to mouth transfer of material .It could happen during handling of nanomaterials. They could also happen during inhalation.

FIRE AND EXPLOSION

For micro scale particles, as particle size decreases and the specific surface area increases, the explosion severity increases .However for organic material dust of organic material, severity increases as the particle size is reduced below 50 micrometer. Metal based nanoparticles exhibit more severe explosions than do carbon nanomaterials.

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