

Nanotechnology: An Emerging Technology

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Abstract: Nanotechnology is a science and technology of small things. This technology has been thrown around a lot in recent years. It's an emerging technology which provides higher level of control over matter at the dimension of roughly 1-100 nm. Nature follows top to bottom approach i.e. sculpting a big chunk of material into small. But in Nanotechnology scientist prefers bottom up approach instead of top bottom.

Index Terms— CNT, Gecko, Nanorobotics, Tunneling Microscope

I. INTRODUCTION

In current century many new avenues are being explored. We are living in the IT world today which leads to a quantum jump in technology. The next technology seems to be “Nanotechnology” which involves various fields like physics, chemistry, biology, engineering, pharmaceuticals, etc

It is an approach through which we understand and master the properties of matter at nano scale referred above. It can also be described as “Disruptive” or “Base Technology”. It provides solution to current problems with help of lighter and smaller materials, system. It is expected that Nanotechnology shall make a remarkable impact on certain industries like medical, chemical, Nanoelectronics, etc.

II. ORIGIN OF NANOTECHNOLOGY :

On 29th December 1959, the Physicist Richard Feynman sowed the seeds of Nanotechnology which was yet untitled

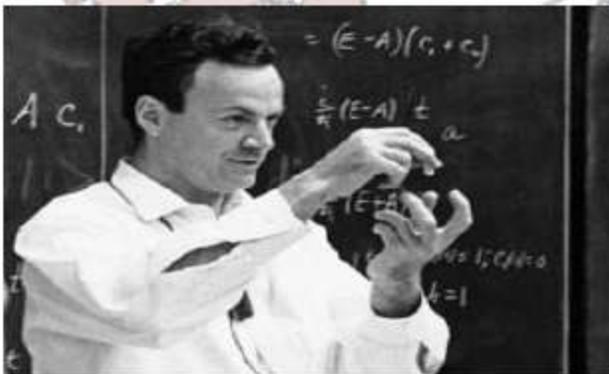


Fig. 1: Physicist Richard Feynman

It was he who led to ideas of Nanoscience and Nanotechnology with a talk “ There’s a plenty of room at the bottom”.

He said a technology in which scientists would be able to manipulate and control individual atoms later after a decade Professor Norio Taniguchi named it as Nanotechnology. Further with development of Scanning tunneling microscope in 1981 by IBM Scientist were able to see individual atoms this was beginning of modern Nanotechnology.

III. LOTUS EFFECT OF NANOTECHNOLOGY:

Rain water is repelled by lotus plants because this plants have natural self cleaning mechanism. When water drops roll off from the lotus leaf it takes dirt, insects, contaminants, water based adhesives and other substances with them. Scientist studied this effect and invented nanocoatings based on it.



Fig. 2: The lotus plant and its water repellent leaf



Fig. 3: As it rolls off, a drop picks up the dirt particles which are lying loosely on the leaf's surface, thereby cleaning it.

In this we use nanostructures as nanotechnology. This structures are applied on required surface so that surfaces become water resistant.

We can use this nanocoatings in various applications such as in bathroom as a self cleaning façade paint or as protection for cars.

Another application of this effect is in house paints by in which hydrophobic polymers(made from nanoparticles) are used to create required surfaces for paint.

But again there is a limitation of this use. The lotus plant's structure continuously renews itself, technological imitations do not have this capability. Also lotus effect has slightly matt finish hence it cant be used in application such as optical glass.

Hence our technology has a limit on imitating the natural self cleaning ability.

IV. NANO TECHNOLOGY IN MEDICAL SCIENCE:

Nanotechnology in medical sector is referred as Nanomedicine. Its an application that uses nanoscale materials and nano enabled techniques to dignos,treat and prevent the various diseases. We use various sensors in Nanotechnology to dignose the disease.

Researchers in Michigan university are developing sensors that can detect a very low level of cancer cells in a blood sample. By the help of nanomedicines we can destroy cancer tumours without dminging healthy tissues and organs. We can also detect and eliminate cancer cells,before they form tumors. For the purpose of detecting,dignosing and treating various

forms of cancers; National Cancer Institute has created the alliance for Nanotechnology in cancer.

Likewise cancer the most common brain disorder "Alzheimer's Disease" can be also treated by Nanomedicine. Around 15 million people in the world are suffering from this disorder. But by using three basic treatments namely

- i) Regeneration therapy
 - ii) Treatment and Prevention
 - iii) Diagnosis and Imaging;
- Nanotechnology tries its best to diagnose and cure the disease.

This emerging technology has potential to radically advance the treatment of the disease that doesn't have any preventive vaccine i.e. HIV/AIDS. For this dignosis and treatment; Nanotechnology offers therapies like advancing antiretroviral therapy, gene therapy, immunotherapy, etc. Even other no. of diseases like cardiovascular diseases, Neurological disorders, gastrointestinal diseases and many more diseases can be treated by Nanotechnology with the help of Nanomedicine.

To biologist Nanotechnology means "Dendrimers". It is type of nanostructure that are used for wide applications. They are large molecules having different branches that can be injected in humans and each branch carry molecules either

for diagnostics or for drug delivery. Thus targeted drug delivery is possible and normal organs do not get affected.

Hence by using this wide variety of uses medical development in Nanotechnology could save great number of lives over the coming years.

V. CARBON NANO TUBES:

Carbon Nanotubes are composed of carbon atoms linked in hexagonal shapes with each carbon atom covalently bonded to three other carbon atoms. Carbon Nanotubes are strong but they are not brittle. They can be bent and when released they will spring back to their original shape. Carbon Nanotubes have such unusual properties which are valuable for

Nanotechnology, Electronics, Optics, and other fields of material Science and Technology. Carbon Nanotubes are classified as Single Walled Nanotubes and Double Walled Nanotubes. Single Walled Nanotubes have diameter of close to one nanometer with tube length that can be many millions of times longer. The structure seems as if a graphene sheet is wrapped into a seamless cylinder it changes its properties as per the sheet. Multi Walled Nanotubes consists of multiple sheets of graphene arranged in concentric form. The resistance of this nanotube to chemicals is significantly improved as compared to Single Walled Nanotube. Carbon nanotubes are used in Bicycle components, Pirhana unmanned Surface vessel, wind turbines, sports gear, Atomic force microscope probes and many more.

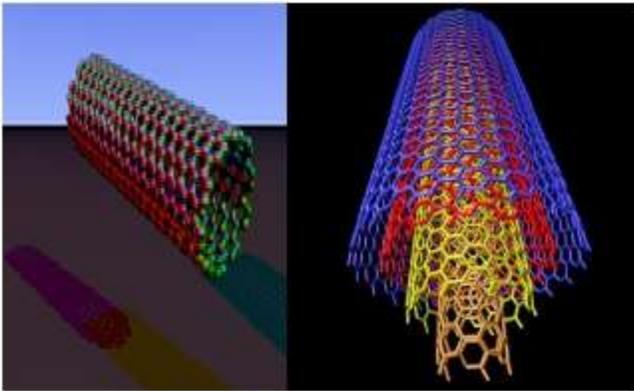


Fig.4 CNT tubes: single wall and multi wall

VI. NANOROBOTICS:

Nanorobotics is technology of creating machines or robots at or close to microscopic scale of nanometer

A nanorobot would typically be devices ranging in size of 0.1-10micrometer .The main components used will be carbon in form of diamond or full erencenano composite because of strength and chemicals of these form.

They are capable of actuation, sensing, signaling, information processing, intelligence and having swarm behavior. The nanorobots are invisible to naked eye and hard to manipulate and work with. Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) can be employed to establish a visual and haptic interface to enable to sense the molecular structure of

These nano scaled devices. The nanorobots or nano machine components are difficult to fabricate and control challenges. Since these robots are very small, they can be inserted into a person's biological system without any noticeable effects. They are so small, in fact, that they may be the same size as blood cells.

They can either be remotely controlled or pre-programmed for a certain procedure. They could, theoretically, be programmed to seek out and deconstruct cancer cells and completely eliminate them without the need for lengthy treatments. They could also be employed to repair and reconstruct damaged tissue on the cellular level.

This would have the effect of drastically increasing a person's own natural ability to heal themselves. No matter how damaged a portion of a person's body may be, these nanobots might be able to repair them.

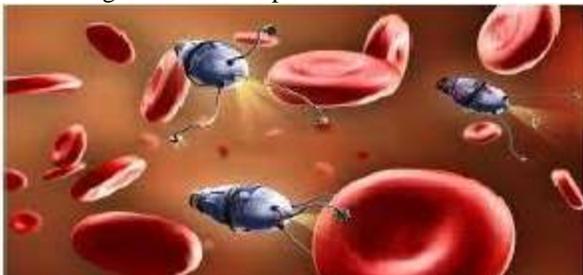


Fig 5:Nanorobots that can be mixed with blood stream

VII. TOOLS AND INSTRUMENTS USED IN NANOTECHNOLOGY:

Scientists use different tools for producing and imaging a nanoscaledobject . Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM) are some instruments of them.

1) Scanning Tunneling Microscope(STM):

Scanning Tunneling Microscope was developed 1981 by Gerd Binnig and Heinrich Rohrer. STM is used for imaging surfaces at atomic level .The lateral resolution of an STM lies around 0.1 nanometre and depth resolution lies around 0.01 nanometre.With this resolution individual atoms are routinely imaged and manipulated.In a STM the tip of device is brought near material,a difference in voltage is applied between them.The difference causes electrons to move through empty space created between them as a result current is formed which depends on position of tip of device and applied voltage.The image is displayed on monitor according to scanning process of the tip on the material.

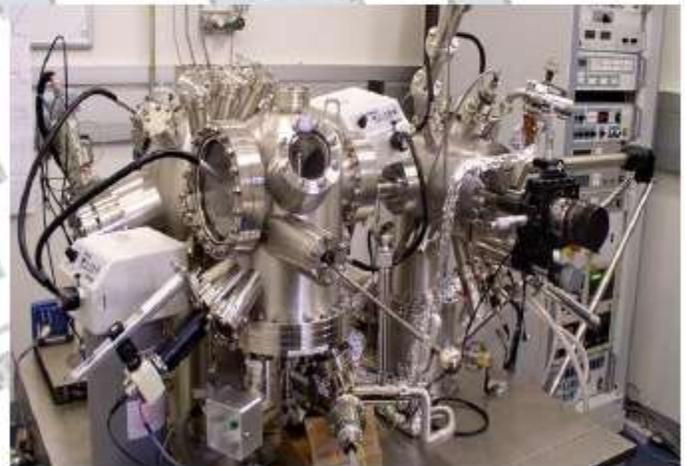


Fig. 6:Scanning Tunneling Microscope

2) Atomic Force Microscope (AFM):

The Atomic Force Microscope (AFM) was developed in the year 1986 by Binnig, Quate and Gerber at the IBM Research – Zurich and earned them the Nobel Prize for Physics for the same year. Atomic force microscopy (AFM) is also known as Scanning force microscopy (SFM). This device is used to visualizing, imaging and for manipulating objects that are in nanometre scale. The resolution of such a device is said to be in the order of fractions of a nanometre. The earlier version of AFM was STM. The AFM uses a small silicon tip as probe to make images of sample material. While probe moves along surface of sample, the electrons of atoms in material begin to repel electrons of probe. The AFM then adjust the height of probe to force of sample constant. A mechanism records the movement of probe and

sends this information to computer that will generate a three dimensional image that will show an exact topography of surface.

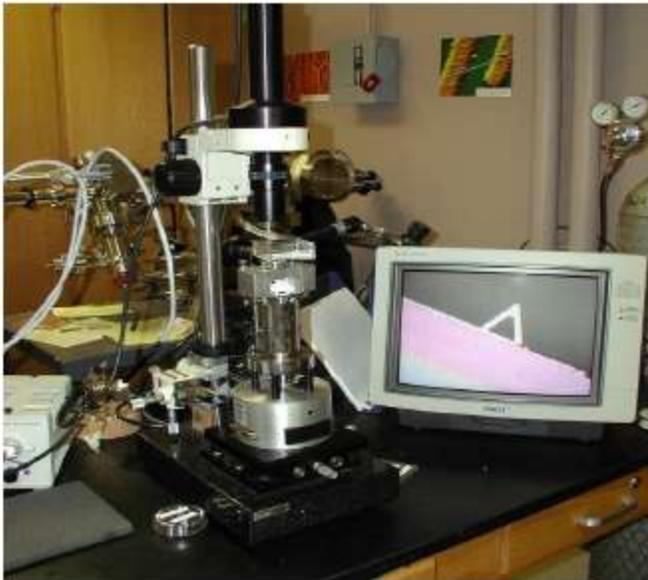


Fig. 7: Atomic Force Microscope

VIII. NANOTECHNOLOGY IN INDIA, GOVERNMENT POLICIES AND INTERNATIONAL COLLABORATIONS:

Nanotechnology in India is at nascent stage which requires government initiatives and emerging industry participation. Department of science and technology initiated "Nanoscience and Technology Mission"(NSTM) in 2007, for 5 years period with allocation of 1000 crores. In this period NSTM has undertaken programme called "Nanoscience and Technology Initiative"(NSTI). Both NSTI and NSTM have operated approximately 200 projects.

Alongwith this Department of Biotechnology is supporting researches in nanotechnology and lifesciences. A network with 38 laboratories that is "CSIR" (Council of Scientific and Industrial Research) has supported nanotechnology in diverse areas. CSIR has also facilitated workshops and collaborative projects in the area of Nanoscience and technology with international partners like South Africa, France, South Korea, China, Japan.

Euro-India collaboration encourages scientist from two regions for research in the area of nanotechnology.

India and UNESCO have signed memorandum of understanding to establish Regional Centre for education and training in biotechnology, where nanotechnology is one of the main focus areas.

Government policies in India indicates awareness of potential to benefit common people although government

support is there; any cut in allocation to nanoscience or Ministry of S&T will affect the funding which is getting to research in nanotechnology.

IX. CARRER OPTIONS IN NANOTECHNOLOGY:

Nanotechnology has increasing impacts on many of our daily lives and hence carrer opportunities in this field are expanding rapidly. With proper training and education we could have bright carrer in this field.

We can have carrer opportunities in different fields like Biotechnolgy, forensis, pharmaceuticals, medical, national security, automobile industry, polymers electronics and many more

For this we need to study sciences of physics, chemistry, biology, computer sciences and mathematics; so that we can develop nanoscience. There is a scope for carrer in research in areas like nanoscience, nanotools, nano crystalline materials, nano photonics etc.

People with associate degree, Bachelors Degree, Masters Degree and Doctorate can have carrer in this field.

According to the recent survey approximately 2 million skilled work interface will be required world wide by 2015

FUTURE APPLICATIONS:

Nanotechnology will redesign future of several technologies, products and markets. Scientists can work with materials at atomic level to create strain proof fabrics, scratch resistant, more efficient fuel cells and batteries.

Experts say that Nanotechnology will create next generation of billionaires and reshape global business. Nanotechnology is producing under range of beneficial materials and pointing to break through in many fields. It has opened scientific enquiry to level of molecule and world of new opportunities.

Some future Applications:

At Feinberg School of medicine at Northwestern University researchers are using nanotechnology to engineer a gel that spurls the growth of nerve cells. The gel fills the space between existing cells encourages new cells to grow while still in expert stage this process could be used to regrow loss or damaged spinal cord or brain cells.

Gecko can run upside down across ceiling and even hang from it by single look inspite being weak. This can be studied using nanotechnology. The feet of Gecko has very fine hairs also its feet is covered with millions of adhesion points

allowing it to run along the ceiling. Scientist are looking forward to produce a synthetic Gecko.



Fig. 8 Gecko with adhesion points

Above figure shows Gecko with adhesion points so that by using these points Gecko can run along the ceiling.

CONCLUSION:

Nanotechnology has evolved over the period of times for many decades and now showing its potential to the entire world. With all its challenges and opportunities, nanotechnology has become unavoidable part of our future.

REFERENCES :

- www.slideshare.net
- www.circuitstoday.com/nanotechnology-tools-instruments
- <http://www.thesleuthjournal.com/i-spy-from-inside/#sthash.8kjVfo7y.dpuf>
- www.nanoall.blogspot.com
- understanding nano.com <https://en.wikipedia.org>
- <ftp.cordis.europa.eu>
- Ses.vierginna.edu
- www.nanotechproject.org
- Wwwwncbi.nlm.nih.gov
- www.nanocap.eu
- www.understandingnano.com
- www.nanowork.com
- www.seas.virginia.edu/admin/diversity/k12files/NIN-What-is-Nanotech.Pdf.