

# NANOTECHNOLOGY



# Topics of the day

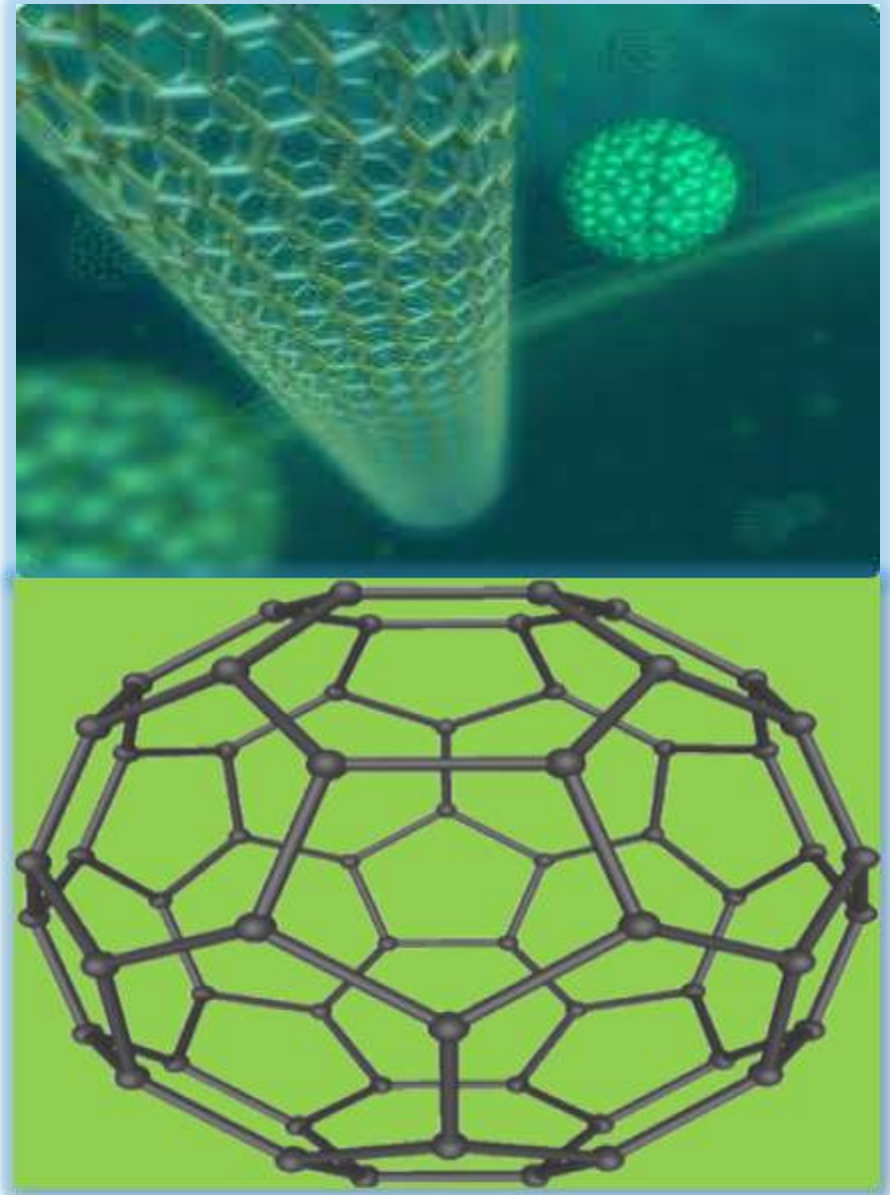
- Introduction
- Defination
- History
- Timeline
- Tools & techniques
  - Carbon nanotubes
  - Nanorods
  - Nanobots
- Approaches used
  - Top-down
  - Bottom-up
- Materials used
- Application
  - Drugs
  - Fabrics
  - Mobiles
  - Electronics
  - Computers
  - Other uses
- Nanotechnology in INDIA
- Possibilities for future
- Pitfalls of nanotechnology.

# NANO & TECHNOLOGY

- A **Nanometre** is a unit of length in the metric system, equal to one billionth of a metre( $10^{-9}$ ).
- **Technology** is the making, usage, and knowledge of tools, machines and techniques, in order to solve a problem or perform a specific function.

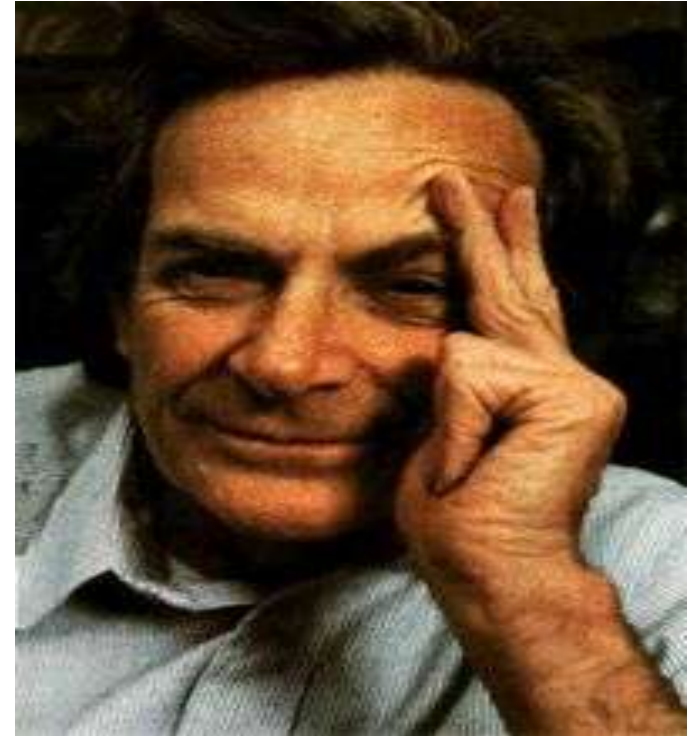
# Defination

- **Nanotechnology** is the study of manipulating matter on an atomic scale.
- **Nanotechnology** refers to the constructing and engineering of the functional systems at very micro level or we can say at atomic level.
- A **Nanometer** is one billionth of a meter, roughly the width of three or four atoms. The average human hair is about 25,000 nanometers wide.



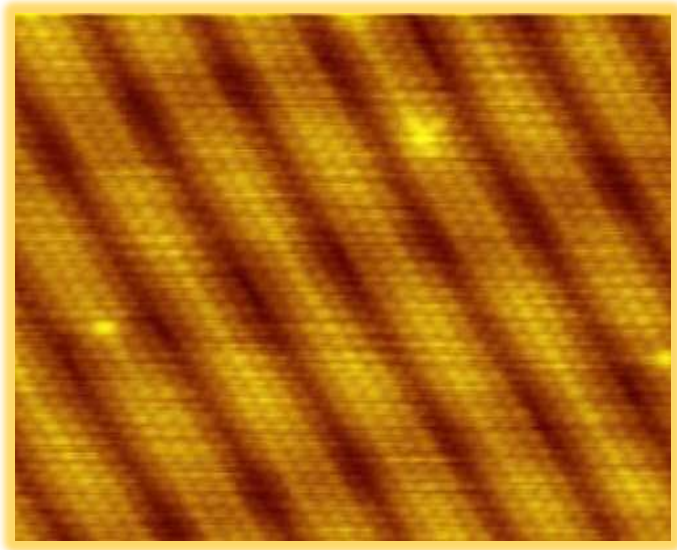
# History

- The first ever concept was presented in 1959 by the famous professor of physics **Dr. Richard P. Feynman**.
- Invention of the **scanning tunneling microscope** in 1981 and the discovery of **fullerene**(C<sub>60</sub>) in 1985 lead to the emergence of **nanotechnology**.
- The term **“Nano-technology”** had been coined by Norio Taniguchi in 1974



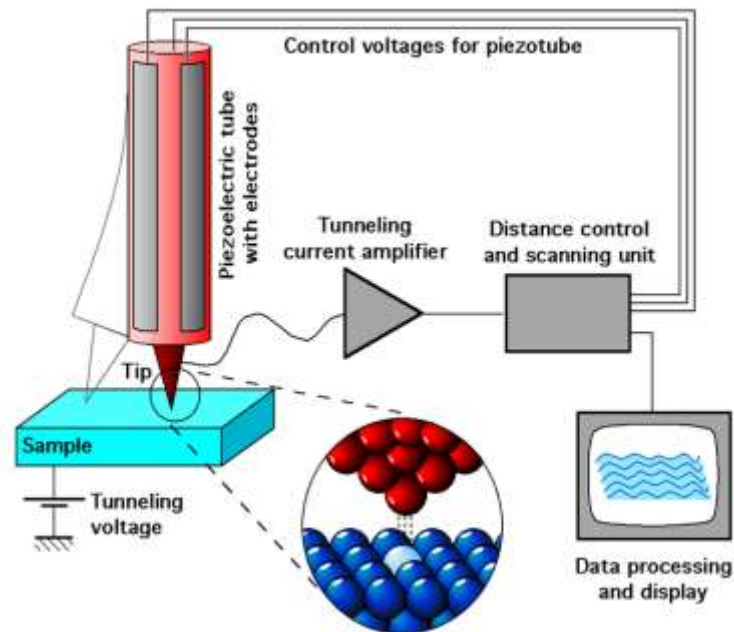
**THERE'S PLENTY  
OF  
ROOM AT THE  
BOTTOM**





- The early 2000s also saw the beginnings of commercial applications of nanotechnology, although these were limited to bulk application of nanomaterials.

- **Silver nano** platform for using silver- nanoparticles as an **antibacterial agent**, **nanoparticle-based transparent sunscreens**, and **carbon nanotubes** for stain-resistant textiles.



# MACRO



PERSON (~6ft tall)  
2 billion nm



APPLE (~8cm)  
80 million nm



ANT (~5mm)  
5 million nm

100,000 nm (.1 mm)



diameter of  
a HUMAN  
HAIR  
75,000 nm

smallest the  
EYE CAN SEE  
10,000 nm



e. coli  
BACTERIA  
2,000 nm

100 nm (.001 mm)

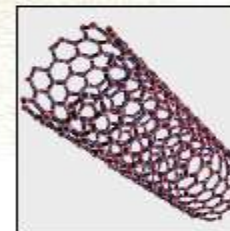
# NANO



BUCKYBALL  
1 nm

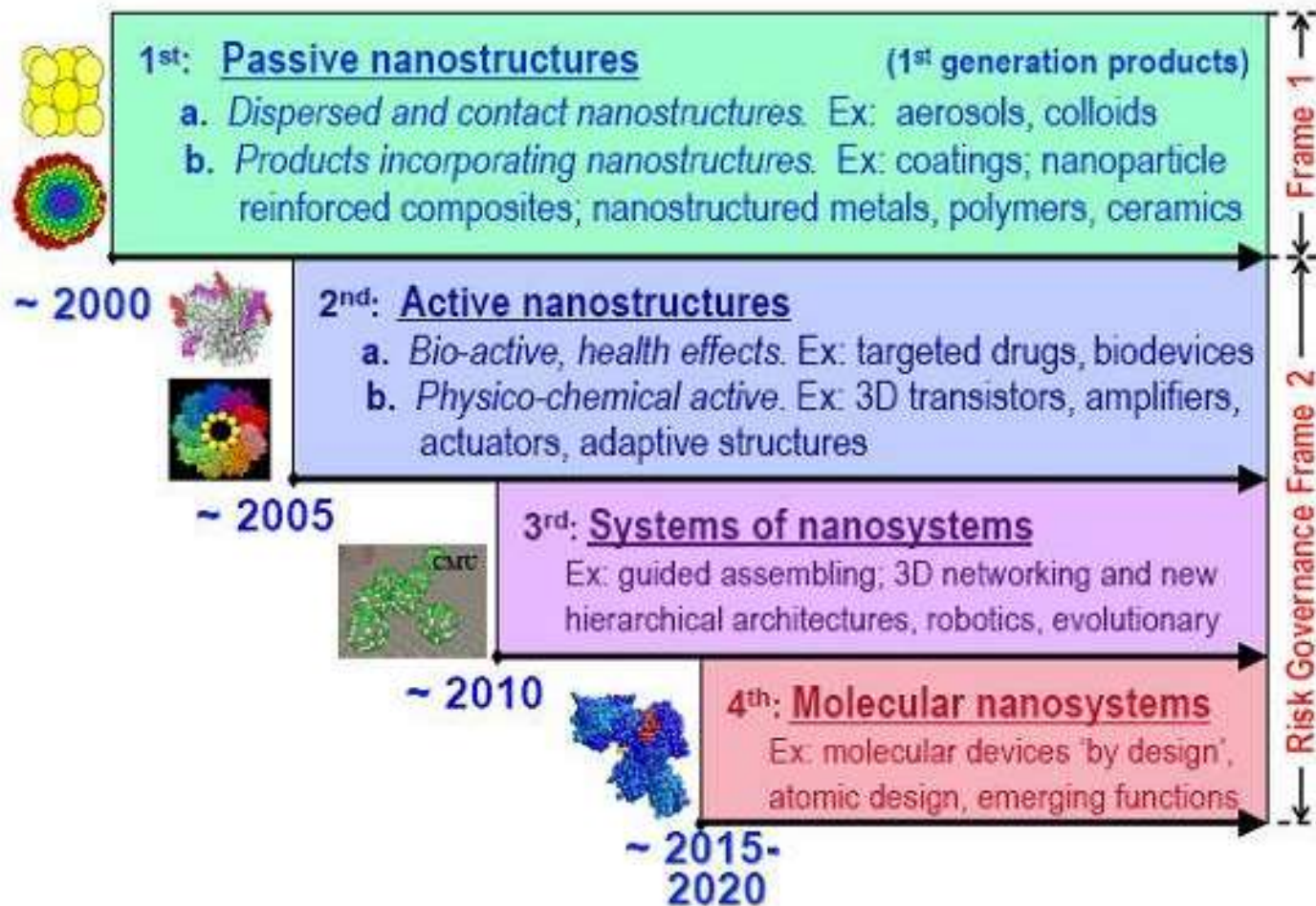


DNA  
2 nm



diameter of a  
CARBON  
NANOTUBE  
1.3 nm

# Timeline

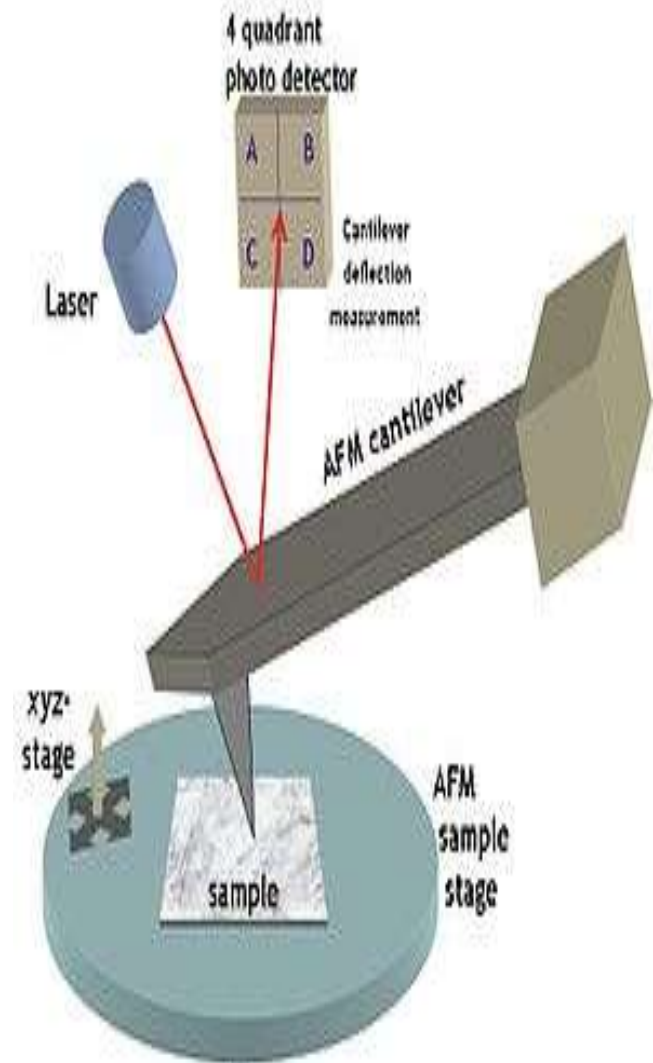




# Tools & Technology

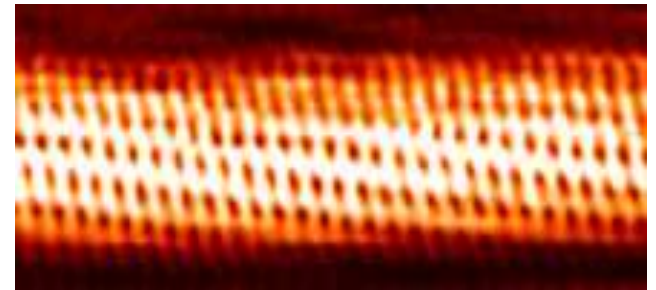
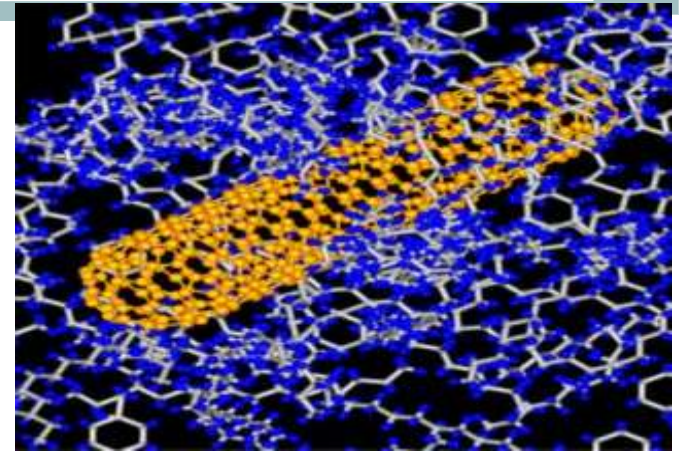
- There are several important modern developments.
  - The **atomic force microscope (AFM)**.
  - The **Scanning Tunneling Microscope (STM)** are scanning probes that launched nanotechnology.
- Various techniques of **nanolithography** such as:
  - optical lithography.
  - X-ray lithography,
  - **Dip pen nanolithography**
  - **Electron beam lithography(inkjet printer)** were also developed.

**Lithography** in MEMS context is typically the transfer of a pattern into a photosensitive material by selective exposure to a radiation source such as light.



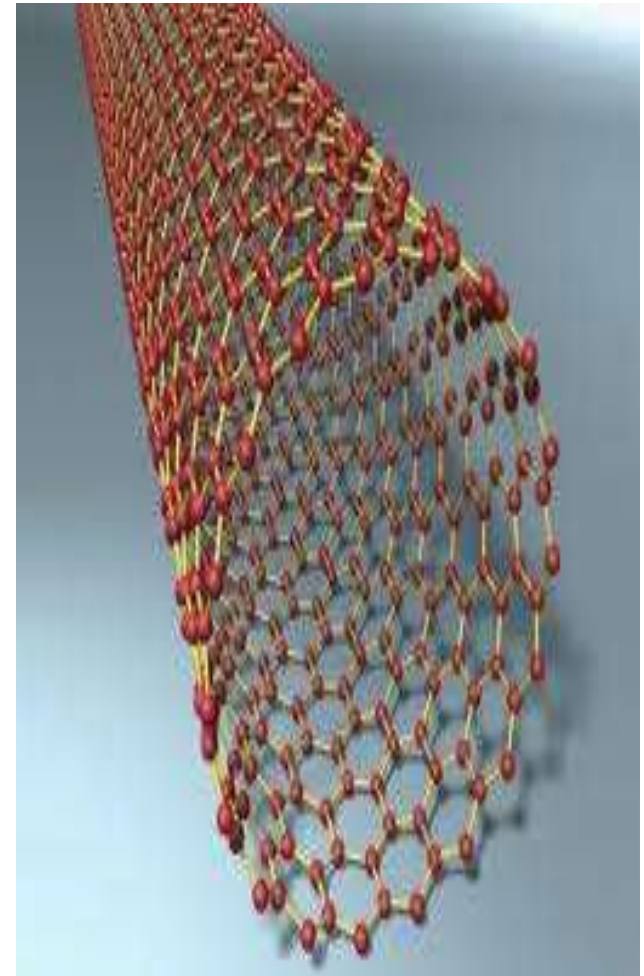
# Carbon Nanotube

- Carbon nanotubes are allotropes of carbon with a cylindrical nanostructure.
- They have length-to-diameter ratio of upto 132,000,000:1.
- Nanotubes are members of the fullerene structural family. Their name is derived from their **long, hollow structure** with the walls formed by **one-atom-thick sheets of carbon, called graphene**.
- **Properties**
  - Highest strength to weight ratio, helps in creating *light weight spacecrafts*.
  - Easily penetrate membranes such as cell walls. Helps in *cancer treatment*.
  - **Electrical resistance** changes significantly when other molecules attach themselves to the carbon atoms. Helps in developing *sensors* that can detect chemical vapours.



# Carbon Nanotube

- Application
  - **Easton-Bell Sports, Inc.** using CNT in making **bicycle component**.
  - **Zyvex Technologies** using CNT for manufacturing of light weight boats.
  - Replacing transistors from the silicon chips as they are **small** and **emits less heat**.
  - In electric cables and wires
  - In solar cells
  - In fabrics

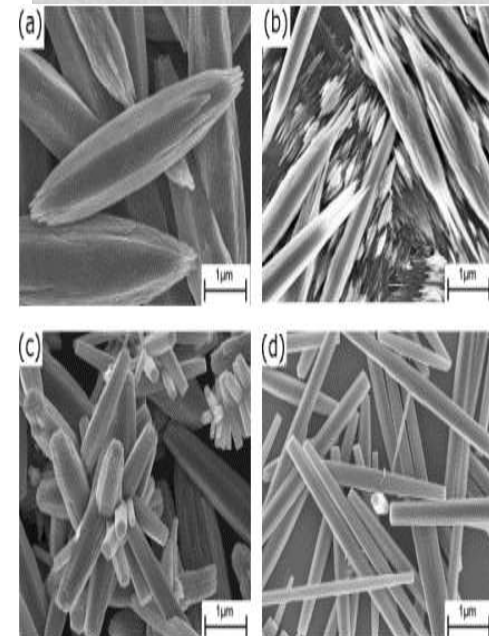
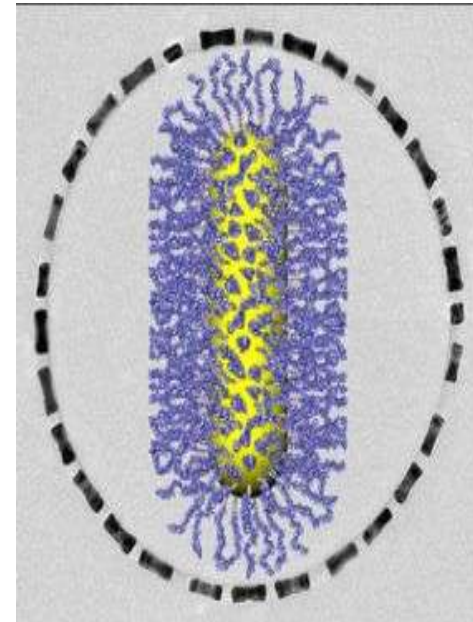


# Nanorods(quantum dots)

- **Nanorods** are one morphology of **nanoscale** objects.
- Dimensions range from 1–100 nm.
- They may be synthesized from metals or semiconducting materials.
- A combination of **ligands** act as shape control agents and bond to different facets of the **nanorod** with different strengths. This allows different faces of the nanorod to grow at different rates, producing an elongated object.

## □ USES:

- In **display technologies**, because the reflectivity of the rods can be changed by changing their orientation with an applied electric field.
- In **microelectromechanical systems (MEMS)**.
- In **cancer therapeutics**.





# Nanobots

- Close to the scale of  $10^{-9}$ .
- Largely in R&d phase .
- Nanobots of 1.5 nanometers across, capable of counting specific molecules in a chemical sample.
- Since nanorobots would be microscopic in size, it would probably be necessary for very large numbers of them to work together to perform microscopic and macroscopic tasks.
- Capable of replication using environmental resources .
- Application:
  - Detection of toxic components in environment.
  - In drug delivery.
  - Biomedical instrumentation.

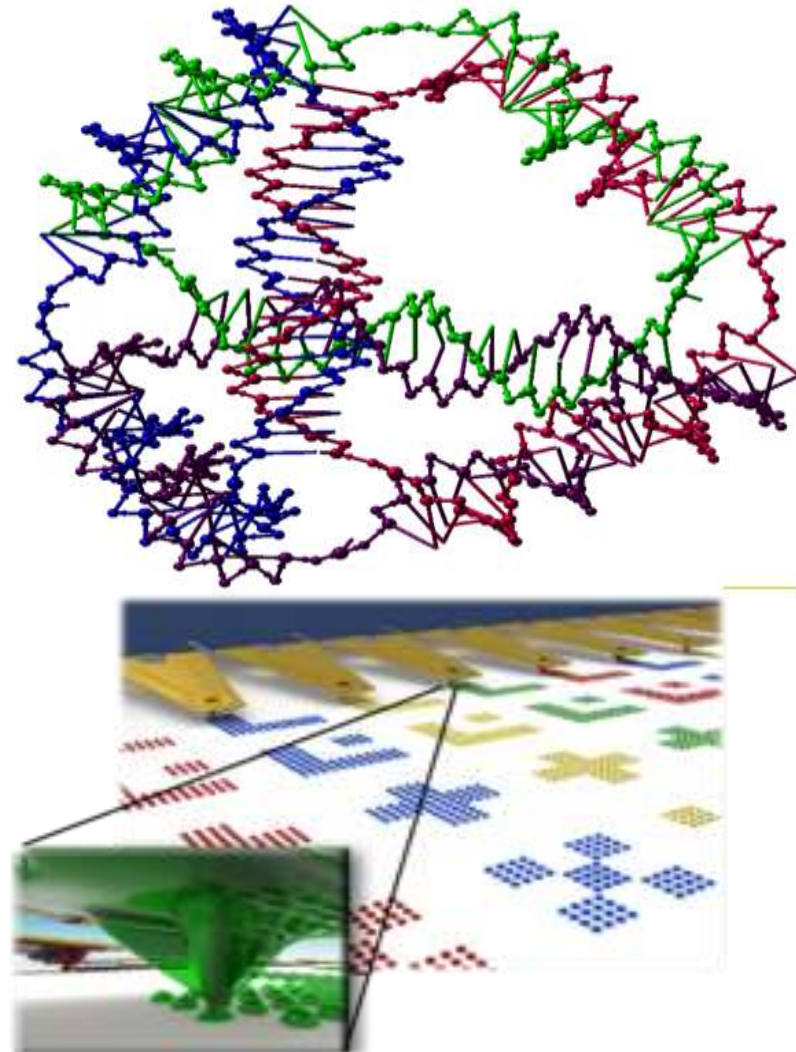


# Approaches in nanotechnology

## 1. Bottom up:

In the bottom up approach different materials and devices are constructed from molecular components of their own. They chemically assemble themselves by recognizing the molecules of their own breed.

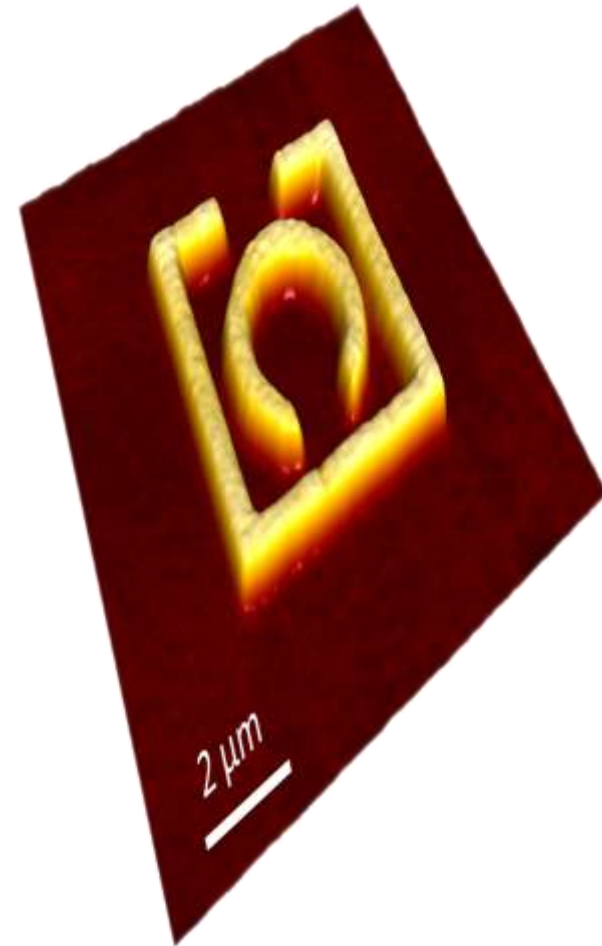
- Examples of molecular self assembly are **Watson crick base pairing , nano-lithography** .



## 2. Top down:

In top down approach nano objects and materials are created by larger entities without bouncing its atomic reactions usually top down approach is practiced less as compared to the bottom up approach.

- **Solid-state techniques** can also be used to create devices known as **nanoelectromechanical systems** or NEMS, which are related to **microelectromechanical systems** or MEMS.
- MEMS became practical once they could be fabricated using modified semiconductor device fabrication technologies, normally used to make electronics.



# Materials used

- Zinc oxide:
  - Dirt repellent, hydrophobic , cosmetics & stain resistant.
- Silver ion:
  - Healing property
- Aluminum silicate:
  - Scratch resistance
- Gold ion:
  - Chip fabrication, drug delivery.

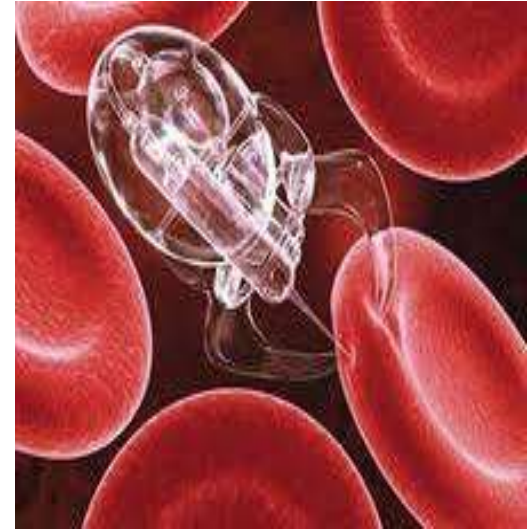


# Application Of Nanotechnology



# Nanotechnology in Drugs(Cancer)

- Provide new options for drug delivery and drug therapies.
- Enable drugs to be delivered to precisely the **right location** in the body and release drug doses on a **predetermined schedule** for optimal treatment.
- Attach the drug to a **nanosized carrier**.
- They become localized at the disease site, i.e cancer tumour.
- Then they release medicine that **kills the tumour**.
- Current treatment is through radiotherapy or chemotherapy.
- Nanobots can **clear the blockage** in arteries.



# Nanotechnology in Fabrics

- The properties of familiar materials are being changed by manufacturers who are adding **nano-sized components** to conventional materials to improve performance.
  - For example, some clothing manufacturers are making water and stain repellent clothing using **nano-sized whiskers** in the fabric that cause water to bead up on the surface.
  - In manufacturing **bullet proof jackets**.
  - Making **spill & dirt** resistant, antimicrobial, antibacterial fabrics.



# Nanotechnology in Mobile

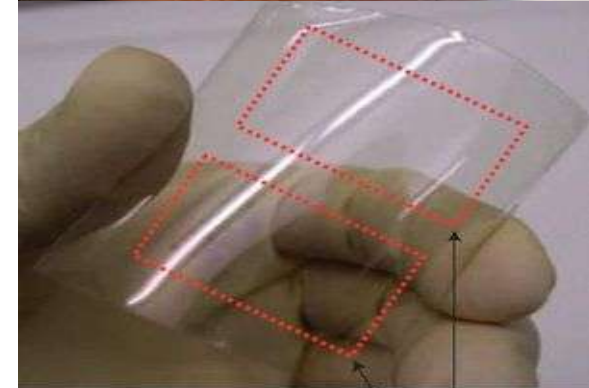
- Morph, a nanotechnology concept device developed by Nokia Research Center (NRC) and the University of Cambridge (UK).
- The Morph will be **super hydrophobic** making it **extremely dirt repellent**.
- It will be able to **charge itself** from available light sources using photovoltaic **nanowire grass** covering it's surface.
- Nanoscale electronics also allow **stretching**. Nokia envisage that a nanoscale mesh of fibers will allow our mobile devices to be bent, stretched and folded into any number of conceivable shapes.





# Nanotechnology in Electronics

- Electrodes made from **nanowires** enable flat panel displays to be flexible as well as thinner than current flat panel displays.
  - Nanolithography is used for **fabrication of chips**.
  - The transistors are made of nanowires, that are assembled on glass or thin films of **flexible plastic**.
  - E-paper, displays on sunglasses and map on car windshields.



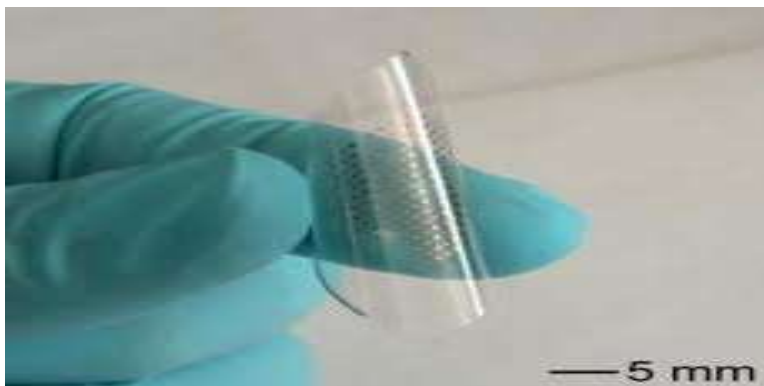
Transistor array regions

# Nanotechnology in computers

- The silicon transistors in your computer may be replaced by transistors based on **carbon nanotubes**.
- A carbon nanotube is a molecule in form of a hollow cylinder with a diameter of around a nanometer which consists of pure carbon.
- **Nanorods** is an upcoming technology in the **displays techniques** due to less consumption of electricity and less heat emission.
- Size of the microprocessors are reduced to greater extent.
- Researchers at North Carolina State University says that growing arrays of magnetic nanoparticles, called **nanodots**.



- Hewlett Packard is developing a memory device that uses **nanowires coated with titanium dioxide**.
- One group of these nanowires is deposited parallel to another group.
- When a perpendicular nanowire is laid over a group of parallel wires, at each intersection a device called a **memristor** is formed.
- A memristor can be used as **a single-component memory cell** in an integrated circuit.
- By reducing the diameter of the nanowires, researchers believe memristor memory chips can achieve **higher memory density than flash memory chips**.
- Magnetic nanowires made of an **alloy of iron and nickel** are being used to create dense memory devices.



- Chips produced by Intel before “i” series processors were between **65nm -45nm**.
- Later with the help of nanotechnology **22nm** chips were made which itself is a milestone.

- **Advantages of using carbon nanotubes:**

- **Faster and smaller-** carbon nanotubes can be used to produce smaller and faster components.
- This will also result in computers that consume **less energy**.
- **High speed and high capacity memory.**
- Allows circuits to be **more accurate** on the atomic level.



# Other uses

- Cutting tools made of **nanocrystalline materials**, such as tungsten carbide, tantalum carbide and titanium carbide, are more wear and **erosion-resistant, and last longer** than their conventional counterparts.
- **Silver nanocrystals** have been embedded in bandages to kill bacteria and prevent infection.
- Nanoparticulate-based **synthetic bone**
  - **Formed by manipulating calcium and phosphate at the molecular level.**
- **Aerogels** lightest known solid due to good insulating properties is used in space suits and are proposed to use in space craft.

# Nanotechnology in India

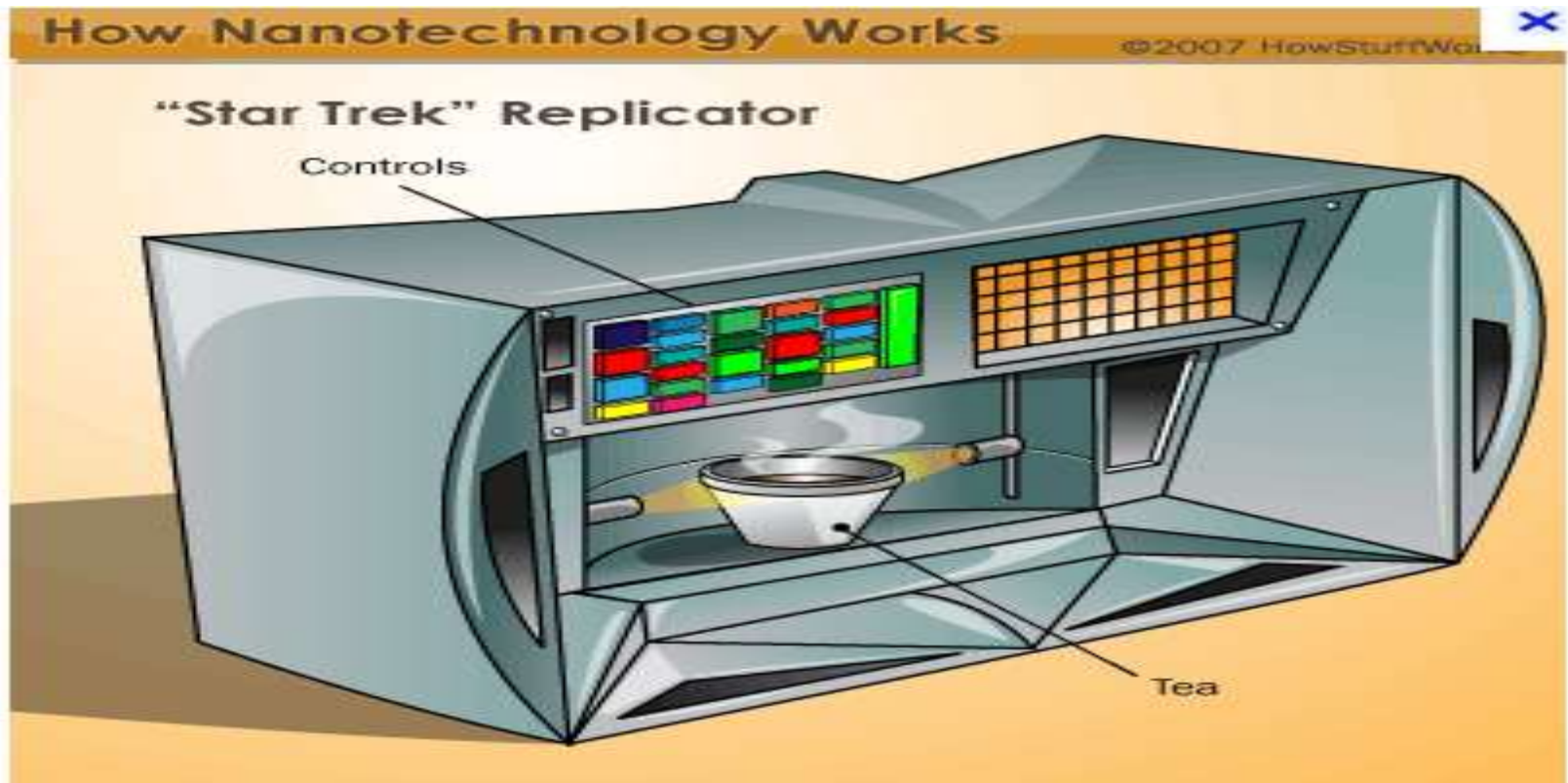
- IIT Mumbai is the premier organization in the field of nanotechnology.
- Research in the field of health, environment, medicines are still on.
- Starting in 2001 the Government of India launched the Nano Science and Technology Initiative (NSTI).
- Then in 2007 the Nanoscience and Technology Mission 2007 was initiated with an allocation of Rupees 1000 crores for a period of five years.
- The main objectives of the Nano Mission are:
  - basic research promotion,
  - infrastructure development for carrying out front-ranking research,
  - development of nano technologies and their applications,
  - human resource development and
  - international collaborations.

[illegible]

# Possibilities for the future

- Nanotechnology may make it possible to manufacture **lighter, stronger, and programmable materials that**
  - require less energy to produce than conventional material
  - and that promise greater fuel efficiency in land transportation, ships, aircraft, and space vehicles.
- The future of nanotechnology could very well include the use of **nanorobotics**.
- These nanorobots have the potential to take on human tasks as well as tasks that humans could never complete. The rebuilding of the depleted ozone layer could potentially be able to be performed.

- There would be an entire nano surgical field to help cure everything from natural aging to **diabetes to bone spurs**.
- There would be almost nothing that couldn't be repaired (eventually) with the introduction of **nano surgery**.





# Pitfalls of nanotechnology

- Nano-particles can get into the body through the skin, lungs and digestive system, thus creating free radicals that can cause **cell damage**.
- Once nano-particles are in the bloodstream, they will be able to **cross the blood-brain barrier**.
- The most dangerous Nano-application use for military purposes is the **Nano-bomb** that contain engineered self multiplying deadly viruses that can continue to wipe out a community, country or even a civilization.
- Nanobots because of their **replicating** behavior can be big threat for GRAY GOO.

# Bottom Line

*"The Next Big Thing Is Really Small"*

# References

1. <http://science.howstuffworks.com/nanotechnology3.htm>
2. [http://en.wikipedia.org/wiki/Carbon\\_nanotube](http://en.wikipedia.org/wiki/Carbon_nanotube)
3. [http://en.wikipedia.org/wiki/\*\*Nanotechnology\*\*](http://en.wikipedia.org/wiki/Nanotechnology)
4. <http://crnano.org/whatis.htm>
5. <http://www.wifinotes.com/nanotechnology/introduction-to-nanotechnology.html>
6. [www.iitb.ac.in/~crnts/](http://www.iitb.ac.in/~crnts/)
7. [www.nafen\*\*india\*\*.com/Final\\_Report\\_Nano\\_OK.pdf](http://www.nafenindia.com/Final_Report_Nano_OK.pdf)
8. [www.sciencedaily.com/releases/2010/05/100531082857.htm](http://www.sciencedaily.com/releases/2010/05/100531082857.htm)
9. <http://www.nanostart.de/index.php/en/nanotechnology/nanotechnology-information/610-schneller-sparsamer-robuster-nanotechnologie-in-computer-handy-a-co>



THANK YOU



**QUERIES**