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Nanotechnology Fundamental

Presented By

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Outline:

- **What is Nanotechnology?**
- **What is nanomaterial?**
- **Properties of nanotechnology materials**
- **Types of Nanomaterials**
- **Applications of Nanotechnology**

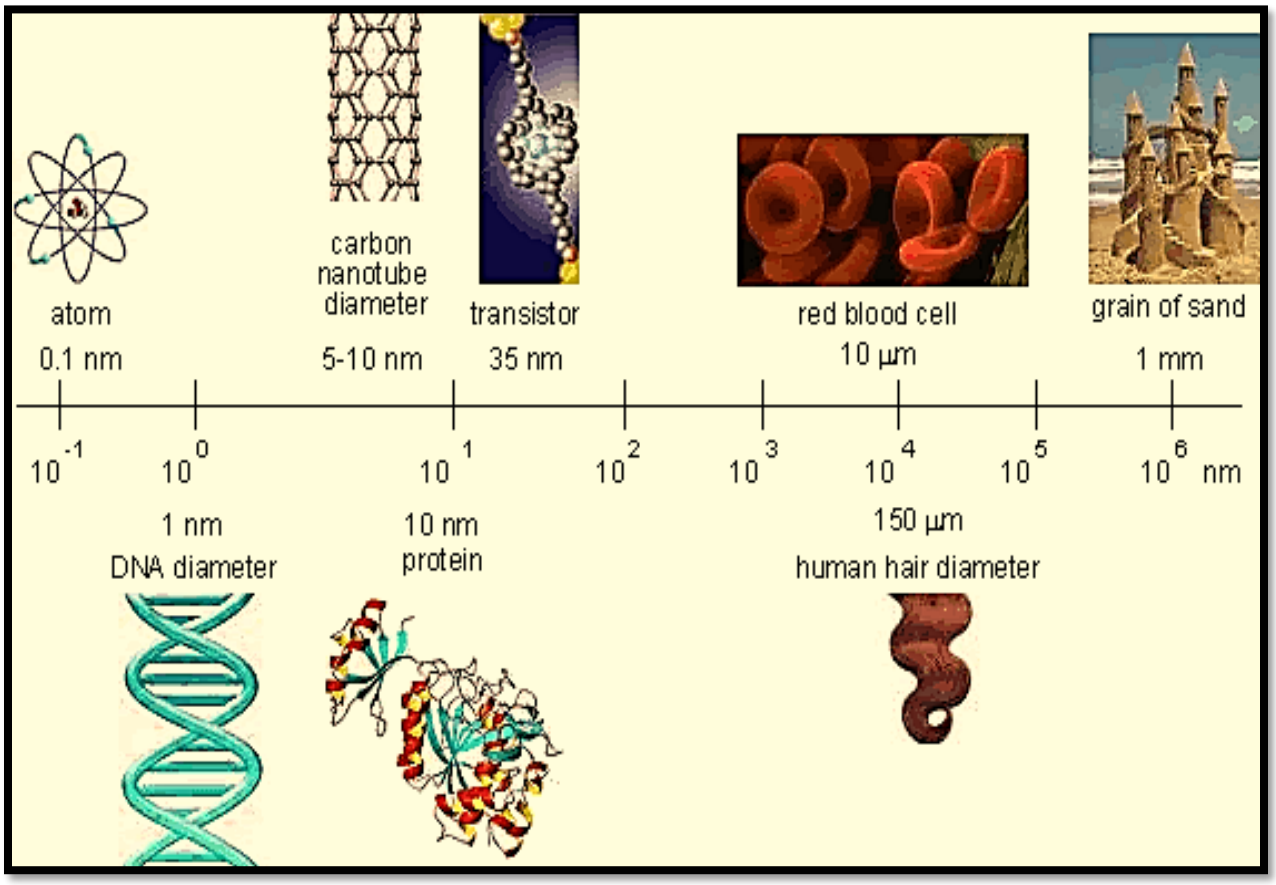
What is Nanotechnology?

The design, characterization, and application of structures, devices, and systems by controlled manipulation of size and shape of materials at the nanometer scale (atomic, molecular, and macromolecular scale), to produce materials with at least one novel/superior characteristic or property.

1 nanometer (nm) = 10^{-9} meter

Principles of nanotechnology materials

- Ability to construct any material.
- Physical and chemical properties in nanomaterials are difference from same material in normal volume.
- Ability to remove impurities and rid of defects.
- Materials have strong, lightest, smaller and cheaper.

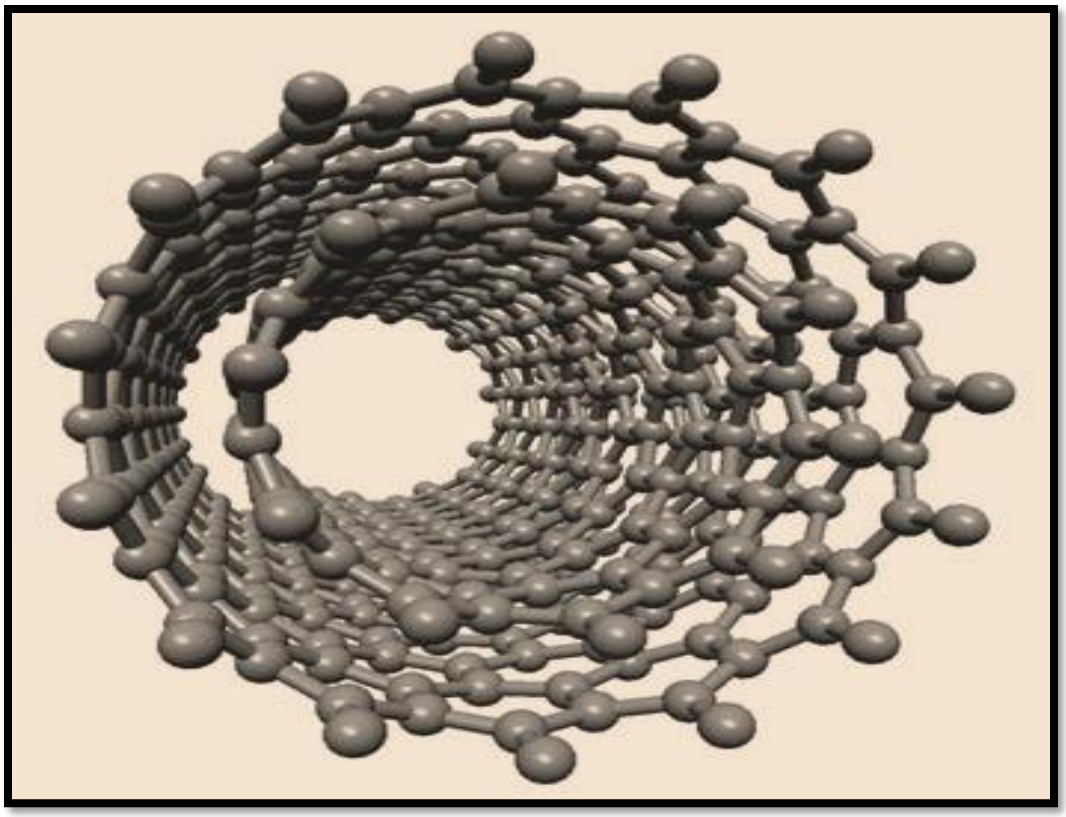


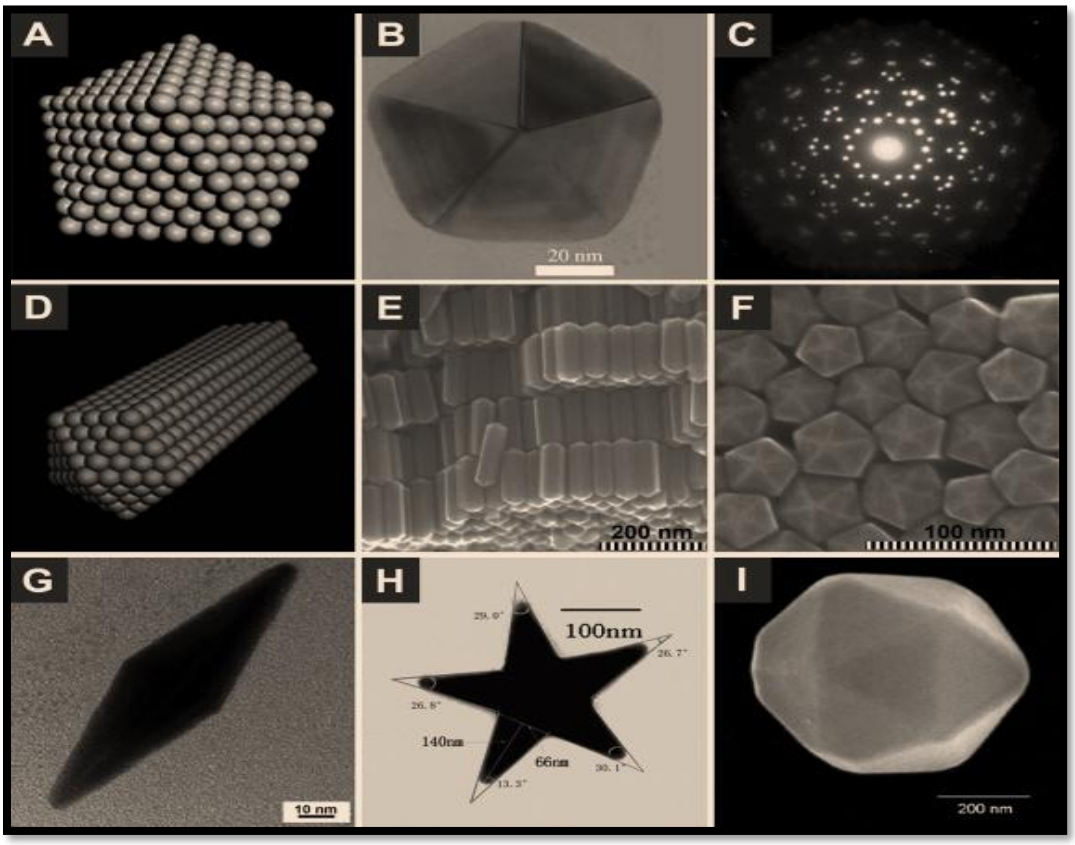
What is nanomaterial?

- Is defined as any material that has unique or novel properties, due to the nanoscale (nano meter- scale) structuring. These are formed by incorporation or structuring of nanoparticles. They are subdivided into nanocrystals, nano powders, and nanotubes: A sequence of nanoscale of C60 atoms arranged in a long thin cylindrical structure.

Nanomaterials are interesting because at the small scale, materials have fundamentally different properties than at the bulk due to increased surface area to volume ratios.

- Nanotubes are extremely strong mechanically and very pure conductors of electric current. Applications of the nanotube include resistors, capacitors, inductors, diodes and transistors.).
- Nanomaterials have a relatively larger surface area compared to the same mass of material produced in a larger/bulk form.
- This makes materials more chemically reactive (sometimes inert materials in larger bulk form can become reactive when produced in their tiny nanoscale), and affect their (mechanical/electrical/optical/magnetic) properties.
- Quantum effects begin to dominate the behavior.
- The mechanical, thermal, optical, electrical and magnetic behavior of materials exhibit huge difference in the nanoscale size.




A
B
20 nm
C
D
E
200 nm
F
100 nm
G
10 nm
H
100nm
140nm
66nm
I
200 nm

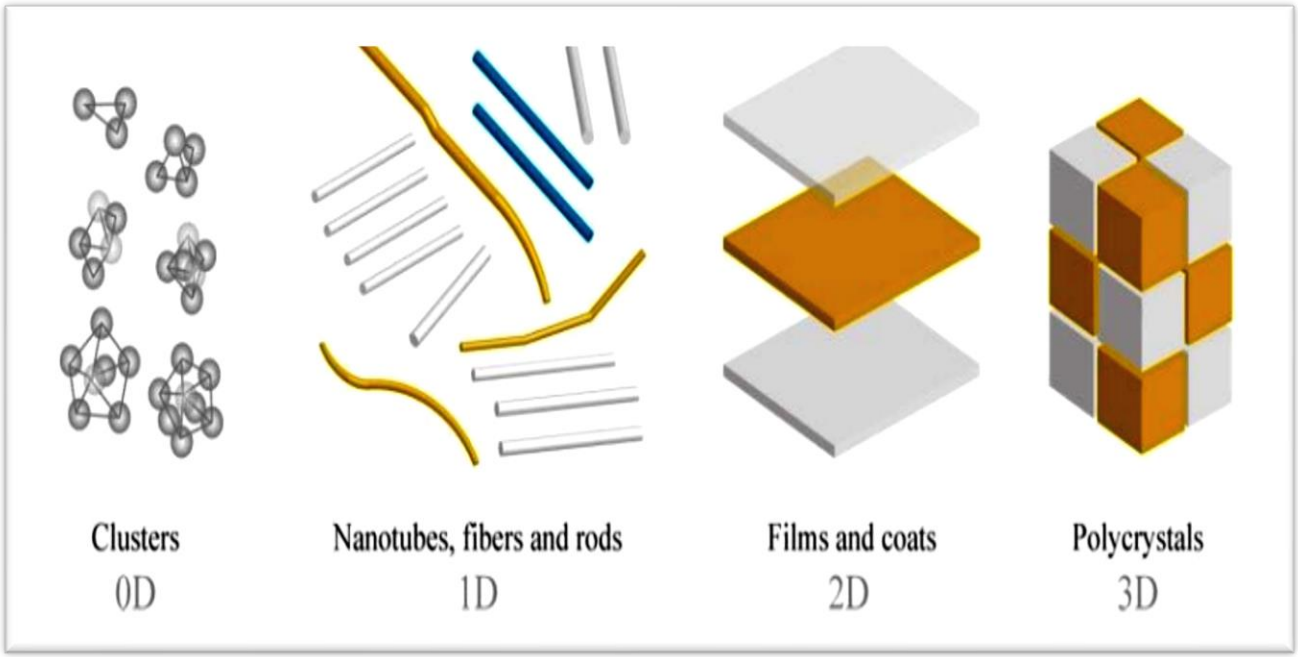
Properties of nanotechnology materials

Nano materials that has a range of dimension(1-100nm) that difference in size leads to change in properties :

1. **Mechanical** : increase in hardness for metallic materials and it's resistant stress , for exp. if we minimize ceramic particle it will be more strength , this character doesn't existed in normal ceramic .
2. **Melting point** : the melting point effect by minimize the dimension, melting point of gold is 1064°if minimize the diameters of gold particles the melting point will be 500°.
3. **Magnetic** : magnetism strength depends on dimension measurement of material that the magnets made of .minimize nanoparticles and increase surface area (increase in atoms at surface) leads to increase in magnetism strength and intensity .
4. **Electrical** : Smallest size of nanomaterials has positive impact on Electrical property, increase in conductivity used in tiny sensors and electric chips .
5. **Chemical:** if the nanoparticles are homogeneous and same size, their Chemical interaction increases.

Types of Nanomaterials

Classification: Based on the Number of free dimensions



- 0-D nanomaterial: None can be outside nanoscale. All the three dimensions are in nanoscale range. Ex. Nanoparticles, Colloids, Quantum dots, fullerenes, etc.
- 1D nanomaterial: One dimension outside the nanoscale & two other dimensions in the nanoscale range.

  Ex.: Nanowires, Nanorods, Nanotubes & Biopolymers.
- 2D nanomaterial: Any two dimensions can be outside the nanoscale & one dimension in nanoscale range. Exhibit plate-like shapes.

  Ex.: Nanolayers, Surface coatings and thin films.
- 3D nanomaterial: Bulk nanomaterials & all three dimensions can be outside nanoscale. But, made up of a collection of nano-particles/materials. Ex.: Dispersions of nanoparticles, bundles of nanowires/nanotubes & multiple nanolayers.

Applications of Nanotechnology
General Applications

Application	Examples
Medicine	Diagnostics, Drug delivery, Tissue engineering, Cryonics
Information and communication	Memory storage, Novel semiconductor devices, Novel optoelectronic devices, Displays, Quantum computers
Heavy Industry	Aerospace, Catalysis, Catalysis, Construction Vehicle manufacturers
Consumer goods	Foods, Household, Optics, Textiles, Cosmetics, Sports
Environment	

Carbon capture	Photocatalyst consisting of silica Nanosprings coated with a combination of titanium dioxide
Sensors	Pollutants sensors that able to detect lower limits with low cost
Remediation (decontamination, oil spill management)	Heavy metal decontaminant removes heavy metals such as lead, cadmium, nickel, zinc, copper, manganese and cobalt in a neutral pH environment without using any form of sulphur .
Wastewater treatment	Veolia Water Solutions & Technologies' ceramic membrane modules, utilizing the CeraMem technology platform, can be supplied with a variety of inorganic microfiltration and ultrafiltration membranes.
Energy	Heat distribution e.g. ceramic-like materials that provide sufficient reliability and durability of the entire structure