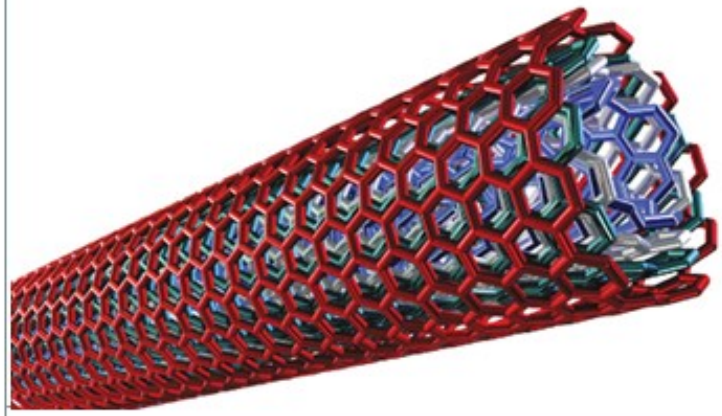


NANOMATERIALS

Prof. Dr. Zohra Nazir Kayani

What is nanomaterial

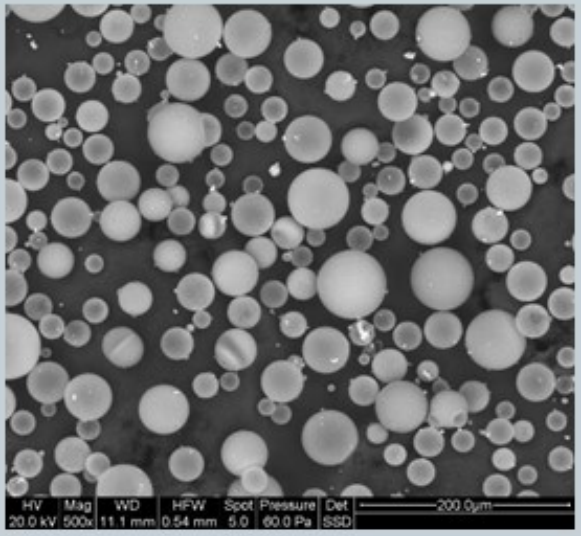
- Nanomaterials are commonly defined as materials with an average grain size **less than 100 nanometers**
- Nanomaterials have extremely small size which having at least **one dimension 100 nm**
- **One billion** nanometers equals **one meter**

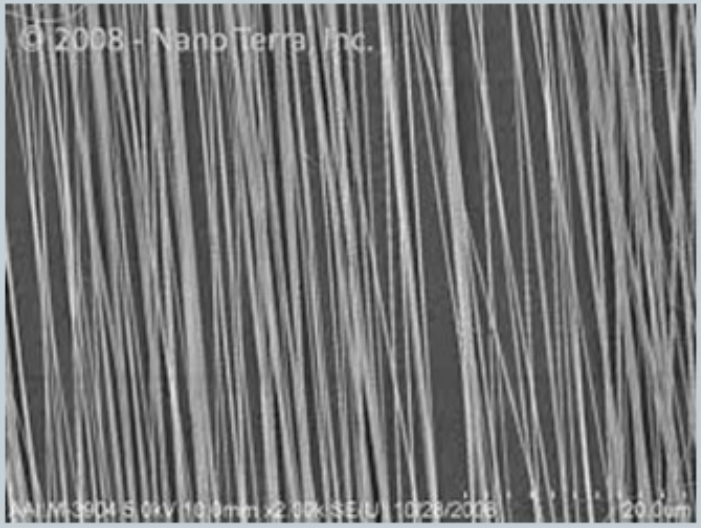
- The average width of a **human hair** is on the order of **100,000 nanometers**

- A single particle of **smoke** is in the order of **1,000 nanometers**

Nanomaterial shapes

- nanomaterials can be nanoscale in **one dimension** (surface films)
- **Two dimensions** (strands or fiber)
- **Three dimensions** (particles)
- They can exist in single or fused forms with spherical, tubular, and irregular shapes.





Why nanomaterials ?

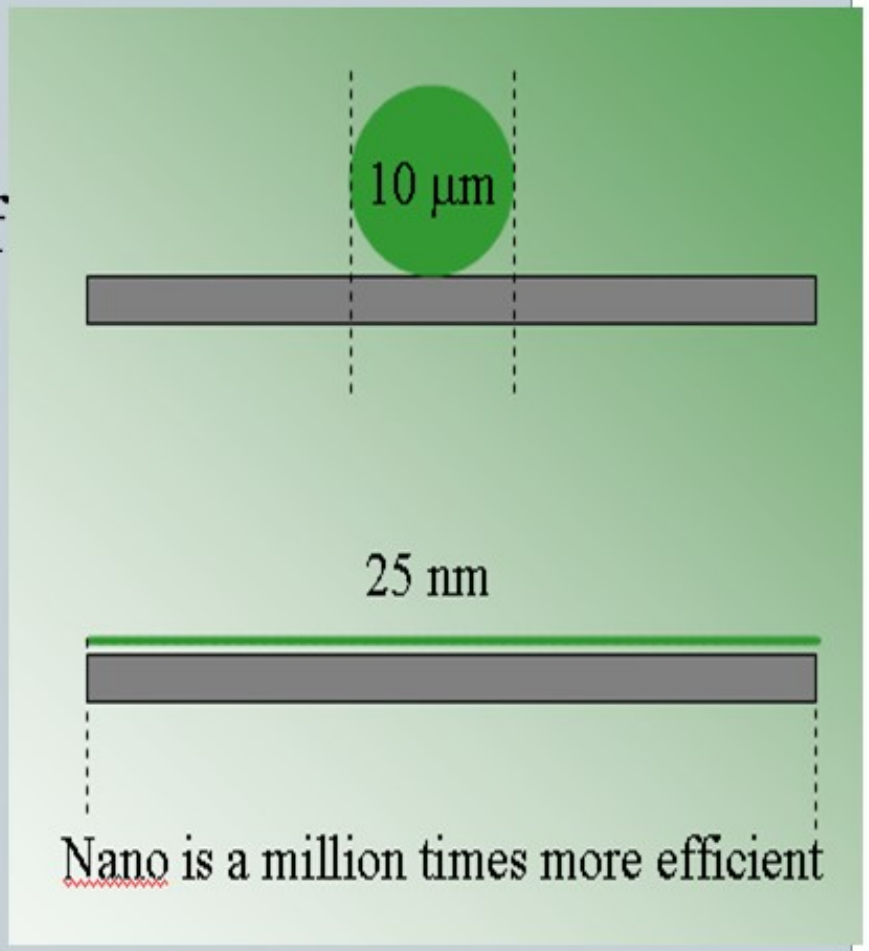
- Nanotechnology exploits benefits of ultra small size, enabling the use of particles to deliver a range of important benefits
  - Small particles are '**invisible**' :
    - **Transparent Coatings**/Films are attainable
  - Small particles are **very weight efficient**:
    - Surfaces can be modified with minimal material

- the behavior of nanomaterials may depend more on **surface area** than particle composition itself.

- Relative-surface area is one of the principal factors that enhance its reactivity, strength and electrical properties.

Weight efficient and Uniform coverage

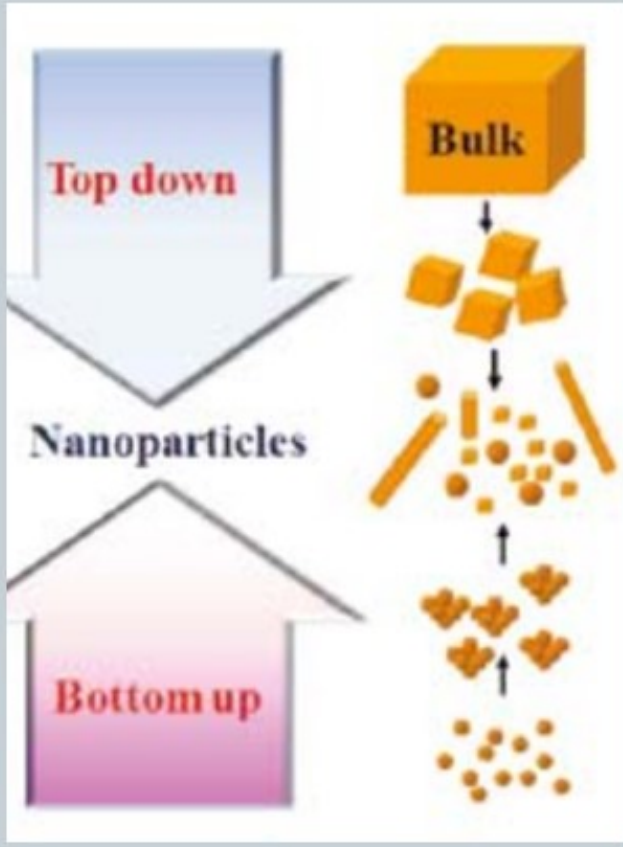
- Large spherical particles do not cover much surface area
- Nanoparticles Equal mass of small platelet particles provides thorough coverage (1 x 106 times more)



- by patterning matter on **the nano scale**, it is possible to vary fundamental properties of materials **without changing the chemical composition**

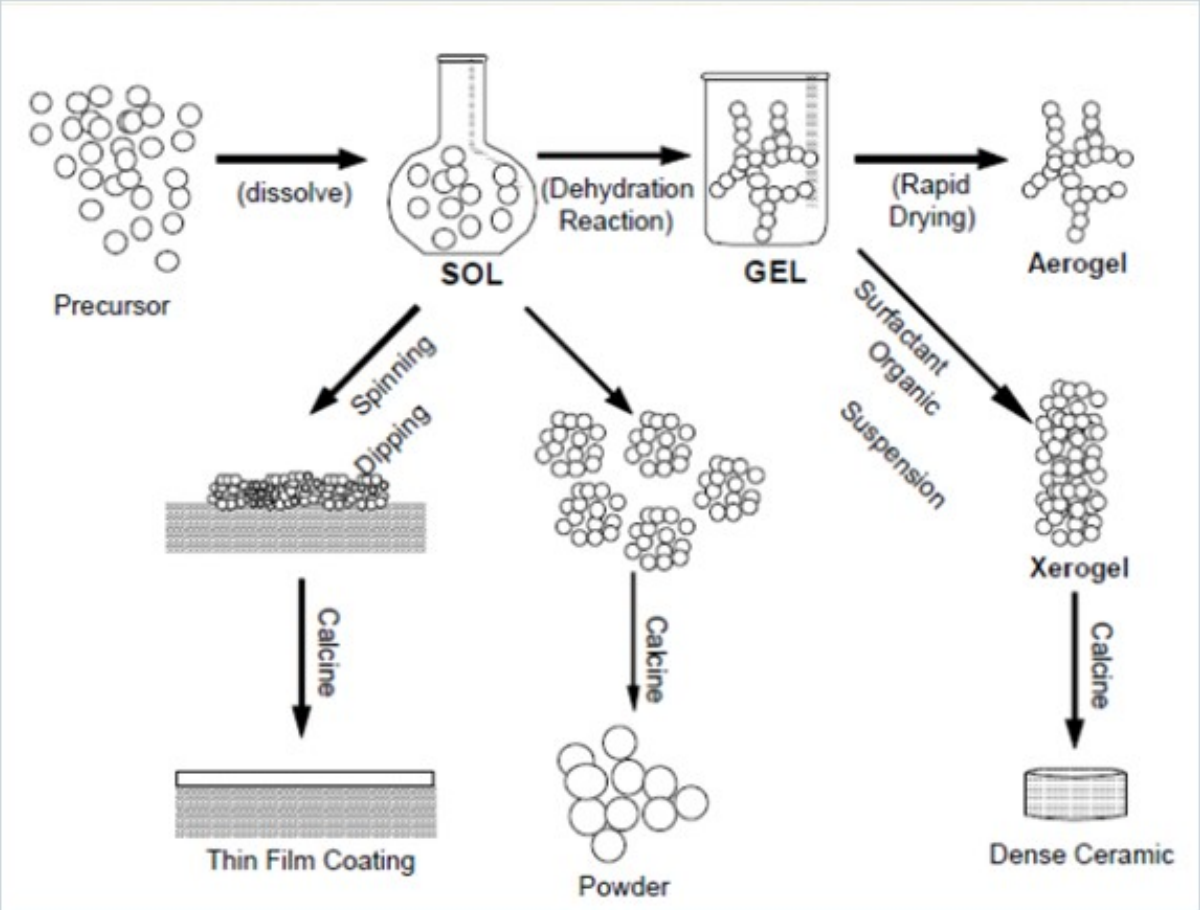
Approaches

- **Top-down** – Breaking down matter into more basic building blocks. Frequently uses chemical or thermal methods.
- **Bottoms-up** – Building complex systems by combining simple atomic-level components.



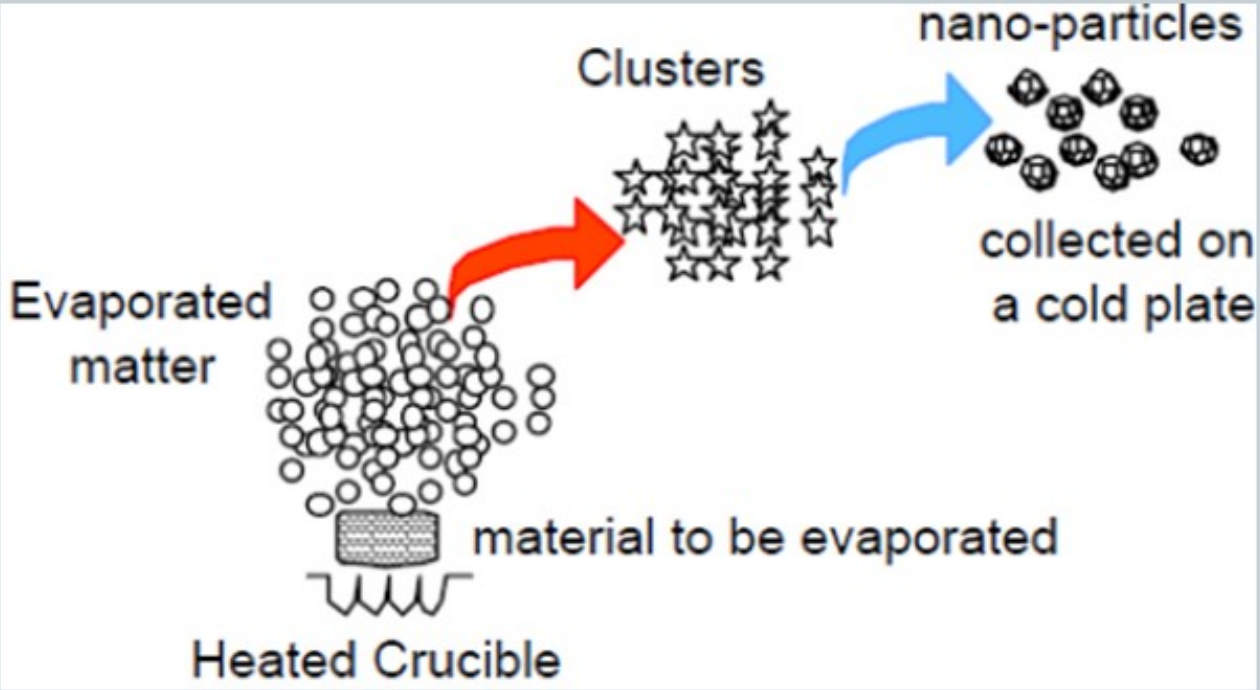
Methods for creating nanostructures

- **Sol-gel process**



Methods for creating nanostructures

- **Gas Phase (furnace)**

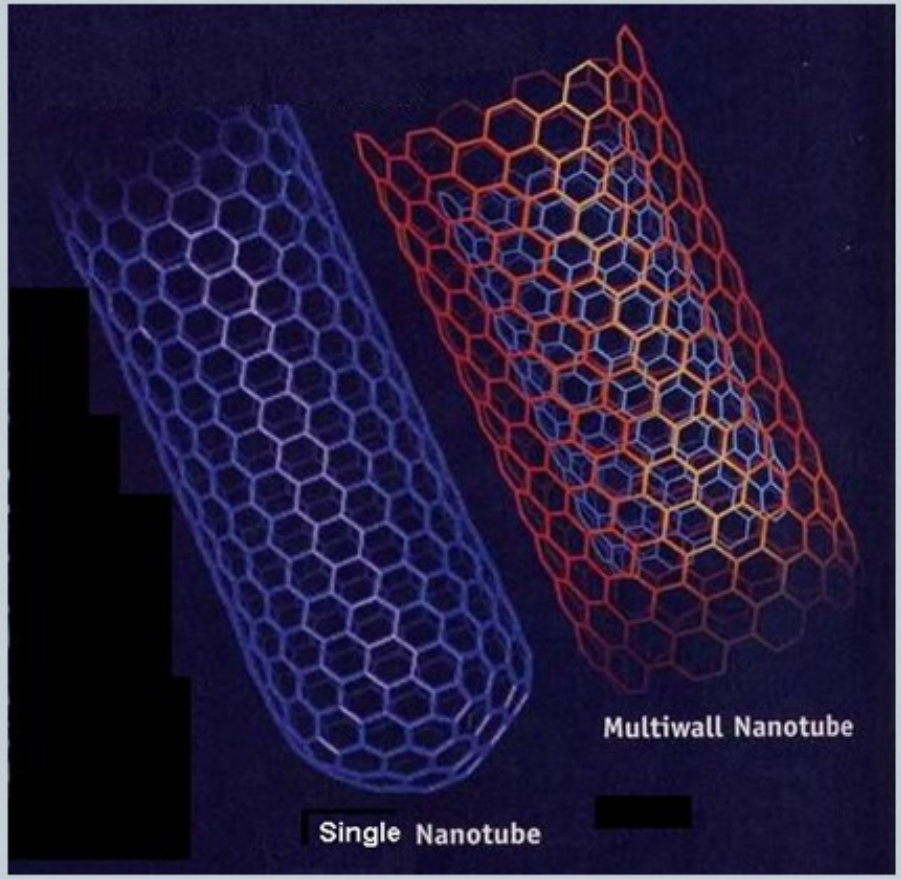


Different types of Nanomaterial

- **Nanopowder**

- **Nanotube** :

  tiny strips of graphite sheet rolled into tubes



Why are nanomaterials important

- These materials have created a high interest in recent years by their high **mechanical**, **electrical**, **optical** and **magnetic** properties.

Applications of nanomaterials

- Light source - QD lasers, QC (Quantum Cascade) lasers
- Light detector – QDIP (Quantum Dot Infrared Photo-detector)
- Electromagnetic induced transparency (EIT) – to obtain transparent highly dispersive materials
- Ballistic electron devices
- Tunneling electron devices
- Single electron devices

Conclusion

- Cylinders always align along diagonal of texture, even with small wave amplitude
- For hydrophilic walls, small wall spacing with small wave amplitude only distorts structure
- For hydrophilic walls, large wall spacing with small wave amplitude promotes (1 0 0) orientation
- For hydrophilic walls, planar defects may be more likely if wall spacing > space needed for # of layers
- systems with hydrophobic walls may avoid planar defects, because
  - the deposition of a monolayer of surfactant on the wall.
  - The chain softness mitigates the pattern

Thank you