

# TYPES OF NANOSTRUCTURES

Lec.2

# nanosttructures

- ▣ Nanostructures- objects with nanometer scale Individual nanostructures involve: clusters, nanoparticles, nanocrystals, quantum dots, nanowires, nanotubes .
  
- ▣ In general most agree that three things are important:
  1. Small size, measured in 100s of nanometers or less.
  2. Unique properties because of the small size.
  3. Control the structure and composition on the nm scale in order to control the properties.
  
- ▣ Nano-particles come in a range of different forms including nanofibres, nanodots, nanotubes, nanowires, and aggregated dendritic forms which are often three dimensional spherical in shape.

# Carbon nanotube (CNTs)

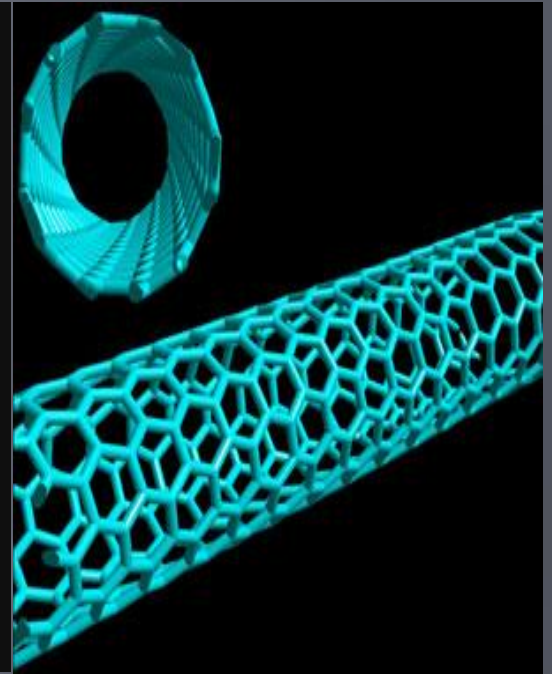
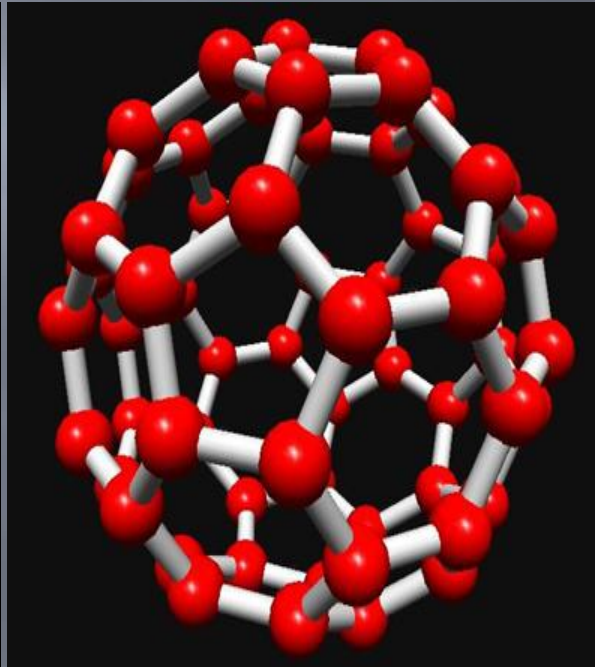
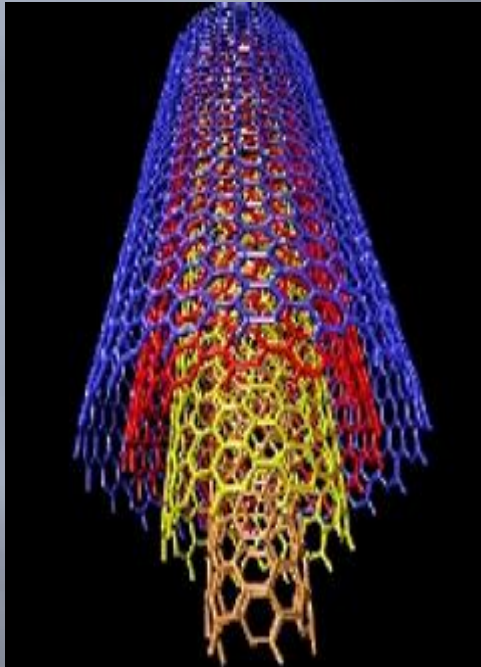
\*CNTs, most simply, are molecules of carbon.

CNTs display extraordinary mechanical, electronic, and optical properties.

\*One of the key advantages of CNTs is their strength.

\*CNTs are expected to have huge applications in nanometre-sized electronics, such as one-dimensional quantum wire, or to strengthen polymer materials.

# Multi and single-walled carbon nanotubes



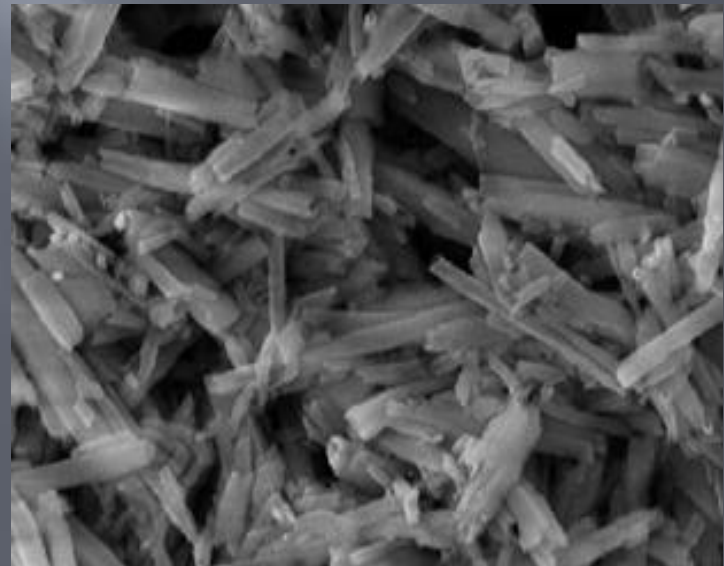
# Nanoclay

- ▣ Nanoclay: a clay consisting of nano-sized particles.
- ▣ There are two origins of nanoclay, firstly, the in situ alteration of **volcanic ash**, and secondly the hydrothermal alteration of **volcanic rocks**.
- ▣ there is interest to use it in food packaging applications such as to make transparent containers and covering films.



# Types of nanoclay

- ▣ The structure of the nanoclay particles can be divided into two main groups, **platelets and halloysite nanotubes**.



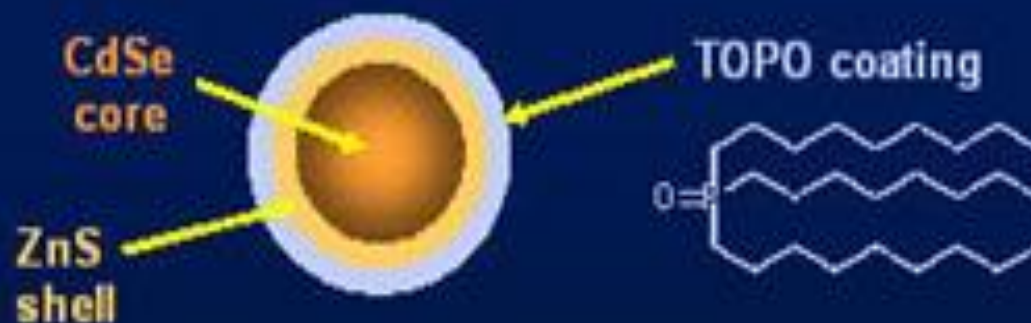
# Quantum Dots

- ▣ Quantum dots are one of the most interesting nanotechnology developments.
- ▣ About **1 to 6 nanometers** in diameter, a quantum dot is a nano-sized semiconductor crystal, and are so small that they are also known as **artificial atoms**.
- ▣ Quantum dots have a range of remarkable electrical, magnetic, optical, and catalytic properties.

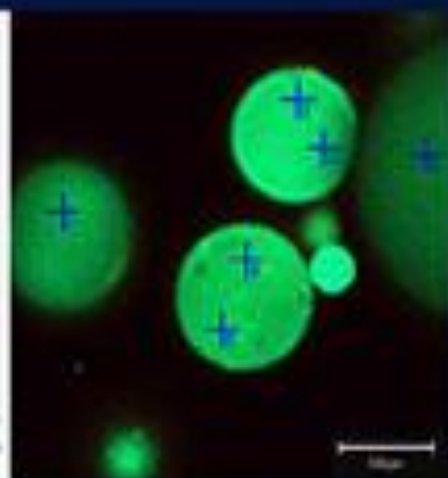
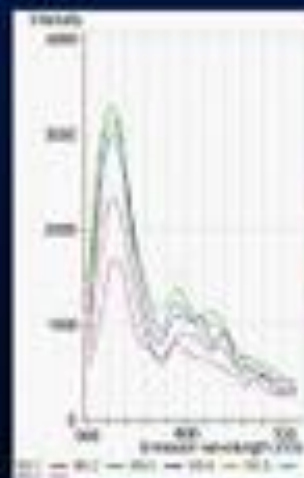
# Quantum Dots



TEM of a 4 nm  
CdSe quantum dot.



Solutions of differently sized  
CdSe quantum dots



Fluorescent emission fingerprinting of polymer  
beads that contain CdSe quantum dots



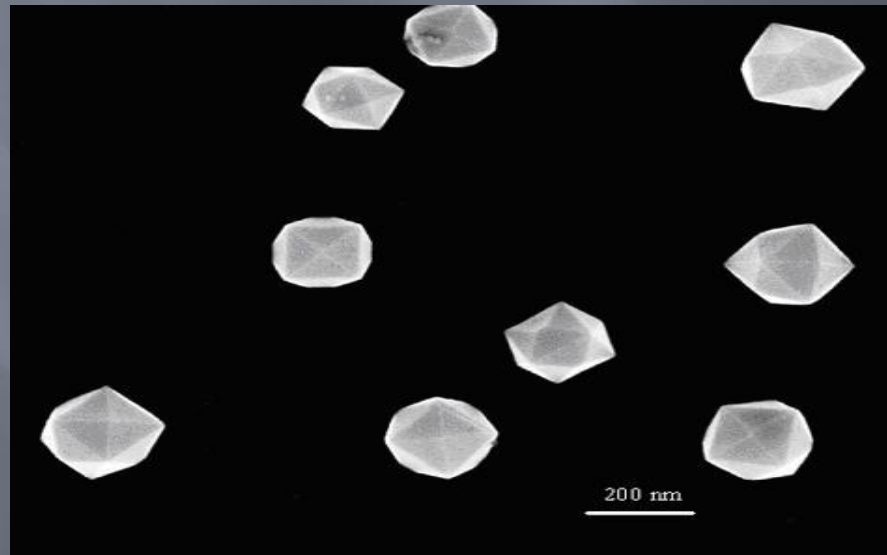
- ▣ Quantum dots are spherical or cubic-like in shape and are made up of thousands of atoms.
- ▣ With highly luminous quantum dots, doctors are able to identify cancerous tissue in vivo by using a Mercury lamp.
- ▣ The quantum dots are attracted to cancerous tissue.



# Nanocrystals

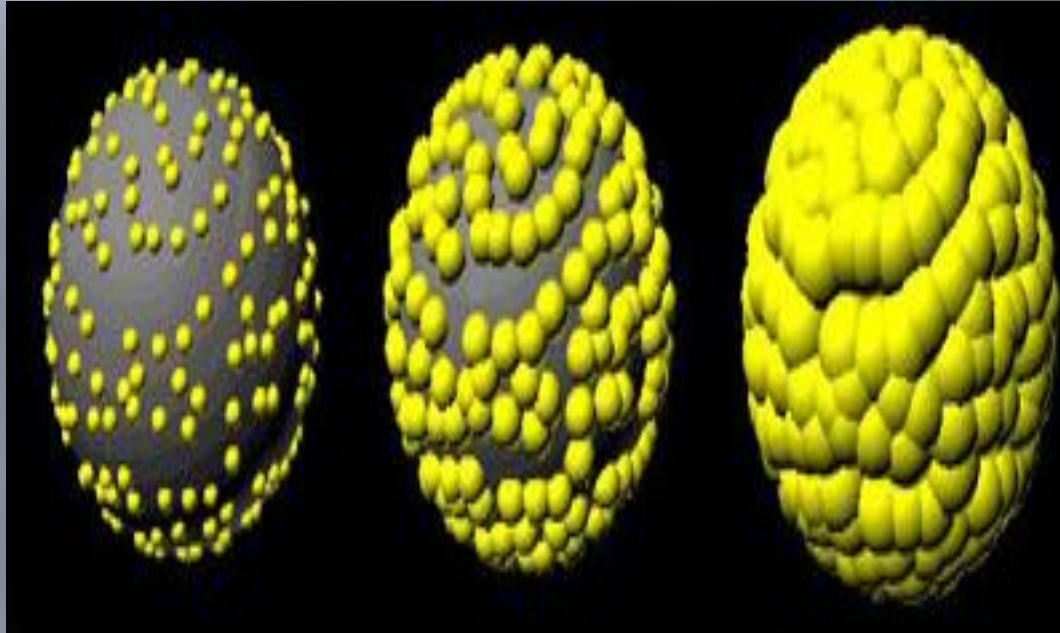
- ▣ Nanocrystals are grown from inorganic materials. **Atoms aggregate** into a crystalline form which is known as a cluster.
- ▣ Usually, nanocrystals are grown from including metals and semiconductors, however, they have been made from, gold, rhodium, platinum, palladium, and silver.

- ▣ Nanocrystals in diameter are roughly 10 nanometers.
- ▣ The most interesting application of nanocrystals may be in the development of solar cells.



# Nanoshells

- ▣ Nanoshells consist of a **silica core**, with an ultrathin **metallic coating**.
- ▣ Nanoshells are ball shaped and about 5% the size of a red blood cell.
- ▣ The core of the nanoshell, which has a diameter of about 100 nm, is non-conducting , while the outer laying, usually gold or silver, approximately 8 to 10 nm is conducting.



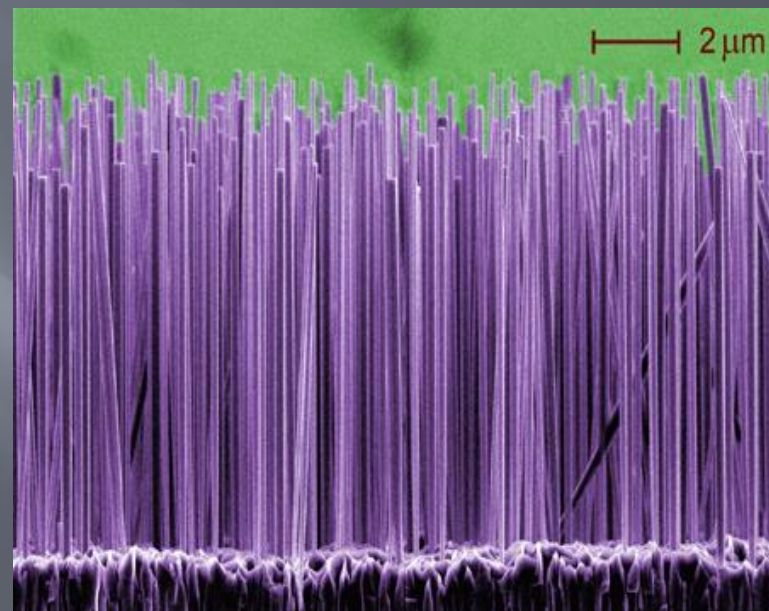
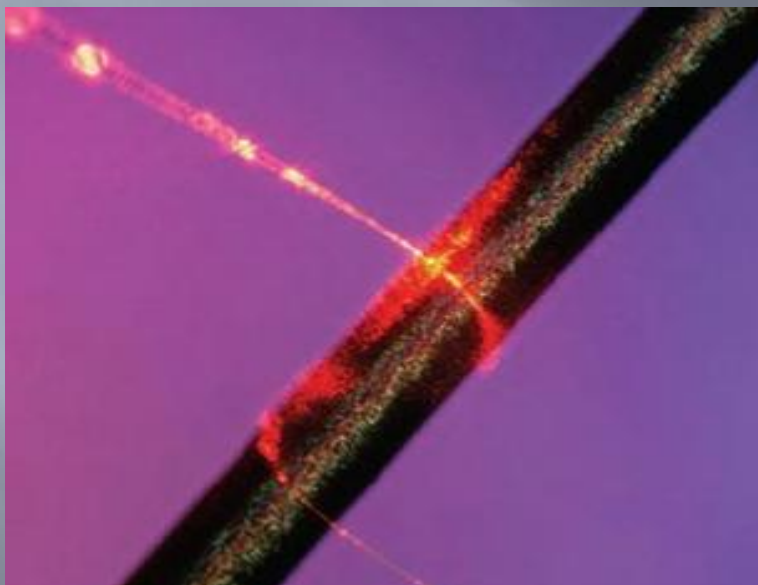
**Growth steps of nano-gold coating “shells” around nanoparticles of silica .**



- ▣ Nanoshells can be created with all shapes, and sizes. It can look like rods, balls, or eggs.
- ▣ **Non-toxic cancer treatment** is the most exciting applications of nanoshells.
- ▣ nanoshells have been injected into the bodies of animals and then illuminated giving off intense **heat destroying tumor cells**.
- ▣ Scientists can create the optimal **sized nanoshell** to create the optimal heating which **destroys the tumor** but not healthy tissue nearby.

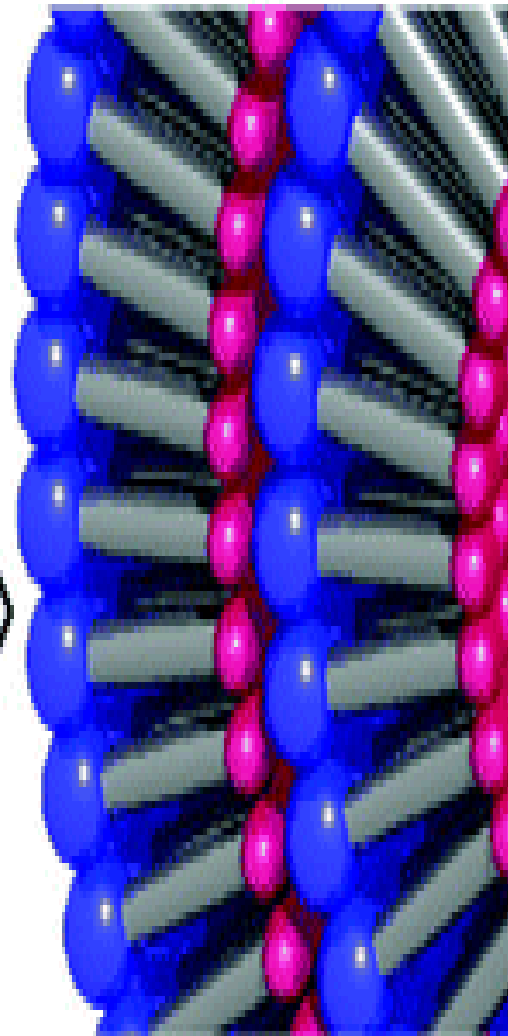
# Nanowires

- ▣ A nanowire is simply a wire made of metal, silicon, or another conductor which is nano-sized.
- ▣ Nanowires are also known as **quantum wires**.
- ▣ Nanowires allow the creation of other nano-sized technologies such as **nano-robots**.
- ▣ Such nano-sized robots could be used in the medical diagnoses.



# self assembly lipid microtube

- ▣ Diacetylenic glycerophosphatidylcholine can self-assemble into a lipid microtubular structure.
- ▣ The lipid microtubule is a **stable structure**.
- ▣ Both lipid microtubules and metallized microtubules can be used **as vehicles for encapsulating biological active molecules** to control their release and to develop micro-components in biological and mechanical systems.



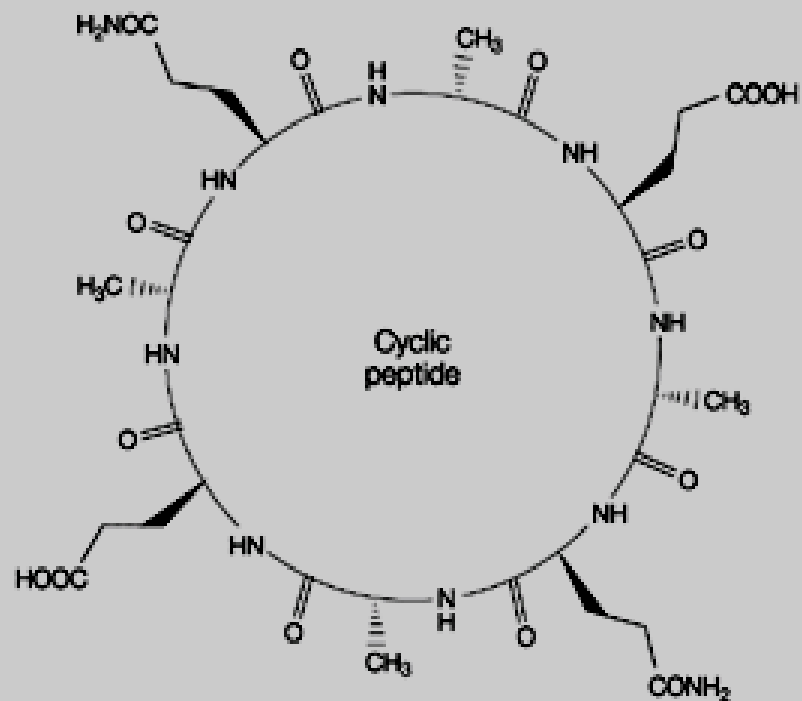


# Gadira Rings

- ▣ Gadira Rings is designed by a pattern of diverse and innovative of **manufactured amino acids** which are equipped with chains amino acids bound to the outside rings .
- ▣ It works **like sensors** with ability to respond to environmental stimuli.
- ▣ the control of **size and composition of sensors** by specific chemical reactions leading to the production of many kinds and different Rings Gadira that fit the diversity of pathogenic bacteria. it is used **as antibiotics**.

# Peptide nanotubes

- ▣ Peptide nanotubes consist of **cyclic peptide** from an equal number of **D-amino acid** and **L-amino acid**. the inner diameter of the tube is determines by the number of amino acids.
- ▣ Peptide nanotubes is used as a new type of antibiotics used to treat bacterial infections that resistant to conventional antibiotics.
- ▣ It is Called **smart drugs**. These cyclic peptides is called **nanobiotics** .



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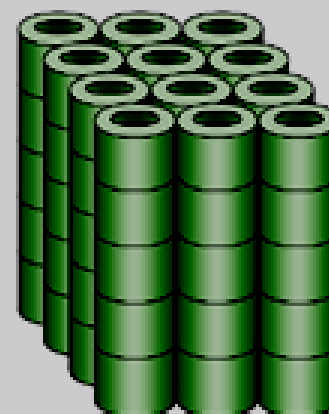
Self-assembly

Peptide nanotube



Self-assembly

Array of peptide nanotubes



# Magnetic nanoparticles

- ▣ Magnetic nanoparticles are a class of nanoparticle which can be manipulated using magnetic field.
- ▣ Such particles commonly consist of magnetic elements such as iron, nickel and cobalt and their chemical compounds.
- ▣ In most cases, the particles range from 1 to 100 nm in size.

- ▣ A wide variety of applications have been envisaged for this class of particles these include:
- ▣ Magnetic nanoparticles are used in an experimental cancer treatment. Another potential treatment of cancer includes attaching magnetic nanoparticles to **free-floating cancer cells**.
- ▣ Magnetic immunoassay
- ▣ drug targeting
- ▣ biomedicine & Biomedical imaging
- ▣ environmental remediation
- ▣ Waste water treatment
- ▣ Genetic engineering



# Inorganic Nanocages

- ▣ Inorganic Nanocages are **hollow porous goldnanoparticles** ranging in size from **10 to over 150 nm**.
- ▣ A contrast agent is required if this technique will be able to image **cancers** at an early, more treatable stage.
- ▣ Gold nanocages also **absorb light and heat up**, killing surrounding cancer **cells**.
- ▣ functionalized nanocages with **cancer-specific antibodies** so they specifically attach to cancer cells.

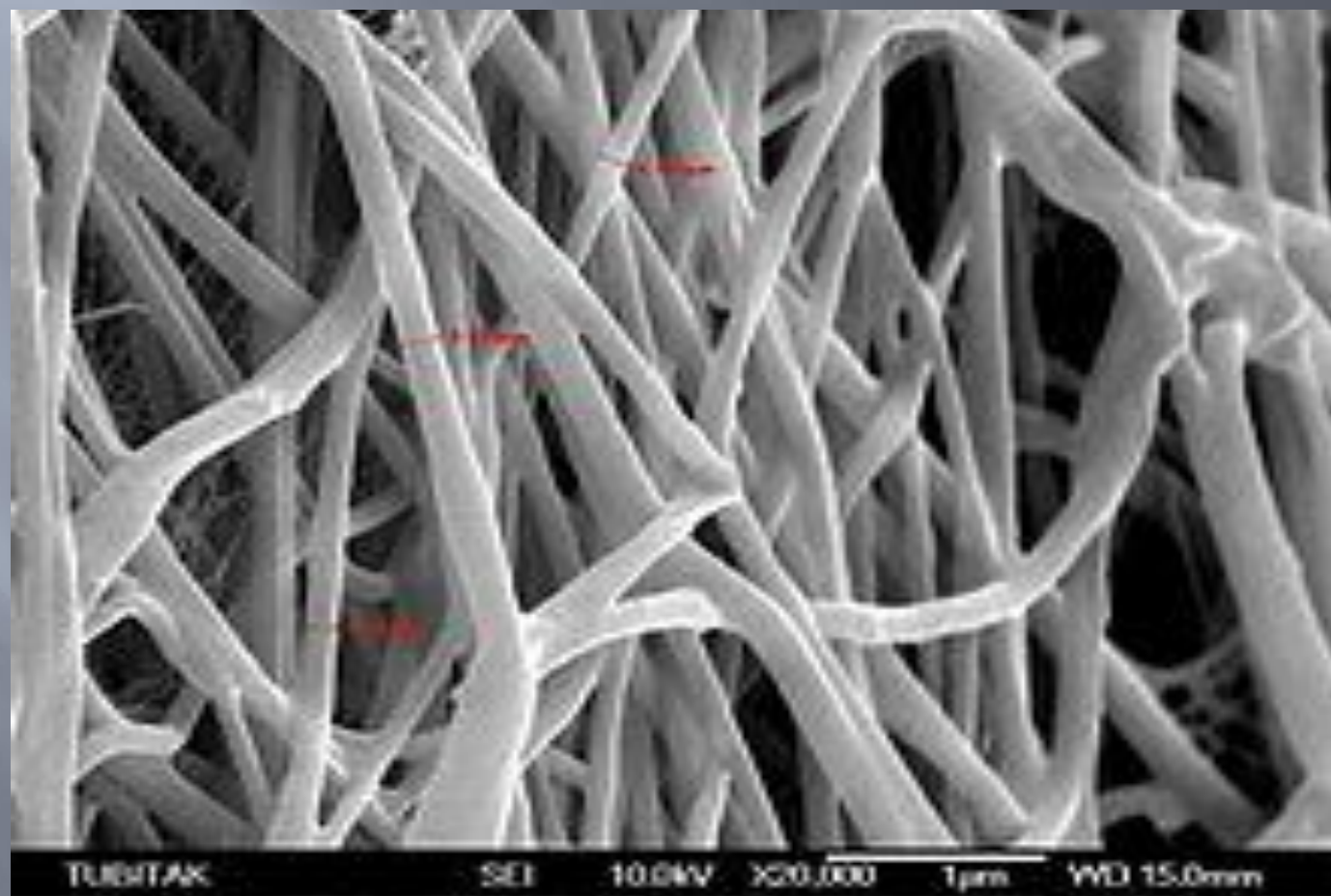
# Metal Nanofoams

- ▣ Nanofoams of iron, cobalt, nickel, copper, silver, and palladium have been prepared.
- ▣ These foams are **effective catalysts** and are being investigated for other applications.

# Nanofibers

- ▣ Nanofibers are defined as fibers with diameters less than 1000 nm .
- ▣ The most frequently mentioned ceramic materials with nanofiber morphology are : titanium dioxide ( $\text{TiO}_2$ ), silicon dioxide ( $\text{SiO}_2$ ), aluminum oxide ( $\text{Al}_2\text{O}_3$ ), or platinum (Pt).
- ▣ In **Medical uses**:  
artificial organ components, tissue engineering, drug delivery, wound dressing, medical textile materials.

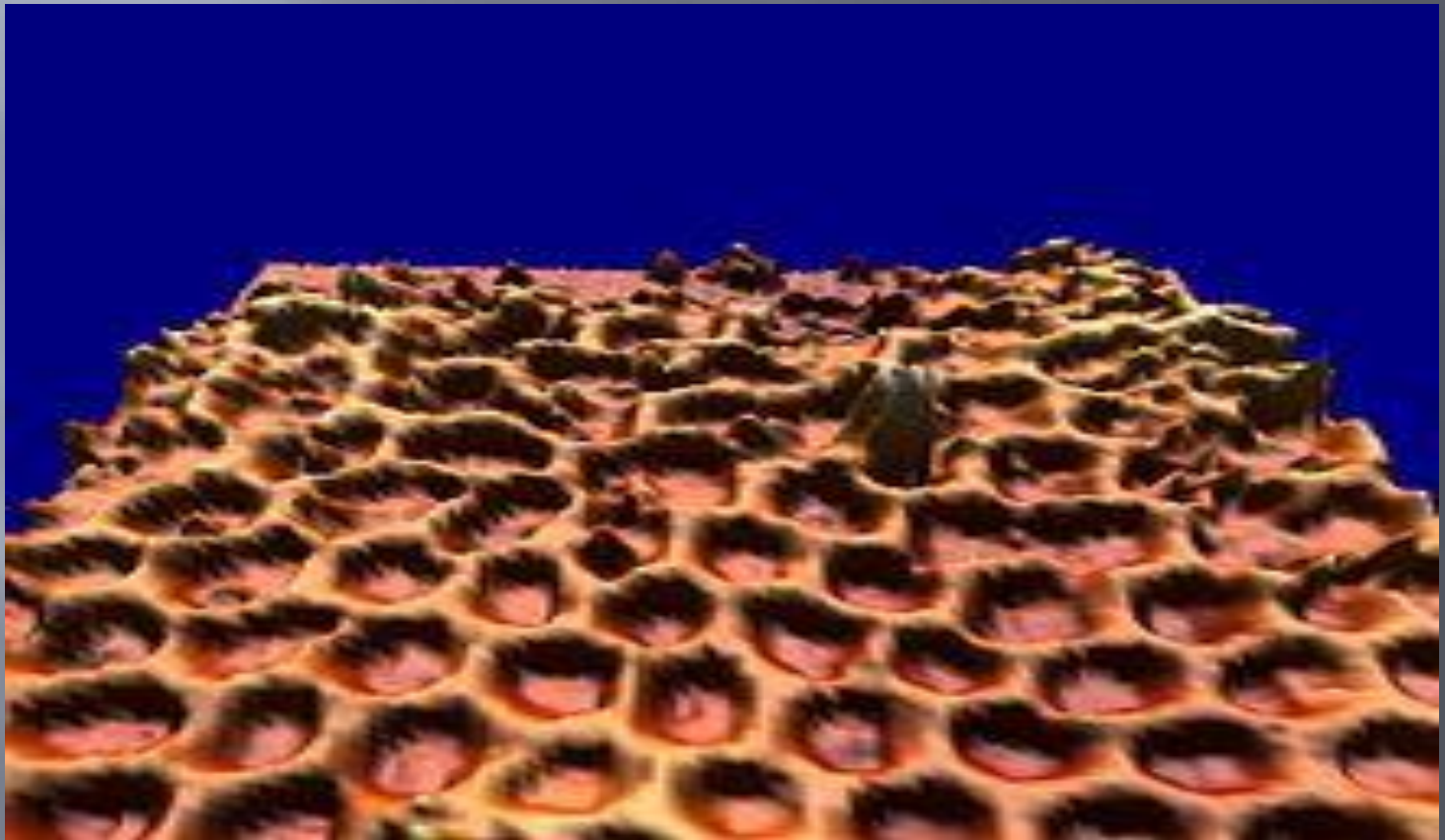




# Nanomesh

- ▣ The nanomesh is a new inorganic nanostructured two-dimensional material. It was discovered in 2003.
- ▣ The nanomesh looks like an **assembly of hexagonal pores** at the nanometer scale.
- ▣ The distance between 2 pore centers is only of 3.2 nm, whereas each pore has a diameter of about 2 nm and is 0.05 nm deep.
- ▣ interesting applications of the nanomesh in areas like nanocatalysis, surface functionalisation, etc.





# Nanoflowers

- ▣ These crystalline are nanostructures of silicon carbide are grown from droplets of gallium on a silicon surface.
- ▣ These nanoflowers will be used in new applications, such as water repellant coatings or new types of solar cells.

