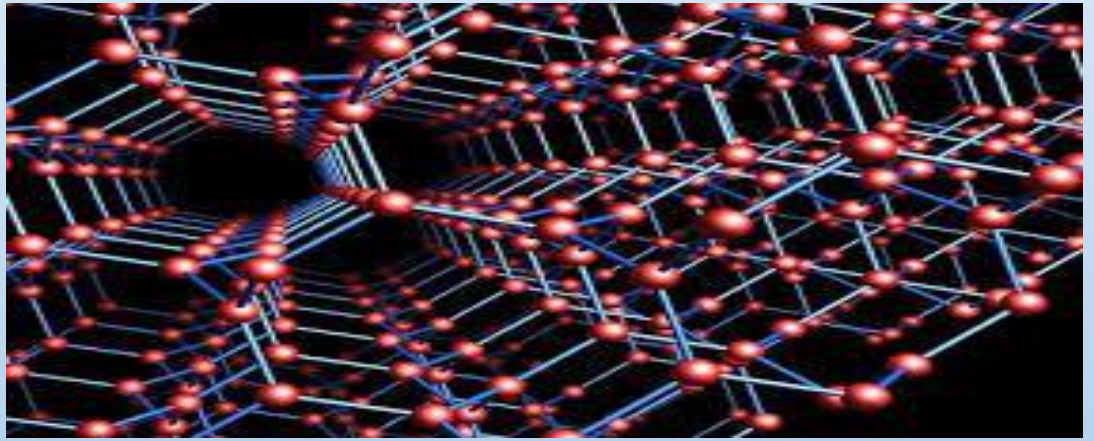
Lec1\ Introduction to nanotechnology



M.S.c. Sarah Raheem

The concept of nanotechnology is attributed to Nobel Prize winner Richard Feynman, who gave a very famous, visionary speech in 1959 (published in 1960) during one of his lectures, saying: “The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom”

What is nano?

The term nano means one billionth; A nanometer is one billionth of a metre.

Nanoscience:

It is the study of the properties of molecules and compounds whose dimensions do not exceed 100 nanometers.

The nanometre is often used to express dimensions on an atomic scale.

- “Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.

- Encompassing nanoscale science, engineering and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.”

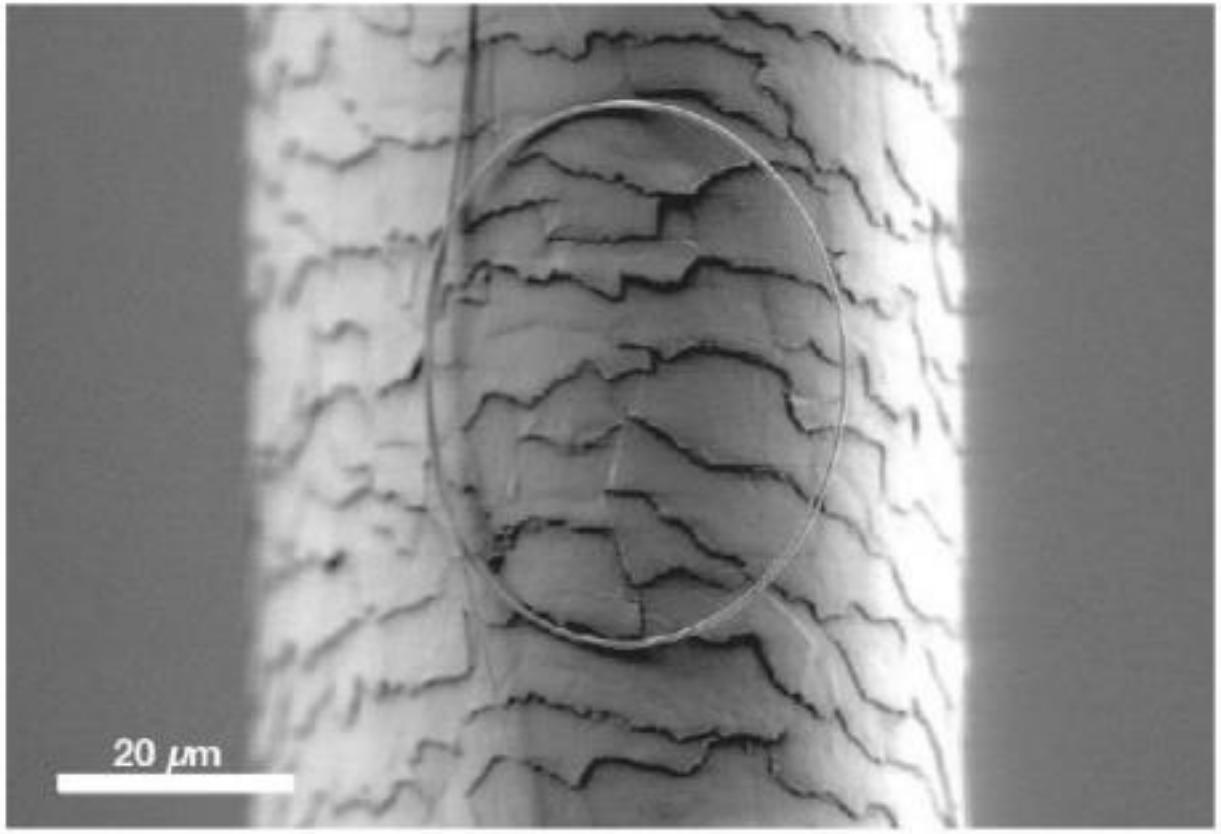
- It is a millionth of millimeter or a billionth of a meter.

How can we compare that to objects we can see the objectives of the study:

- An atom is 0.1 to 0.5 nm in diameter
- DNA molecules are 2.5 nm wide
- Virus is about 100 nm wide, bacterium 1000 nm
- Width of human hair – 100,000 nm
- Head of a pin – a million nanometers wide

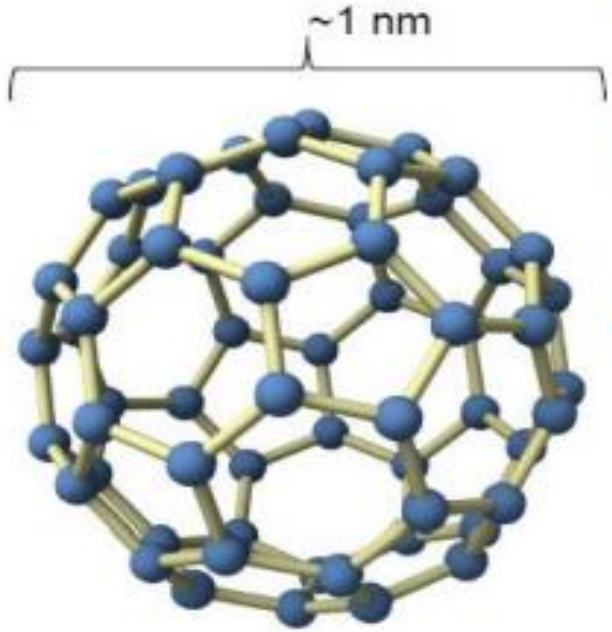
This is a silver nanowire resting on a human hair.

Look at a strand of your own hair and imagine how small that is…



What is a nanoparticle?

An example is a bucky ball
- a fullerene



- Roundest and most symmetrical molecule known to man
- Compressed - becomes stronger than diamond
- Third major form of pure carbon
- Heat resistance and electrical conductivity

- 60 carbon atoms linked together in one unit.

How big is ‘nano’?

ratio
earth / football = ratio
football / fullerene

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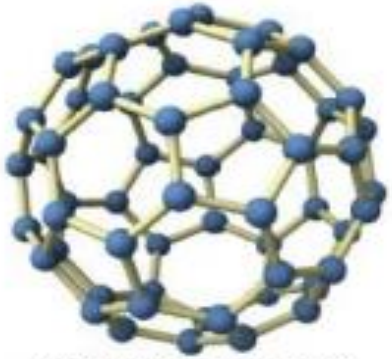


nanotechnologyuniverse.com

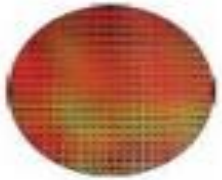
Why is Small Good?

- Faster

- Lighter

- Can get into small spaces

- Cheaper



- More energy efficient

- Less waste products, and uses less energy and materials to produce

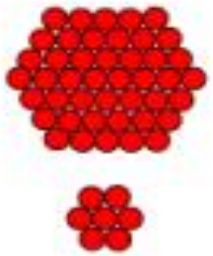
- Different properties at very small scale

Why Nanotechnology?

- At the nanoscale, the physical, chemical, and biological properties of materials differ in fundamental and valuable ways from the properties of individual atoms and molecules or bulk matter.

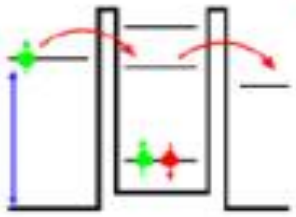
- Nanotechnology is directed toward understanding and creating improved materials, devices, and systems that exploit these new properties.

Why might properties of materials/structures be different at the nanoscale?



Two of the reasons:

1. Ratio of surface area-to-volume of structure increases
   (most atoms are at or near the surface, which make them more weakly bonded and more reactive)



2. Quantum mechanical effects are important
   (size of structure is on same scale as the wavelengths of electrons, and quantum confinement occurs resulting in changes in electronic and optical properties)

Risks of Nanomaterials

- **Health Risk المخاطر الصحية**
- Ultrafine particles can catalyze chemical reactions in the body.
- Carbon nanotubes can cause infections of lungs.
- They could easily cross the blood-brain barrier, a membrane that protects the brain from harmful chemicals in the bloodstream.

Social and Ethical Risks المخاطر الاجتماعية

- More powerful weapons
- Privacy

Examples of Nanotechnology Applications

- Clean and Cheap Energy.
- Using “Nano-silver” (solutions of silver nanoparticles) to coat medical tools, and in burn and surgical dressings, which protects against bacteria and fungus by inhibiting cellular metabolism and growth (Nanotech)
- Superhydrophobic Coatings
- Self-cleaning surfaces
- Water Purification Using Nanotechnology

Properties of nanomaterials

- **Mechanical properties**: Mechanical properties come at the top of the properties that benefit from the small size of the material's grains and the presence of many numbers of atoms on its outer surfaces, as the degree of hardness of metallic materials and their alloys increases, and their resistance to confronting the stresses and loads imposed on them increases.
- **Physical properties**: The values of the melting points of the material are affected by reducing the dimensions of its grains.

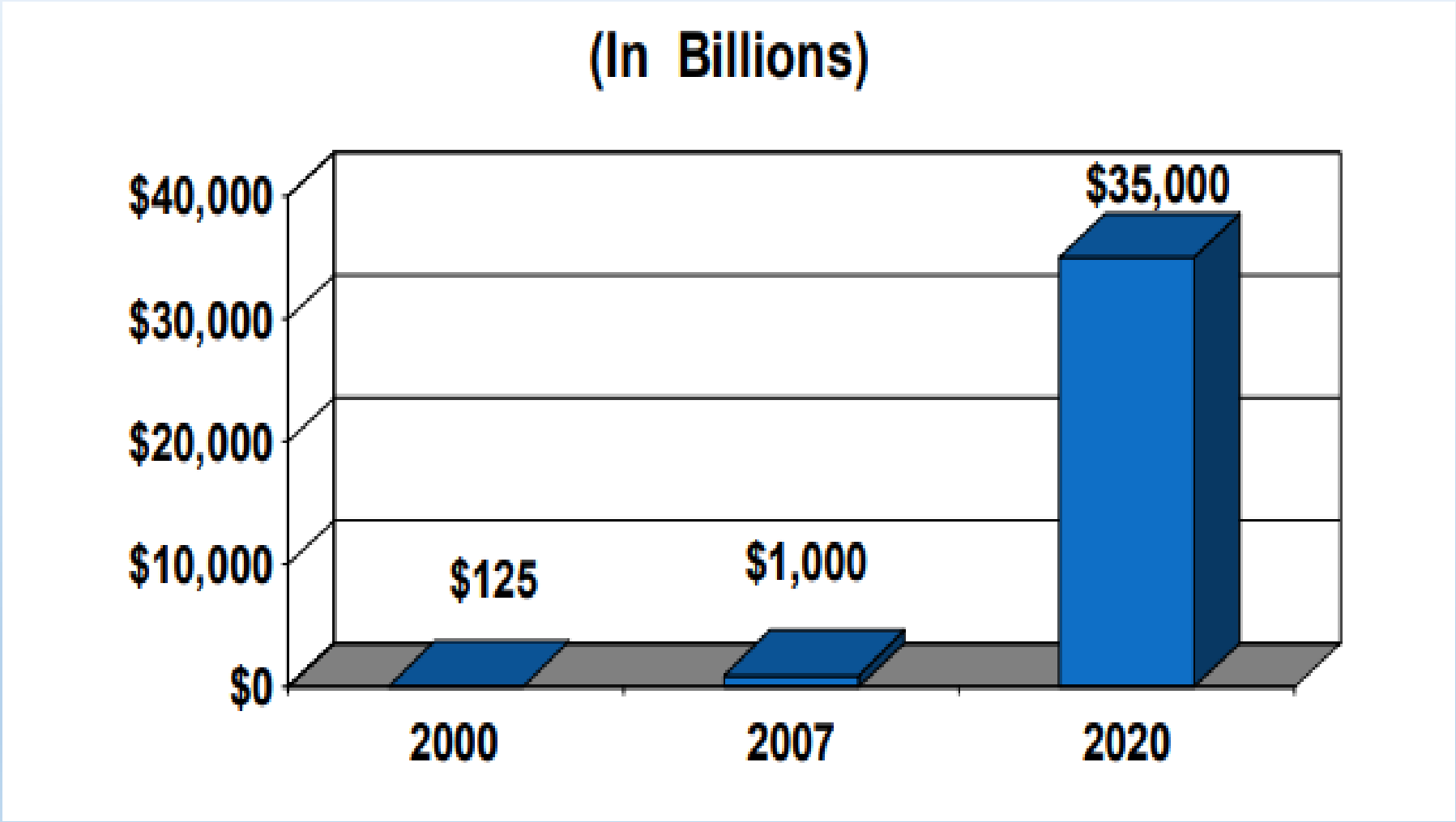
Properties of nanomaterials

- **Magnetic properties:** The smaller the grains of materials and the greater the presence of atoms on their external surfaces, the stronger and more effective their magnetic ability becomes.

- **Electrical properties:** Reducing the particle sizes of materials to less than 100 nanometers leads to an increase in their ability to conduct electrical current.

- **Biological properties**: increasing the ability of nanomaterials to penetrate biological barriers and barriers, and improving compatibility and biological compatibility, which facilitates the delivery of drugs and therapeutic drugs to the affected part through membranes and blood vessels.

USA Market Nanomaterials Projections



History of Nanotechnology

Norio Taniguchi was a professor of Tokyo University of Science.

He coined the term Nano-technology in 1974 to describe semiconductor processes such as thin film deposition and ion beam milling exhibiting characteristic control on the order of a nanometer: "Nano-technology' mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule.

History of Nanotechnology

Kim Eric Drexler is an American engineer best known for popularizing the potential of molecular nanotechnology (MNT), from the 1970s and 1980s. His 1991 doctoral thesis at Massachusetts Institute of Technology was revised and published as the book Nano systems: Molecular Machinery Manufacturing and Computation (1992), which received the Association of American Publishers award for Best Computer Science Book of 1992.

History of Nanotechnology

- In 1985, fullerenes, or “Bucky balls” , were discovered (Kroto et al. 1985)
- In 1990, the first academic nanotechnology journal was published,
- in 1993 the first Feynman Prize was awarded, and by 2000 President Bill Clinton announced the U.S. National Nanotechnology Initiative (NNI).