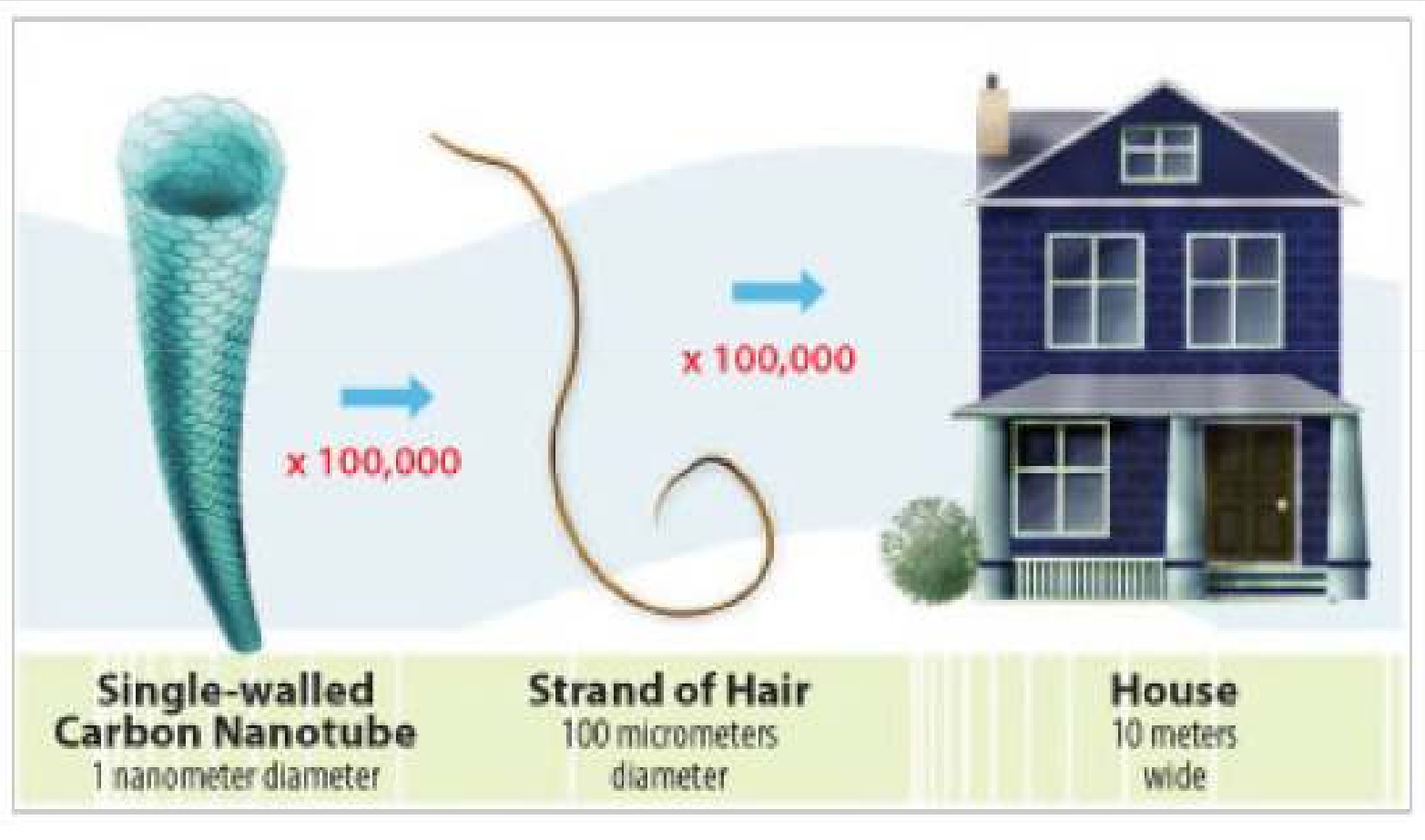
NANOBIOTECHNOLOGY

By
Pramod Kumar Mahish
Asst. Professor
Dept. of Biotechnology
Govt. Digvijay PG College Rajnadgaon (C.G.)
pramod.mahish@rediffmail.com

DEFINITION

- Scientists have not unanimously settled on a precise definition of nanomaterials, but agree that they are partially characterized by their tiny size, measured in nanometers.
- A nanometer is one millionth of a millimeter approximately 100,000 times smaller than the diameter of a human hair.
- Different biotechnological tools apply to the nanomolecules for human welfare.
- Namotechnology includes – nanodevices, nanoparticles, nanoscale, nanoorganisms etc.


x 100,000
x 100,000
Single-walled
Carbon Nanotube
1 nanometer diameter
Strand of Hair
100 micrometers
diameter
House
10 meters
wide

NANOMOLECULES

- Nanosized particles exist in nature and can be created from a variety of products, such as carbon or minerals like silver, but nanomaterials by definition must have at least one dimension that is less than approximately 100 nanometers.
- Most materials are too small to be seen with the naked eye and even with conventional lab microscopes.
- Materials engineered to such a small scale are often referred to as engineered
- nanomaterials (ENMs), which can take on unique optical, magnetic, electrical, and other properties. These emergent properties have the potential for great impacts in electronics, medicine, and other fields.

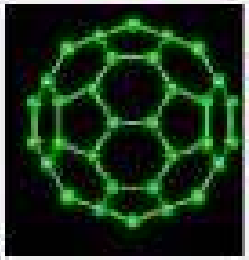
NANOMOLECULES

- Nanomaterials can be used to design pharmaceuticals that can target specific organs or cells in the body such as cancer cells, and enhance the effectiveness of therapy.
- Nanomaterials can also be added to cement, cloth and other materials to make them stronger and yet lighter.
- Their size makes them extremely useful in electronics, and they can also be used in environmental remediation or cleanup to bind with and neutralize toxins.

Classification of Nanomaterials

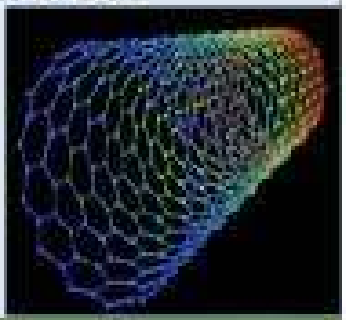
Three nano-dimensions
(1 – 100 nm)

- Nanoparticles
- Nanopowders
- Nanocapsules
- Fullerenes
- Dendrimers
- Quantum dots
- Nanostructures
- Nanopore



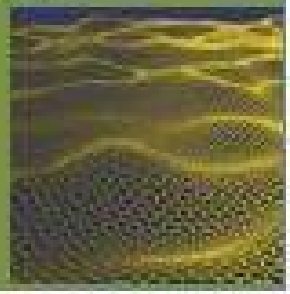
Two nano-dimensions
(1 – 100 nm)

- Nanofibers
- Nanowires
- Nanotubes



One nano-dimension
(1 – 100 nm)

- Nano thin-film



WHERE ARE NANOMATERIALS FOUND?

- Some nanomaterials can occur naturally, such as blood borne proteins essential for life and lipids found in the blood and body fat.
- Scientists, however, are particularly interested in engineered nanomaterials (ENMs), which are designed for use in many commercial materials, devices and structures.
- Already, thousands of common products including sunscreens, cosmetics, sporting goods, stain resistant clothing, tires, and electronics—are manufactured using ENMs. They are also in medical diagnosis, imaging and drug delivery and in environmental remediation.

NATURAL NANOMATERIALS

- Biological systems often feature natural, functional nanomaterials. The structure of viruses (capsid), the wax crystals covering a lotus or nasturtium leaf, spider-mite silk, some butterfly wing scales, natural colloids (milk, blood), horny materials (skin, claws, beaks, feathers, horns, hair), cotton, and even our own bone matrix are all natural *organic* nanomaterials.

Synthetic nanomaterials

- Synthetic nanomaterials includes fullerenes, and inorganic nanomaterials based on other elements, such as silicon.

FULLERENES

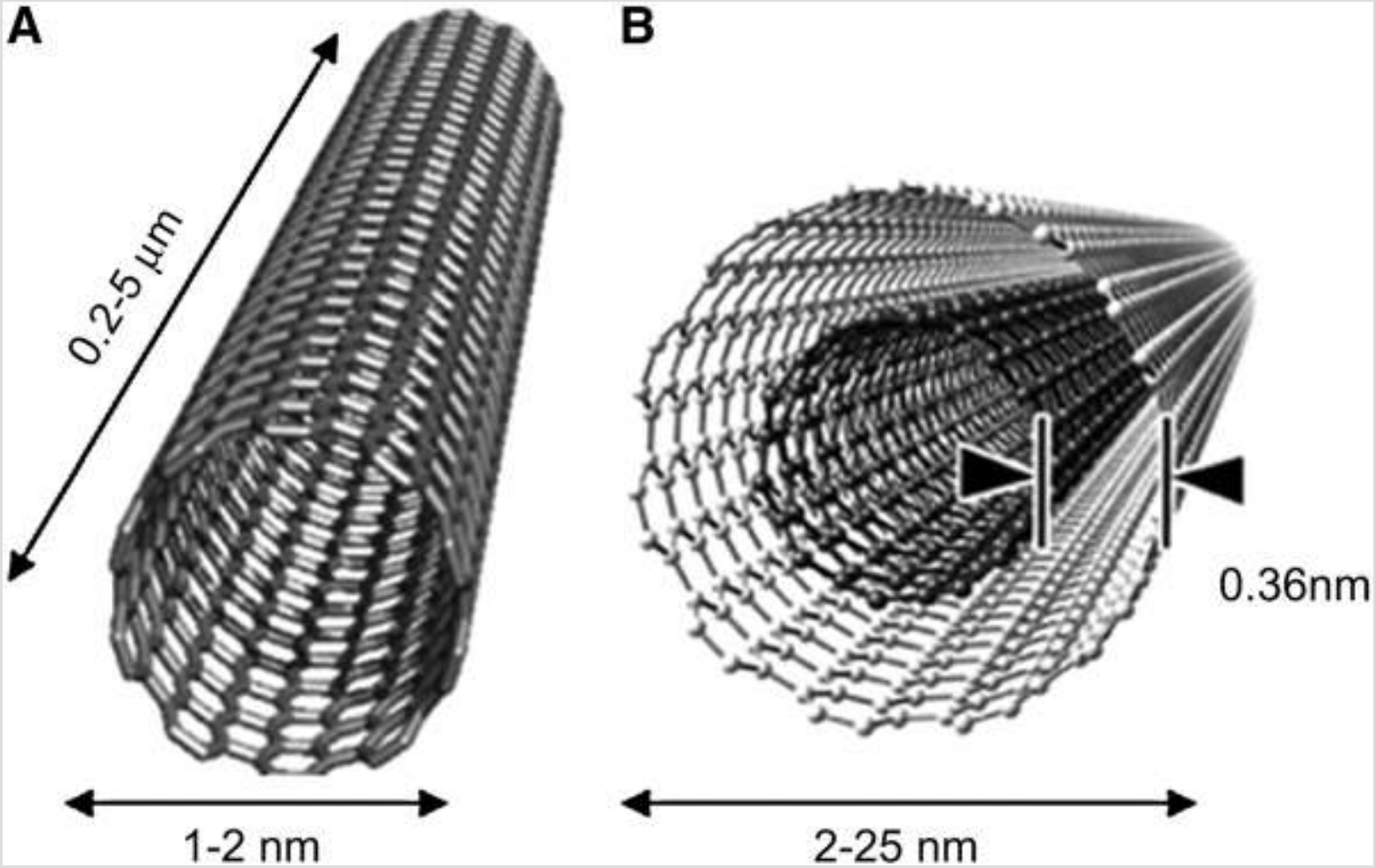
- The fullerenes are a class of allotropes of carbon which conceptually are graphene sheets rolled into tubes or spheres. These include the carbon nanotubes (or silicon nanotubes) which are of interest both because of their mechanical strength and also because of their electrical properties.
- fullerenes are now using as potential medicinal use: binding specific antibiotics to the structure of resistant bacteria and even target certain types of cancer cells such as melanoma.

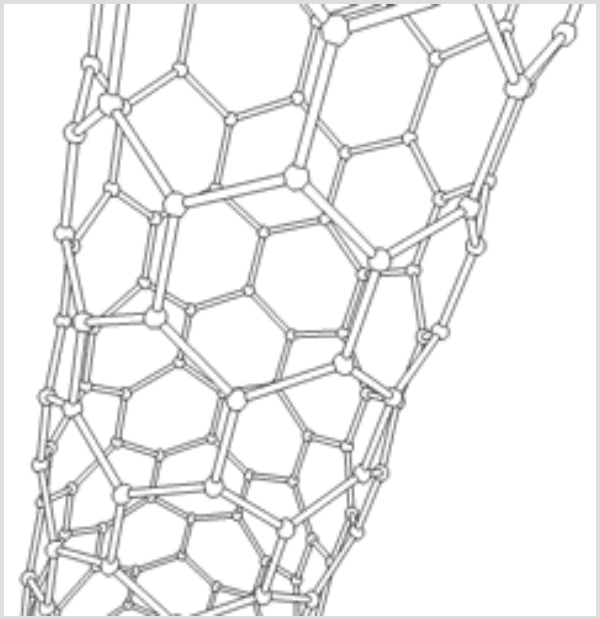
NANOPARTICLES

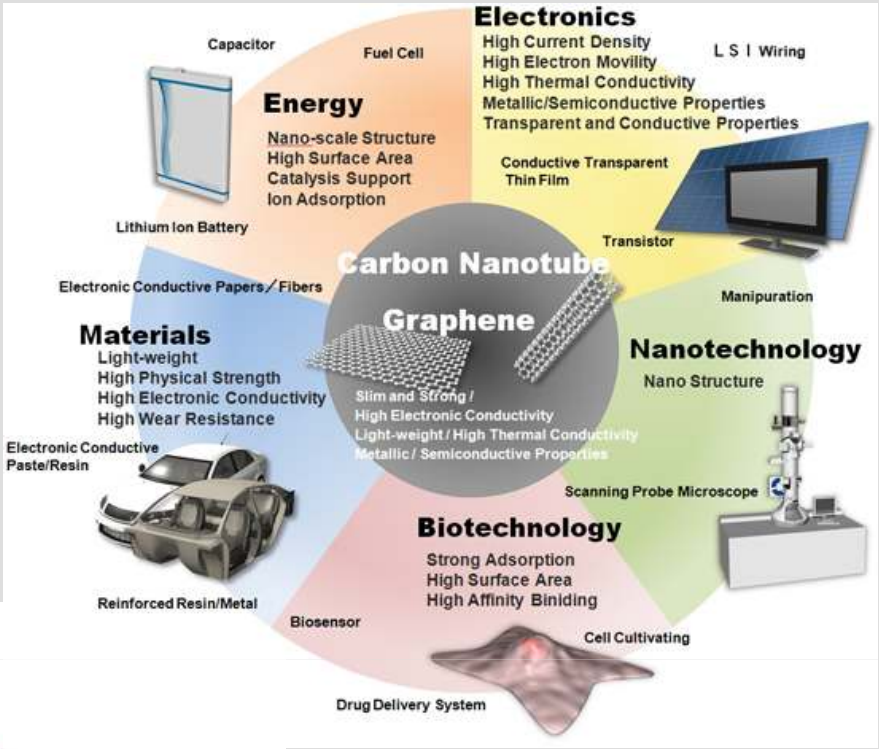
- Inorganic nanomaterials, (e.g. quantum dots, nanowires and nanorods) because of their interesting optical and electrical properties, could be used in optoelectronics.
- There are the possibilities to use those materials in organic material based optoelectronic devices such as Organic solar cells, OLEDs etc.
- The operating principles of such devices are governed by photoinduced processes like electron transfer and energy transfer.

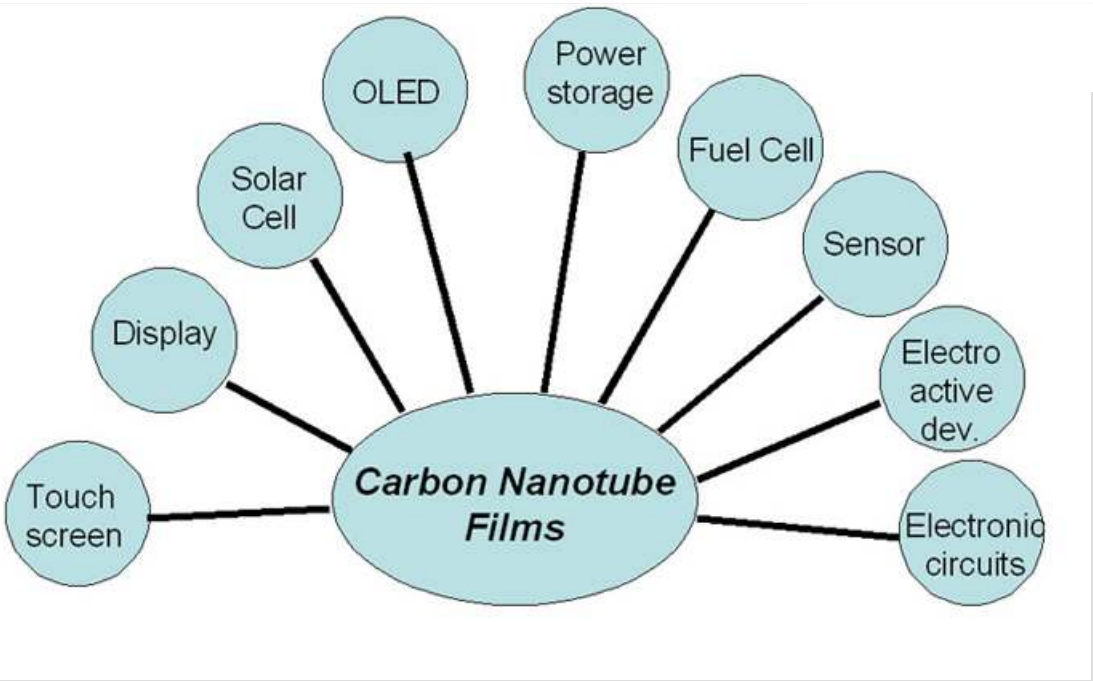
CARBON NANOTUBES

- Carbon nanotubes are cylindrical molecules of carbon with novel properties that are potentially useful in a **wide variety of applications** including nano-electronics, optics, materials applications, etc. They exhibit extraordinary tensile strength, a unique range of electrical properties, and are efficient thermal conductors.
- Types – single walled and double walled


A
0.2-5 µm
1-2 nm
B
0.36nm
2-25 nm




Electronics
High Current Density
High Electron Movility
High Thermal Conductivity
Metallic/Semiconductive Properties
Transparent and Conductive Properties
L S I Wiring
Capacitor
Fuel Cell
Energy
Nano-scale Structure
High Surface Area
Catalysis Support
Ion Adsorption
Lithium Ion Battery
Conductive Transparent Thin Film
Transistor
Carbon Nanotube
Graphene
Electronic Conductive Papers / Fibers
Manipuration
Materials
Light-weight
High Physical Strength
High Electronic Conductivity
High Wear Resistance
Slim and Strong /
High Electronic Conductivity
Light-weight / High Thermal Conductivity
Metallic / Semiconductive Properties
Nanotechnology
Nano Structure
Electronic Conductive Paste/Resin
Scanning Probe Microscope
Biotechnology
Strong Adsorption
High Surface Area
High Affinity Binding
Reinforced Resin/Metal
Biosensor
Cell Cultivating
Drug Delivery System


OLED
Power storage
Solar Cell
Fuel Cell
Sensor
Display
Electro active dev.
Touch screen
Carbon Nanotube Films
Electronic circuits

SILVER NANOPARTICLES

- Silver nanoparticles are nanoparticles of silver, i.e. silver particles of between 1 nm and 100 nm in size.
- Silver nanoparticles have unique optical, electrical, and thermal properties and are being incorporated into products that range from photovoltaics to biological and chemical sensors. Examples include conductive inks, pastes and fillers which utilize silver nanoparticles for their high electrical conductivity, stability, and low sintering temperatures.

- Additional applications include molecular diagnostics and photonic devices, which take advantage of the novel optical properties of these nanomaterials. An increasingly common application is the use of silver nanoparticles for antimicrobial coatings, and many textiles, keyboards, wound dressings, and biomedical devices now contain silver nanoparticles that continuously release a low level of silver ions to provide protection against bacteria.

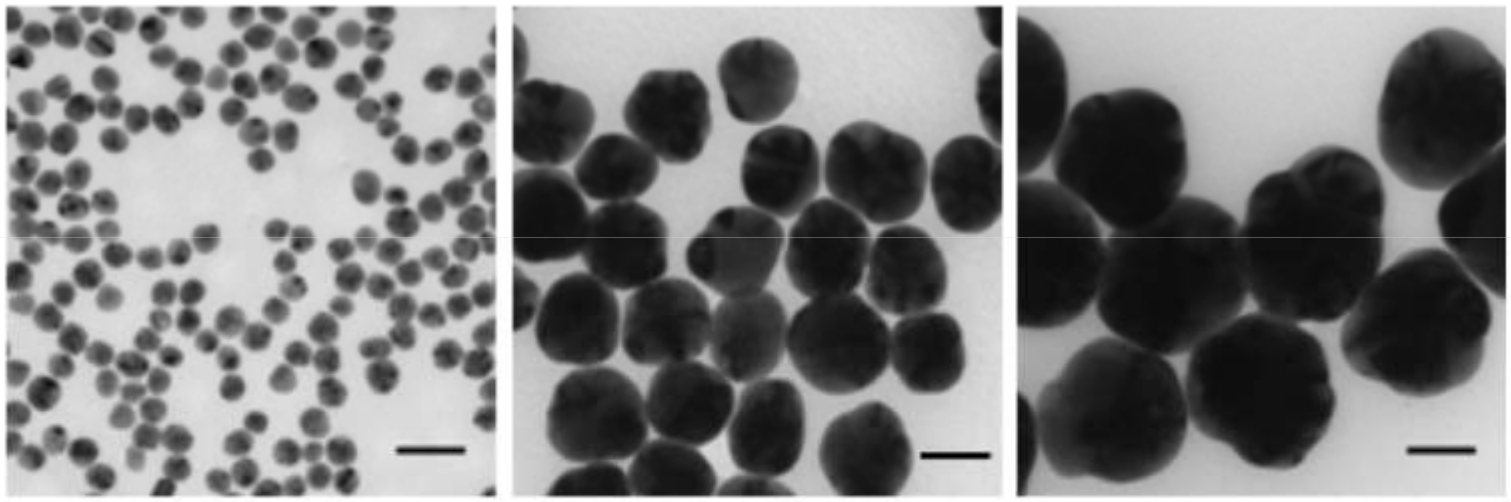


Figure 1: Transmission electron microscopy (TEM) images of silver nanoparticles with diameters of 20 nm (Aldrich Prod. No. 730793), 60 nm (Aldrich Prod. No. 730815), and 100 nm (Aldrich Prod. No. 730777) respectively. Scale bars are 50 nm.

- Silver nanoparticles are being used in numerous technologies and incorporated into a wide array of consumer products that take advantage of their desirable optical, conductive, and antibacterial properties.
- **Diagnostic Applications:** Silver nanoparticles are used in biosensors and numerous assays where the silver nanoparticle materials can be used as biological tags for quantitative detection.
- **Antibacterial Applications:** Silver nanoparticles are incorporated in apparel, footwear, paints, wound dressings, appliances, cosmetics, and plastics for their antibacterial properties.
- **Conductive Applications:** Silver nanoparticles are used in conductive inks and integrated into composites to enhance thermal and electrical conductivity.
- **Optical Applications:** Silver nanoparticles are used to efficiently harvest light and for enhanced optical spectroscopies including metal-enhanced fluorescence (MEF) and surface-enhanced Raman scattering (SERS).