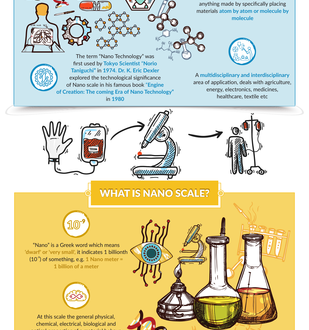
NANO TECHNOLOGY

Advancement in the field of nanotechnology and its applications especially to the field of medicines and pharmaceuticals has revolutionized the twentieth century.

WHAT IS NANOTECHNOLOGY?

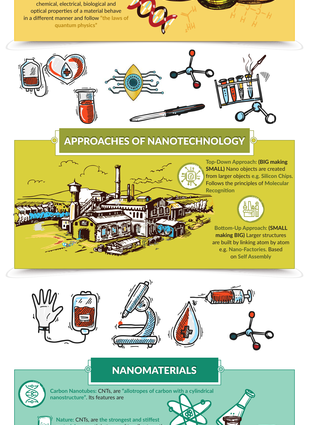


The term "Nano Technology" was first used by Taiwo Scientist "Norio Taniguchi" in 1974. Dr. K. Eric Drexler explored the technological significance of Nano scale in his famous book "Engine of Creation: The coming Era of Nano Technology" in 1980

The study of Extremely Small structures in the physical size range of 1-100 nanometres (nm) or anything made by specifically placing materials atom by atom or molecule by molecule

A multidisciplinary and interdisciplinary area of application, deals with agriculture, energy, electronics, medicines, healthcare, textile etc

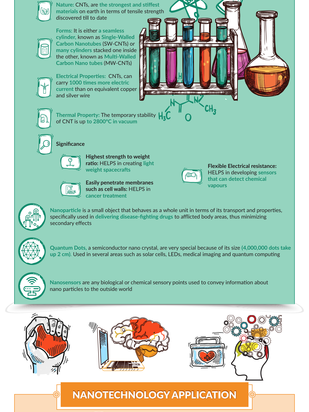
WHAT IS NANO SCALE?



"Nano" is a Greek word which means 'dwarf' or 'very small'. It indicates 1 billionth (10^{-9}) of something, e.g. 1 Nano meter = 1 billion of a meter

At this scale the general physical, chemical, electrical, biological and optical properties of a material behave in a different manner and follow "the laws of quantum physics"

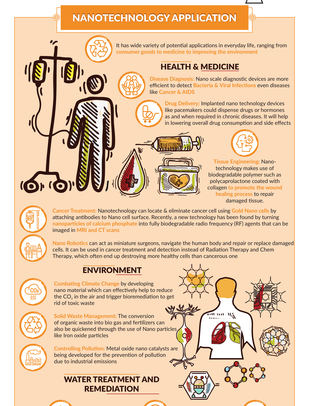
APPROACHES OF NANOTECHNOLOGY



Top-Down Approach: **(BIG making SMALL)** Nano objects are created from larger objects e.g. Silicon Chips. Follows the principles of Molecular Recognition

Bottom-Up Approach **(SMALL making BIG)** Larger structures are built by linking atom by atom e.g. Nano-Factories. Based on Self Assembly

NANOMATERIALS



Carbon Nanotubes: **CNTs**, are "allotropes of carbon with a cylindrical nanostructure". Its features are

Nature: CNTs, are the strongest and stiffest materials on earth in terms of tensile strength discovered till to date

Forms: It is either a seamless cylinder, known as Single-Walled Carbon Nanotubes (SW-CNTs) or many cylinders stacked one inside the other, known as Multi-Walled Carbon Nano tubes (MW-CNTs)

Electrical Properties: CNTs, can carry 1000 times more electric current than on equivalent copper and silver wire

Thermal Property: The temperature stability of CNT is up to 2800°C in vacuum

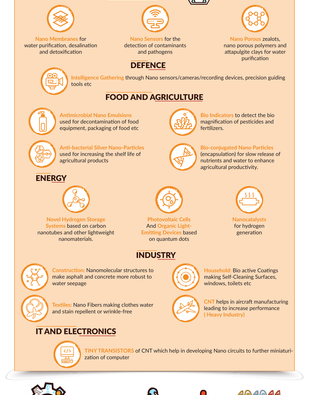
Significance

- **Highest strength to weight ratio:** HELPS in creating light weight spacecrafts
- **Easily penetrate membranes such as cell walls:** HELPS in cancer treatment
- **Flexible Electrical resistance:** HELPS in developing sensors that can detect chemical vapours

Nanoparticle is a small object that behaves as a whole unit in terms of its transport and properties, specifically used in delivering disease-fighting drugs to afflicted body areas, thus minimizing secondary effects

Quantum Dots, a semiconductor nano crystal, are very special because of its size (4,000,000 dots take up 2 cm). Used in several areas such as solar cells, LEDs, medical imaging and quantum computing

Nanosensors are any biological or chemical sensory points used to convey information about nano particles to the outside world



NANOTECHNOLOGY APPLICATION

It has wide variety of potential applications in everyday life, ranging from consumer goods to medicine to improving the environment

HEALTH & MEDICINE

Disease Diagnosis: Nano scale diagnostic devices are more efficient to detect Bacteria & Viral infections even diseases like Cancer & AIDS

Drug Delivery: Implanted nano technology devices like pacemakers could dispense drugs or hormones as and when required in chronic diseases. It will help in lowering overall drug consumption and side effects

Tissue Engineering: Nano-technology makes use of biodegradable polymer such as polycaprolactone coated with collagen to promote tissue-bound two cells to repair damaged tissue.

Cancer Treatment: Nanotechnology can locate & eliminate cancer cell using Gold Nano cells by attaching antibodies to Nano cell surface. Recently, a new technology has been found by turning nanoparticles of calcium phosphates into fully biodegradable radio frequency (RF) agents that can be imaged in MRI and CT scans

Nano Robotics can act as miniature surgeons, navigate the human body and repair or replace damaged cells. It can be used in cancer treatment and detection instead of Radiation Therapy and Chem Therapy, which often end up destroying more healthy cells than cancerous one

ENVIRONMENT

Combating Climate Change by developing nano material which can effectively help to reduce the CO_2 in the air and trigger bioremediation to get rid of toxic waste

Solid Waste Management: The conversion of organic waste into bio gas and fertilizers can also be quickened through the use of Nano particles like Iron oxide particles

Controlling Pollutants Metal oxide nano catalysts are being developed for the prevention of pollution due to industrial emissions

WATER TREATMENT AND REMEDIATION

Nano-Membranes for water purification, desalination and detoxification

Nano Sensors for the detection of contaminants and pathogens

Nano Porous zealots, nano porous polymers and attapulgite clays for water purification

DEFENCE

Intelligence Gathering through Nano sensors/cameras/recording devices, precision guiding tools etc

FOOD AND AGRICULTURE

Antibacterial Nano Emulsions used for decontamination of food equipment, packaging of food etc

Bio Indicators to detect the bio magnification of pesticides and fertilizers.

Anti-bacterial Silver Nano-Particles used for increasing the shelf life of agricultural products

Bio-conjugated Nano Particles (encapsulation) for slow release of nutrients and water to enhance agricultural productivity.

ENERGY

Novel Hydrogen Storage Systems based on carbon nanotubes and other lightweight nanomaterials.

Photovoltaic Cells And Organic Light-Emitting Devices based on quantum dots

Nanocatalysts for hydrogen generation

INDUSTRY

Nanocoatings: Nanomolecular structures to make asphalt and concrete more robust to water seepage

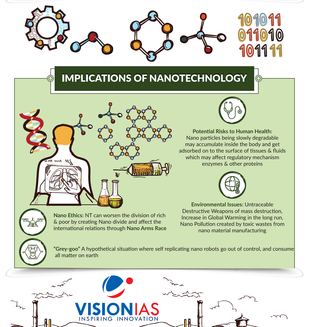
Household: Bio active Coatings making Self-Cleaning Surfaces, windows, toilets etc

Textiles: Nano Fibers making clothes water and stain repellent or wrinkle-free

CNT helps in aircraft manufacturing leading to increase performance (Heavy Industry)

IT AND ELECTRONICS

TINY TRANSISTORS of CNT which help in developing Nano circuits to further miniaturization of computer



IMPLICATIONS OF NANOTECHNOLOGY

Potential Risks to Human Health: Nano particles being slowly degradable may accumulate inside the body and get adsorbed on to the surface of tissues & fluids which may affect regulatory mechanism enzymes & other proteins

Environmental Issues: Untraceable Destructive Weapons of mass destruction, Increase in Global Warming in the long run, Nano Pollution created by toxic wastes from nano material manufacturing

Nano Ethics: NT can worsen the division of rich & poor by creating Nano divide and affect the international relations through Nano Arms Race

"Grey-goo" A hypothetical situation where self replicating nano robots go out of control, and consume all matter on earth

WAY FORWARD

Need for Proper Analysis Methods to detect nano particles in the environment & human body and an effective strategy for Recycling & Recovery