# What is Nanotechnology?

(1) The word 'Nano' is derived frm Greek word nano's which means very small.
(2) Nanotechnology deals with various structures of matter having dimensions of the order of billionth of a meter
(3) Nanotechnology is science of designing, producing and using structures having one / more $1D^3$ of the order of billiont of meter
(4) ~~Than~~ Nanotechnology is used in

## Quantum Confinement. (Q C)

(1) Q C effects describes electrons in terms of energy levels, potential wells, V.B, C.B
(2) Density state of metals in 3D is

$$g(E) = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3}\, \epsilon^{1/2}$$

(3) In 3D bulk material desity of states is $\propto \epsilon^{1/2}$ and hence ↑ with energy
(4) $\epsilon^-$ are confined in one/more dir$^n$ by reducing the 'D' in that dir$^n$, the density of state changes due 2 quantisation of energy.

## Surface 2 Volume Ratio

(1) Props of N.P depend on size of N.P
(2) S.2 V Ration of N.P > than bulk material
(3) S2 V. Ratio of spherical N.P $= \frac{4\pi r^2}{\frac{4}{3}\pi r^3} = \frac{3}{r}$
(4) This shows S V ration ↑ if size of particle ↓
(5) N.P will be more active.

# Application of Nano-Particles

## Electronic Industry.

(1) Nanoparticles are used 4 coating on screen of TV, monitors so that color quality & resolution can be improved.
(2) Nanoparticles are used 2 make efficient solar cells 2 produce Solar energy.
(3) Hydrogen can become source fuel for automobiles / Transportation purpose. Research is going on to tap it by splitting $H_2O$ using sunlight in presence of nanomaterial
(4) To increase Data Storage capacity spin valve type devices are used
(5) The flat panel Television & computer monitors are products of nanotechnology.
(6) Single Electron Transistor (SET), spin valves type devices are based on Nanotechnology. These are faster and cheaper.

## Automobiles

(1) Nanotube composites have better mechanical strength as compared 2 steel. Research is made 2 develop cheaper Nanotube composites that can replace steel.
(2) Use Nanomaterial catalyst can convert harmful emmission into less harmful gases. This help in red of Air pollution
(3) Nanoparticle spray painting can provide smooth, thin & attractive coating.
(4) Nanoparticles are being used 2 produce better, light weight, less rubber consuming, thinner tyres.
(5) These kind of tyres will help 2 ↑ mileage of automobiles
(6) Use of nanotubes 2 store H is explored so that automobiles can run on H as a fuel.

## Space and Defence

(1) Satellites & spacecrafts use solar energy. Efficient solar cells are made using nanoparticles
(2) Aerogels are porous material with nanosized pores. These are of low density & poor conductor of heat
(3) These can be used in spacecraft, light weight snit, jackets, etc
(4) Chemicals used in warfare GD, GB, VX, HD. Nanoparticle oxides like CaO, $Al_2O_3$, MgO interact with such chemicals faster than microparticles
(5) Special light Temperature materials are difficult 2 make can be made @lower T as nonomaterials.
(6) Polymer composites using silica fible & nanoparticles have largere mechanical strength + low T coeff. So, they can be used in spacecraft that have 2 withstand high T & stress during launching or during re-entry into earth's atmosphere.

## Targeted Drug Delivery

(1) At pr treatment 4 cancer is chemotherapy (C8) / radiation therapy in ~~Blood~~ strong chemical injected in blood kill cancer affected cell but along with this it has tremendous side effects like indigestion, sleeplessness, hair fall affected cell
(2) Nanotechnology helps 2 deliver medicine to cancer affected cell
(3) Gold N.P are used 2 deliver drugs 4 cancer Treatment.
(4) Required drugs are encapsulated in Gold N.P.
(5) These N.P are injected in body.
(6) After this, their movement is controlled externally with the help of Magnetic field & IR radiation
(7) This helps 2 release medicine in effected area only
(8) This reduces side effects due 2 toxicity of medicines

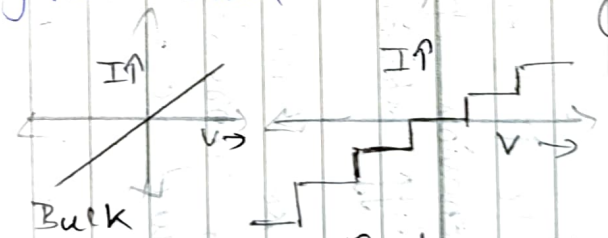
## OPTICAL

1. Color of Nanoparticle is different from bulk material.
2. Gold in bulk - Yellow but Gold N.P appear Red
3. Atomic clusters of diff sizes have diff energy level sep$^n$ & color of cluster depends on SIZE
4. Size can be altered 2 change color of cluster.
5. Tinted glass is made by dissolving gold, iron, silver, cobalt
6. In semiconductor N.P there is shift in optical absorption spectra 2wards blues as particle size is reduced.

## ELECTRICAL

smaller particle size ↑ resistivity

1. High Current Density
2. High Heat conductivity
3. Anisotropic thermal conductivity.
4. Field emission properties
5. Super Conductivity under certain conditions
6. Variable electrical conductivity
7. Electrical Props of N.P diff from bulk




Here, $e^-$ s transfer using tunneling

~~At~~ low V $e^-$ s not able to tunnel which produces Coloumb blocked zone

## Mechanical

1. Carbon nanotubes are 20 times stronger than steel.
2. Imperfections & impurities result in change in props.
3. As N.P are highly pure they show diff mechanical prop than bulk material.
4. Young's Modulus ↓eses with ↓ese in particle size.
5. Yield stress ↑ese with ↓ese in grain size in bulk material with nanosized grains
6. Hence stronger materials can be produced using nanosized grains.

Name :
Date : / /

# What is NDT

① NDT is technique used to determine the overall quality of the product without causing damage to original part.

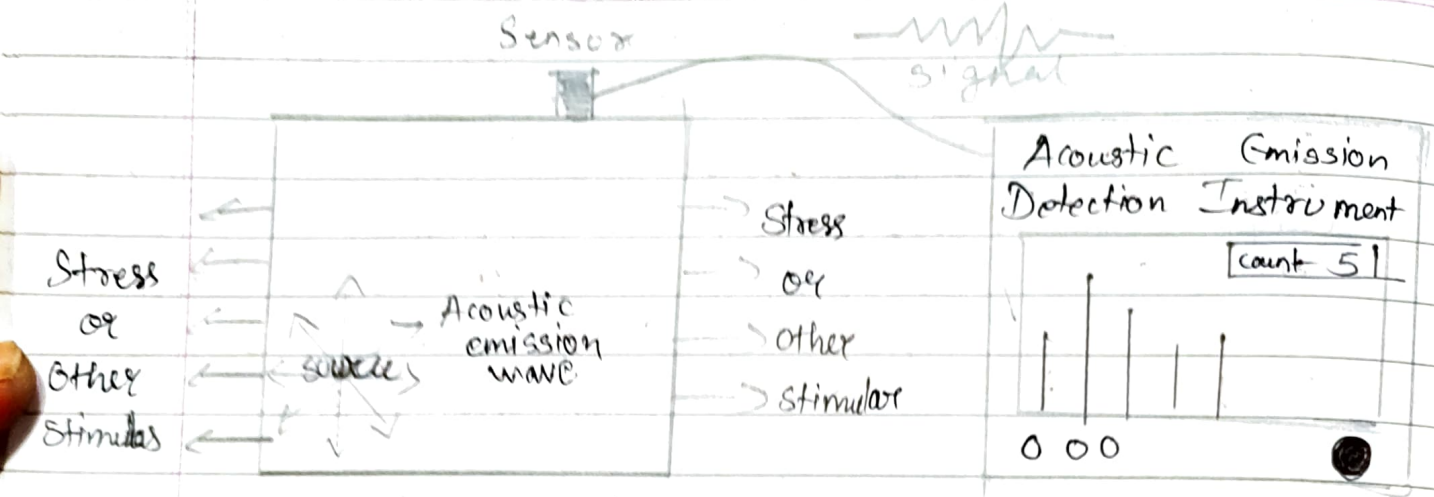
② Types :
a) Ultrasonic Testing Technique
b) Acoustic emission Technique
c) Radiography Testing
d) Magnetic Particle Testing.

| | DT | NDT |
|---|---|---|
| ① | Testing to find out props and behavior of material props under diff external conditions | ① Testing is done to find defects inside the material. |
| ② | Props like Tensile Strength, Bending, compression can be found out. | ② Props of material cannot be found out. |
| ③ | Defects inside material as flaws, cracks cannot be located. | ③ Defects inside material can be located. |
| ④ | Object under testing is damaged. | ④ Object under testing remains intact. |
| ⑤ | Production cost ↑ as parts damaged need to be replaced. | ⑤ As parts remain intact production cost does not ↑ |

| | |
|---|---|
| 6. All components cannot be tested | 5. All components can be tested |
| 7. Testind during operation not possible | 7. Testing during operation possible |
| 8. Test results are quantitative | 2. Test results are qualitative |
| 9. Time consuming | 9. Testing is rapid. |
| 10. Ex: Tensile test, compression test | 10. Acoustic Emmission, Radiography Testic |

# Acoustic Emission Technique.

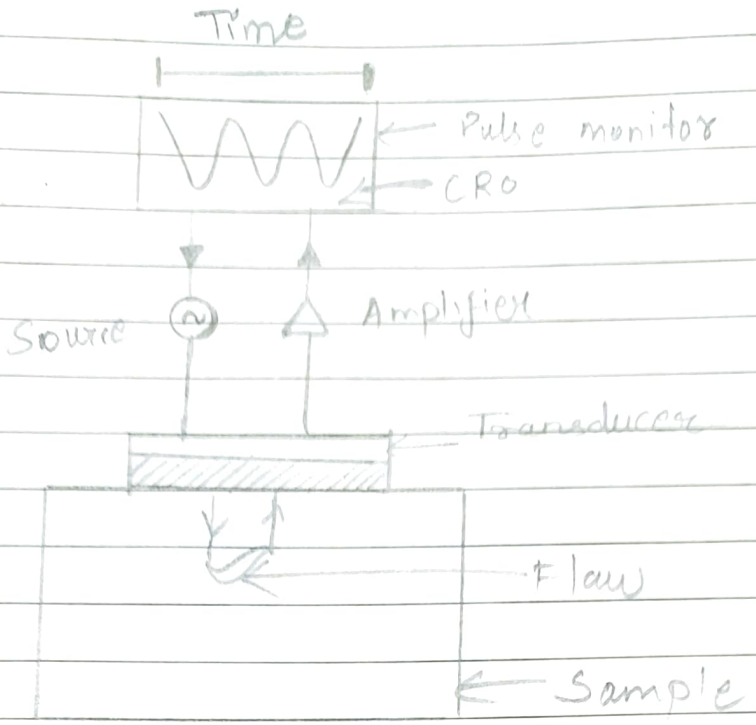
Name :
Date : / /




(1) A mechanical load / rapid T/P is applied to the material under test, and resulting stress waves are sensed by sensors.
(2) This stress wave propogate ~~along surface~~ inside material in the form of elastic wave
(3) The elastic wave is short-lived and of high frequency.
(4) Due to high freq the defect can be detected in very less time.
(5) Acoustic emmission takes place due to development of cracks, defects, breaking, etc.
(6) This method gives real time data on development of cracks & breaking within the structure.

# Ultrasonic Testing for flaw Detection.

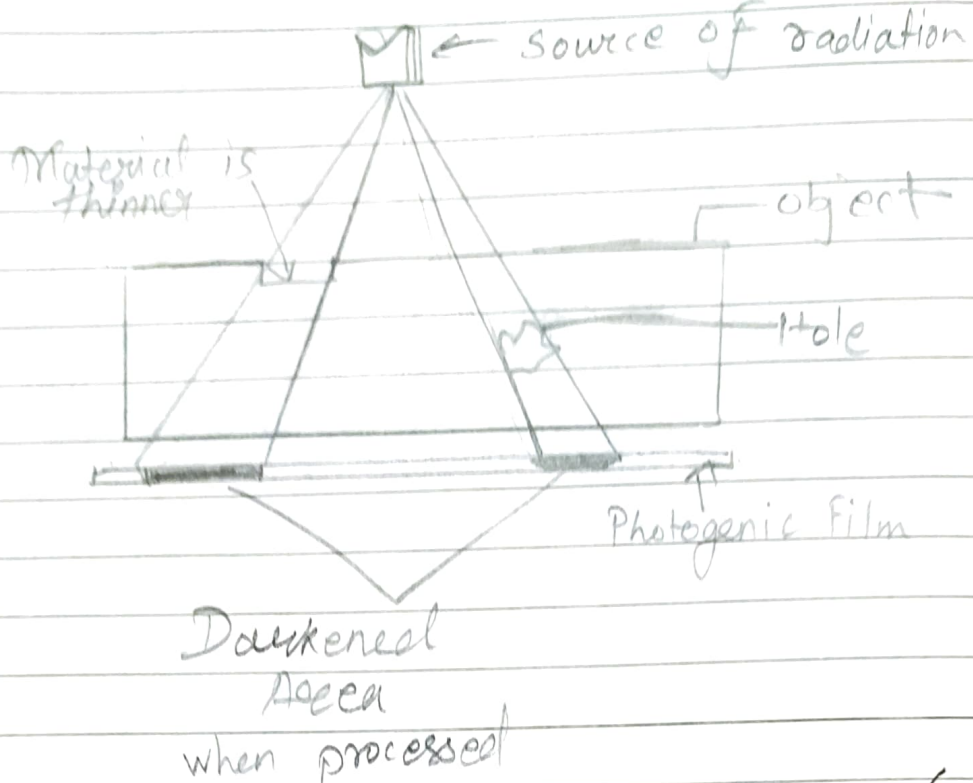
Name :
Date : / /




① Pulse generator produces a radio frequency pulse of few microseconds duration.
② Then it is the impressed on crystal placed up against the material under test.
③ Ultrasonic waves are reflected from the flaws.
④ Time elapsed between the pulse and the reflection is noted on CRO.
⑤ The time taken by reflected signal is less than the time taken for std sample, the material is treated as defective.
⑥ Location of the defect can be determined from equation : $d = \frac{v \times t}{2}$

# Radiographic Testing Method

Name :
Date : / /




(1) In Radiographic Testing X-ray / γ rays are passed through material
(2) Object is placed in path of Radiation and Photogenic Plate
(3) Absorbtion of radiation is different inside the material where defect is pr & that are free from defect. Rad gets scattered Absorbed
(3) Scattered Rad$^{n}$ produces image on Photogenic plate
(4) After analysis of PP the defects are identified.
(5) For getting exact Pos$^{n}$ of defect Rad$^{n}$ should be passed thro' diff angles
(6) The resulting radiogram is analyzed.
(7) With single radiogram presence of flaw can be detected.