

* FUNCTIONAL MATERIALS : Materials which possess particular native properties and functions of their own are known as functional materials.

All types of Biomaterials, smart materials, advanced materials are included under Functional materials.

* Biomaterials : The materials which are used for making components, that are used for implantation into human body for the replacement of damaged part or organ are known as biomaterials.

* Examples: (i) Titanium alloy (Ti-6Al-4V), with composition 90% wt% Ti, 6 wt% Al & 4 wt% V is a bio-compatible substance (biomaterial) used for replacing prosthetic hip joint.

(ii) polyethylene terephthalate for making heart valves.

* Applications / Uses of Biomaterials :

* In making bone plates, Dental implants, artificial ligaments & tendons (muscles), Heart Valves, skin repair device, contact lenses, stents.

* Important characteristic of a Biomaterial : →

(1.) It should be bio compatible.

(2.) It should have mechanical properties matchable with the replaced body part.

* needle shaped
 Fe_2O_3 crystal.

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* ADVANCED MATERIALS : The materials, which are used in high technology applications, like space-craft, air-craft, computers, electronic equipments like (CD-players VCRs etc.) are known as advanced materials.

* (i) Example : \rightarrow material for magnetic information storage like Fe_2O_3 embedded with epoxy phenolic resin,
(ii) Graphene etc.

* Uses : \rightarrow Advanced (magnetic) materials are used for information storage in audio-tapes, VCRs, computers, hard-disk, floppy disks, credit cards etc.

* Important Characteristics of Advanced Materials : \rightarrow

- (1.) The advanced used magnetic information storage should have large & square hysteresis loop.
- (2.) They should have high storage densities.

Limitations : \rightarrow (1.) High Cost (2.) less Availability.

* SMART MATERIALS : Materials, which have the ability to sense the change in external environment like (temperature, light, electric & magnetic field) and respond to them by changing their appearance, structure & functions are called smart materials.

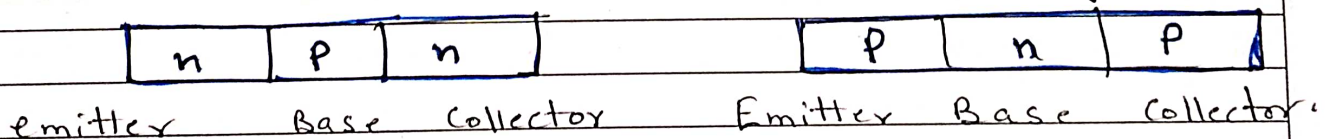
Examples : \rightarrow Shape memory Alloys, piezo electric ceramics, lead Zirconium titanate (PZT)

* Applications of smart materials \rightarrow Plz. see on next page.

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PHOTOVOLTAIC CELLS : → A solar cell or photo-voltaic cell, is an electrical device that converts light energy directly into electricity by photovoltaic effect.

WORKING OF A PHOTOVOLTAIC CELL : → When a p-n junctions is excited with light (photons) then some bonds break giving electrons and holes. The electrons are promoted from valence band to conduction band. As a result of this the n-type regions becomes more negative due to extra electrons in the conduction band and in 'p'-region the electrons are trapped by positively charged holes. Now suppose if two regions are connected in an external circuit, the electrons flow from n-region to p-region and thus a current flows from p-region to 'n'-region. Such a diode which ~~set~~ can generate electric current from light is called a photovoltaic cell. and is used to harness solar energy.



Applications of Smart materials : →

- (1) To sense & reduce undesirable vibrations of a component
- (2) Piezo-electric smart materials are used as sensors for detection of under water objects like sub-marine & fishes.
- (3) Smart materials like (magnetic fluids) are used in suspension system of automobiles.

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* Di-Electric Substance or material: A di-electric material is a substance that is poor conductor of electricity, but an efficient supporter of electrostatic field.

* Piezo-Electric MATERIALS :→ Piezo electric materials are those di-electric materials, in which pressure can produce an electrical response and electrical forces produce a mechanical response.

Example:→ piezo-electric sensors are inserted into the blades of helicopters
other examples are:→ quartz, Topaz, Computer inkjet printers, Cigarette lighters, speakers, telephones

* Pyroelectrics :→ pyroelectrics are those di-electric materials, in which change in polarization occurs as the temperature is changed.

examples: Capacitors, Strain sensors, Sonar detectors, Binary memories, I.R. detectors, optical memory display etc.

* Ferroelectrics :→ Ferroelectrics are those di-electric materials that show spontaneous & reversible di-electric polarization on application of electric field.

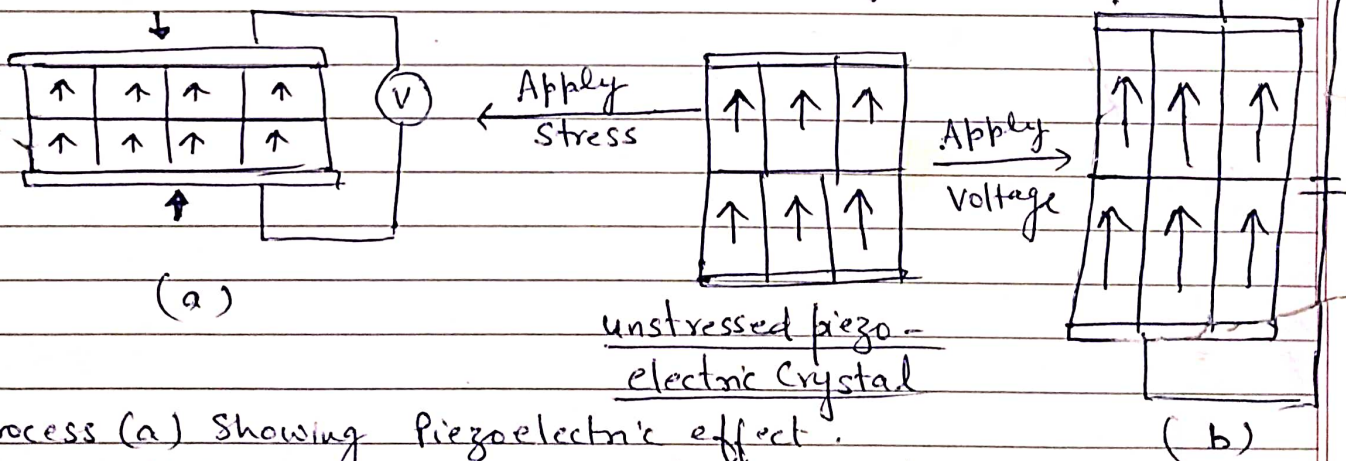
All ferroelectric materials are pyroelectrics, but all pyroelectric materials are not necessary ferroelectrics.

PIEZO-ELECTRIC EFFECT : → Piezo-electric effect is the production of measurable voltage change, across a piezo-electric material by the application of stress.

Reverse piezoelectric effect : Reverse piezo-electric effect is the production of a measurable dimensional change, due to change in magnitude of polarization in a piezo-electric material, when voltage is applied across it.

Piezo-electric effect is used in devices, where mechanical energy is converted into electrical energy.
Examples → Ultrasonic detectors, gas lighters, microphones etc.

Reverse or inverse piezo electric effect is used in devices where electrical energy is converted into mechanical energy.
Examples → Record player, ultrasonic generators, Crystal speakers



Process (a) Showing Piezoelectric effect.

process (b) " reverse piezoelectric effect.

Electric dipole : It is a two charged object with equal but opposite electrical charges, separated by the distance.

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