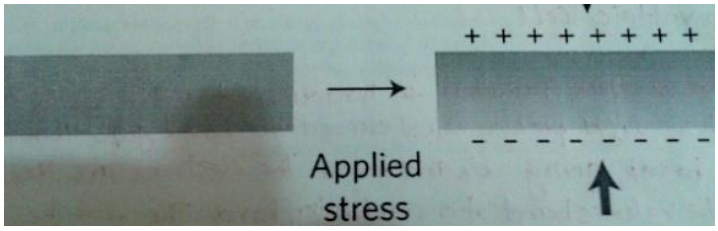
Smart materials

Definition: The materials that have the ability to sense external environmental stimuli (temperature, light, stress, electric and magnetic fields) and respond to them by changing their appearance, structure, functions and properties are called smart materials.

Description: systems that use smart materials consist of sensors and actuators. The sensor components detect a change in the environment and the actuators component performs a specific function or a response.

Piezoelectric Materials

Piezoelectric are those dielectric materials in which pressure can produce an electric response and electric forces produce a mechanical response. (The word Piezo means pressure).ex. Piezo sensors are inserted in to the blades of helicopters. Examples are PZT (Lead Zirconate titanate), Barium titanate, and Lithium niobate.



Piezoelectric effect is used in devices where mechanical energy is to be converted into electric energy. e.g: Ultrasonic detectors, gas lighter, microphones and pressure sensors.

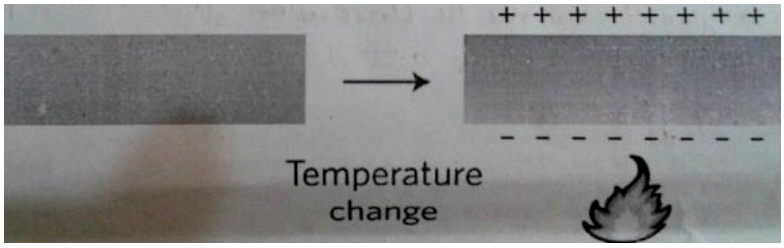
Reverse piezoelectric effect is the internal generation of mechanical strain by the application of external electrical field.

Reverse piezoelectric effect is used in devices where electrical energy is to be converted into mechanical energy. e.g: Record player, ultrasonic detectors etc.

Examples of piezoelectric materials are: Quartz, bone, ceramics, DNA, PZT (Lead Zirconate titanate), Barium titanate, and Lithium niobate. 2

Pyroelectric Materials

Pyroelectric are those dielectric materials in which change in temperature (heating or cooling) generates a temporary voltage.

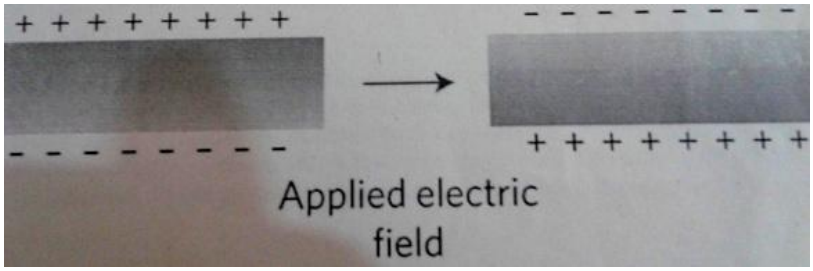


Pyroelectric materials are used in capacitors, strain sensors, sonar detectors and IR detertors.

Examples of pyroelectric materials are: Barium titanate, lead zirconate titanate and lithium tantalate.

Ferroelectric Materials

Ferroelectric are those dielectric materials that show spontaneous and reversible dielectric polarization on application of external electric field.



Ferroelectric materials are used in RAM and RFID cards.

Examples of ferroelectric materials are: Barium titanate, lead zirconate titanate and lithium tantalate.

Advanced materials

The materials which are used in high technology applications like space craft, aircraft, computer and electronic equipments (CD players, VCR's etc) are known as advanced materials.

These materials are of high cost and are less available.

Examples: γ-Fe_2O_3, graphene etc.

Uses: They are used in information storage in audio tapes, VCR's computer hard disk, floppy disks, credit cards, spacecraft body etc.

Functional Materials

Materials which possesses particular native properties and functions of their own to achieve an intelligent action.

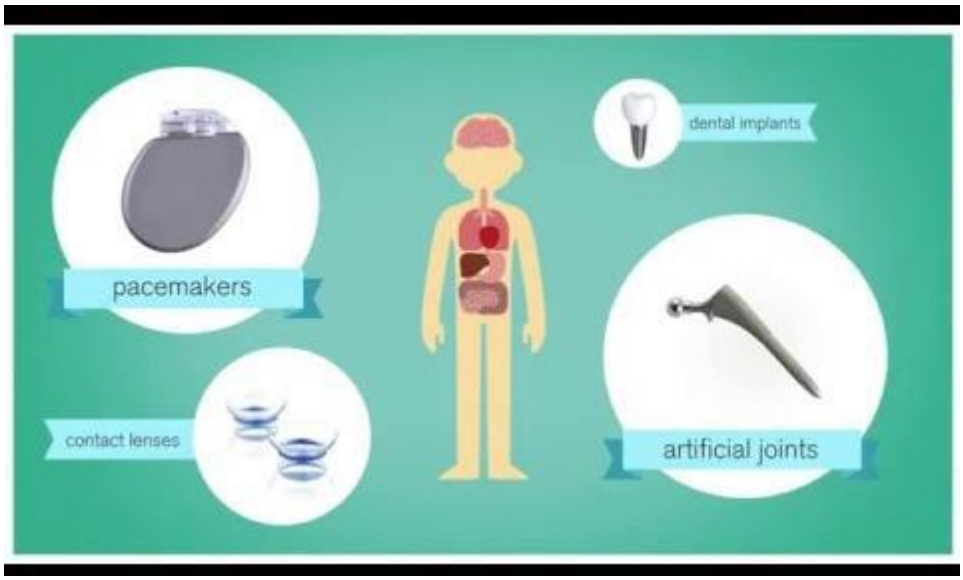
Description: The functional materials exhibit an intelligent action. They do so by utilizing their native properties and functions. Physical and chemical properties of functional materials are sensitive to the change in environment such as pH values, temperature, and pressure. This change in property is responsible for the working of these materials.

e.g: **Inorganic**	**Organic**
Ferroelectric	Ionic liquids
Light detectors	conductive polymers
Magnetic field sensors	natural proteins

Biomaterials

Definition:

The materials which are used for making components for implantation in to the human body for replacement of damaged organs are known as biomaterials.



Ideally the biomaterial is not only biocompatible but also has mechanical properties that match the body part being replaced (like bone). The biomaterial must not produce toxic substances. Biomaterials still have limitations that they are costly and some of body parts like brain heart cannot be permanently replaced.

Examples:

- Examples: Titanium alloy (Ti-6Al-4V) is used for prosthetic hip joints, copolymer of lactic acid and glycolic acid and polyethyleneterephthalate is used as heart valve.

- Al_2O_3, ZrO_2.
- Dacron, Teflon, PMMA.
- Applications: -

1. Bone plates 2. Bone cement (Artificial joints PMMA)

3. Dental implant 4. Artificial ligaments and tendons. 5. Heart valves

6. Skin repair device (artificial tissues) 7. Contact lenses. 8. Stents