Smart materials are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, temperature, moisture, pH, electric or magnetic fields.

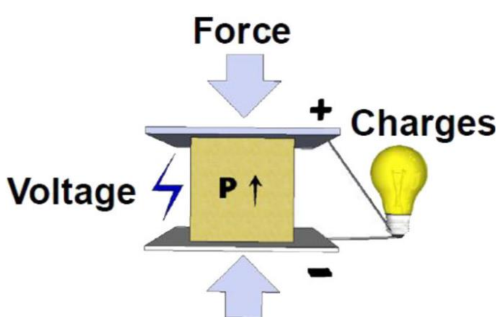
There are a number of types of smart material, some of which are already common. Some examples are as following:

1. Piezoelectric materials are materials that produce a voltage when stress is applied. Since this effect also applies in the reverse manner, a voltage across the sample will produce stress within the sample. Suitably designed structures made from these materials can therefore be made that bend, expand or contract when a voltage is applied.
2. Shape-memory alloys and shape-memory polymers are materials in which large deformation can be induced and recovered through temperature changes or stress changes (pseudoelasticity). The shape memory effect results due to respectively martensitic phase change and induced elasticity at higher temperatures.
3. Magnetic shape memory alloys are materials that change their shape in response to a significant change in the magnetic field.
4. pH-sensitive polymers are materials that change in volume when the pH of the surrounding medium changes.
5. Temperature-responsive polymers are materials which undergo changes upon temperature.
6. Halochromic materials are commonly used materials that change their colour as a result of changing acidity. One suggested application is for paints that can change colour to indicate corrosion in the metal underneath them.
7. Photomechanical materials change shape under exposure to light.
8. Polycaprolactone (polymorph) can be molded by immersion in hot water.

9. Self-healing materials have the intrinsic ability to repair damage due to normal usage, thus expanding the material's lifetime.
10. Dielectric elastomers (DEs) are smart material systems which produce large strains (up to 300%) under the influence of an external electric field.
11. Thermoelectric materials are used to build devices that convert temperature differences into electricity and vice versa.

1- Piezoelectricity : is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics,) in response to applied mechanical stress. The word *piezoelectricity* means electricity resulting from pressure.

The nature of the piezoelectric effect is closely related to the occurrence of electric dipole moments in solids. The latter may either be induced for ions on crystal lattice sites with asymmetric charge surroundings (as in $BaTiO_3$ and PZTs)



Materials of piezoelectric

Many materials, both natural and synthetic, exhibit piezoelectricity:

Naturally occurring crystals

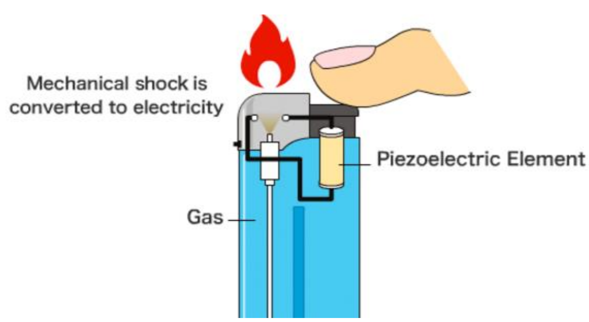
- Quartz
- Berlinite ($AlPO_4$),
- Rochelle salt
- Topaz
- Tourmaline-group minerals
- Lead titanate ($PbTiO_3$). Although it occurs in nature as mineral macedonite, it is synthesized for research and applications.

Polymers

- Polyvinylidene fluoride (PVDF): PVDF exhibits piezoelectricity several times greater than quartz.

Application of piezoelectric materials :

1- **High voltage and power sources (** **cigarette lighter)**



2-Sensors :

3- Actuators : such as AFM (Atomic force microscopes)

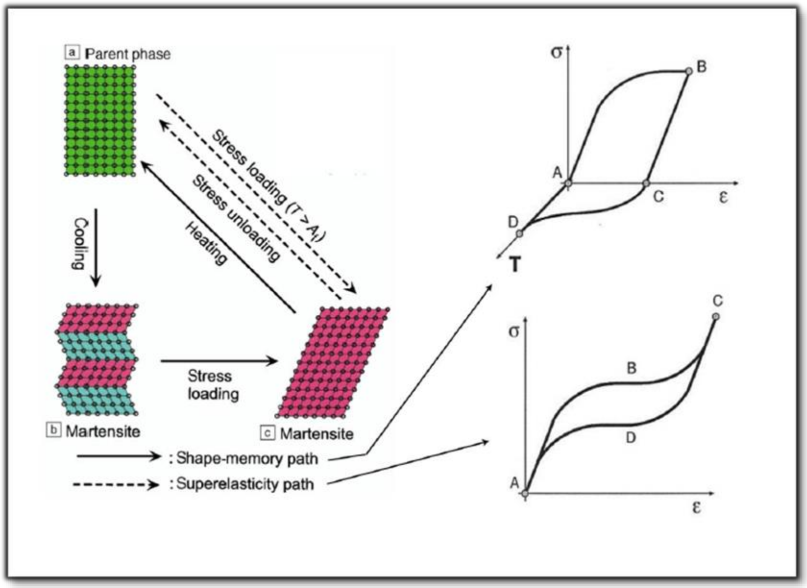
4- Reduction of vibrations and noise

5- Surgery

6- Construction

2- Shape memory alloys (SMA)

Shape memory alloys (SMAs) are the most important branch of smart or intelligence materials, it's a metallic alloys which undergo solid-to-solid phase transformations induced at appropriate temperature or stress changes and during which they can recover seemingly permanent strains.



Shape memory alloys have two phases namely austenite and martensite; Austenite is the high temperature or “parent” phase **.**

Ni-Ti is the most widely used shape memory alloys for technological applications .

Application of shape memory alloys :

SMAs have found applications in many areas due to their high power density, solid state actuation, high damping capacity, durability and fatigue resistance. Accordingly their use gives new possibilities of introduction on the market of innovative commercial products based on their particular characteristics, these characteristics of SMAs can be used for a number of applications, like free recovery applications as blood-clot filters (medical application) , constrained recovery applications as hydraulic couplings, force actuators as fire safety valves, proportional control as fluid flow control valve . Superelastic applications as eyeglass frames and guide wires for steering catheters into vessels in the body.