

Microactuation:-

- "a mechanical device for moving or controlling something."
- The actuator is a very important part of a microsystem that involves motion.

- 4 means of microactuation are

- ① Thermal forces
- ② Shape memory alloys.
- ③ piezoelectric crystals
- ④ Electrostatic forces

- Actuators can be as simple as an electrical relay, switches or as complex as an electric motor.

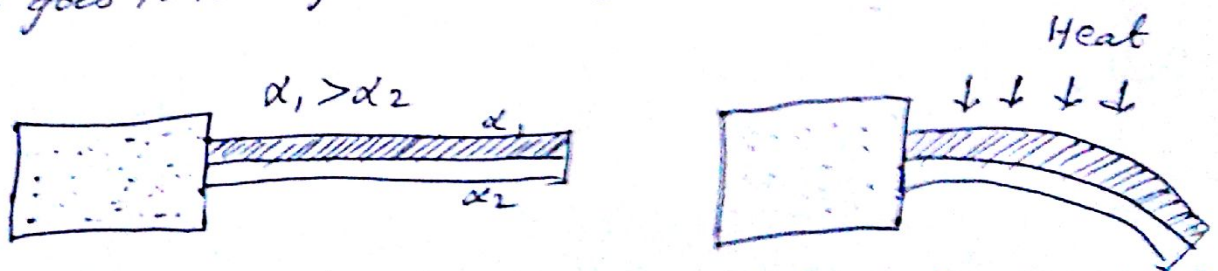
Actuation using Thermal forces:-

- Bimetallic strips are actuators based on thermal forces.

- These strips are made by bonding two materials with distinct thermal expansion coefficients.

- The strip will bend when is heated (or) cooled from the initial reference temperature because of its compatible thermal expansions of the materials that are bonded together.

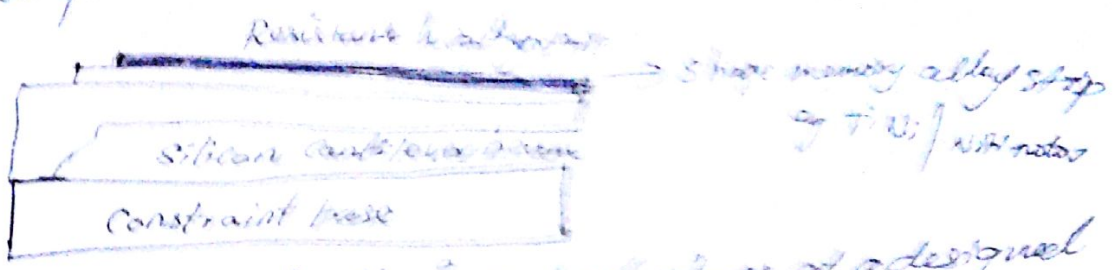
- it goes to its original position by removing applied thermal force.



- The same principle has been used to produce several microactuators, such as microclamps (or) valves.

Actuation using shape memory alloys

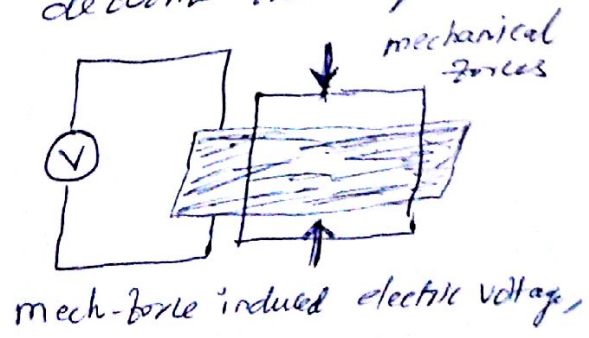
- micro actuation can be realized more accurately and effectively by using shape memory alloy (SMA) such as Nitinol or TiNi alloys.
- These alloys tend to return to their original shape at a preset temperature.



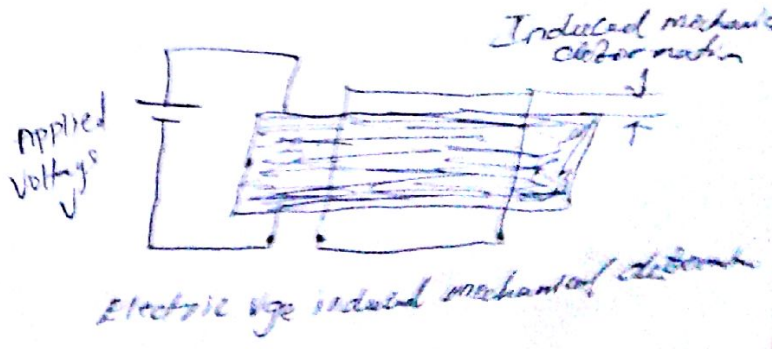
- An SMA strip originally in a bent shape at a designed preset temperature T_0 is attached to a silicon cantilever beam.
- The deformation of the SMA strip causes the attached silicon beam to deform with the strip's micro actuation of the beam is thus achieved.
- This type of actuation has been used extensively in micro robot actuators, micro joints & robots & micro springs.

Actuation using piezoelectric crystals

- Certain crystals such as quartz, that exist in nature deform with the application of an electric voltage.
- The reverse is also valid (i.e.) electric voltage can be generated across the crystal when an applied force deforms the crystal.



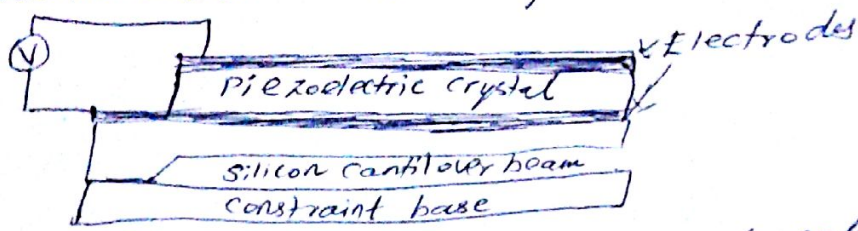
mech-force induced electric voltage,



Electric vge induced mechanical deformation

- An applied voltage across the piezoelectric crystal prompts a deformation of the crystal, which can in turn bend the attached silicon cantilever beam.

- Piezoelectric actuation is used in a micropositioning mechanism and micro clamp.



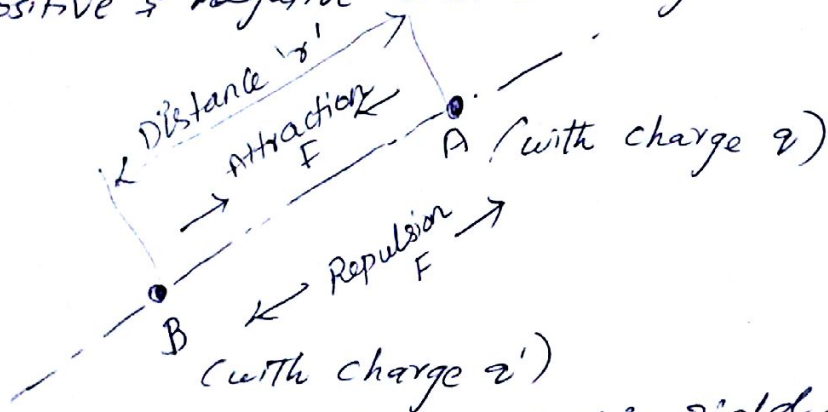
- Piezoelectric crystals are essential material for micro actuators.

Actuation using Electrostatic Forces:-

- it is used as the driving forces for many actuators

- Electrostatic force 'F' is defined as the electrical force of repulsion or attraction induced by an electric field E.

- w.k.t, an electric field 'E' exists in a field carrying positive & negative electric charges.



- A & B are in an electric field, the induced electrostatic force, according to Coulomb can be expressed as,

$$F = \frac{1}{4\pi\epsilon} \frac{qq'}{r^2}$$

ϵ - permittivity of the material separating 2 particles
 r - distance b/w 2 charged particles

F - repulsive if both charge q & q' , carry positive (or) negative charges, attractive if the two charges have opposite signs.