SENSORS & ACTUATORS

SENSORS

- I/P components
- collect information/ data by sensing
- a device which detects or measures a physical property and records, indicates, or responds to it.
- Passive &active devices
- Ex: PIR sensor, EMF sensor, RADAR…

ACTUATORS

- o/p components
- Use information& control signals to alter surrounding or environment
- a component of a machine that is responsible for moving or controlling a mechanism or system.
- active devices
- Ex: Servo mechanism, digital circuits, stepper motor…

SENSORS

Technical aspects

- Coverage range-power
- Data range- β,f
- Mobility
- Size/type
- Battery power
- Environment
- Ex: microwaves for cell phone (-80dbm)& base station (+43dbm)
- RFID : automatic detection, embedded &detected

Quality aspects

- Functionality testing
- Validation
- Compliance
- Certification
- Near field /far field communication
- Ex: sensor fixed near the door sensing entry/ sensing passersby
- Bar code: physical detection, shown near scanner& detected

TYPES OF SENSORS

- Position sensor
- Presence sensor
- Motion sensor
- Velocity sensor
- Displacement sensor
- Temperature sensor
- IR Sensor
- Flow sensor
- Ultrasonic Sensor
- Touch Sensor
- Proximity Sensors
- Pressure Sensor
- Level Sensors
- Smoke &Gas Sensors
- Humidity sensor
- Optical sensors…

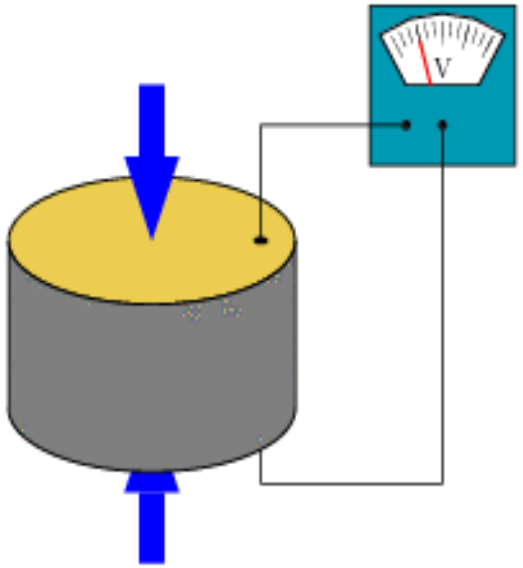
Technology increases (wireless, blue tooth, GSM…)
but basic science behind remains the same

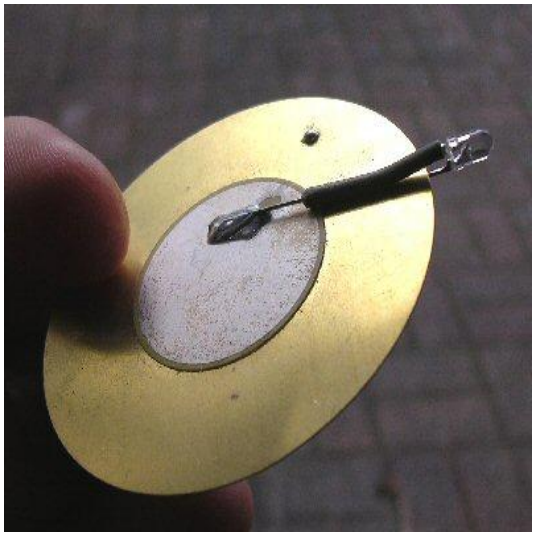
Sensing & actuation principles

- Piezo electric effect
- Converse of piezo electric effect
- Magneto striction effect
- Villary effect-Converse of Magneto striction effect
- Wiedemann effect
- Joule effect
- Matteuci effect-Converse of Wiedemann effect
- Nagoka-Honda effect
- Shape memory effect

Piezoelectric Materials

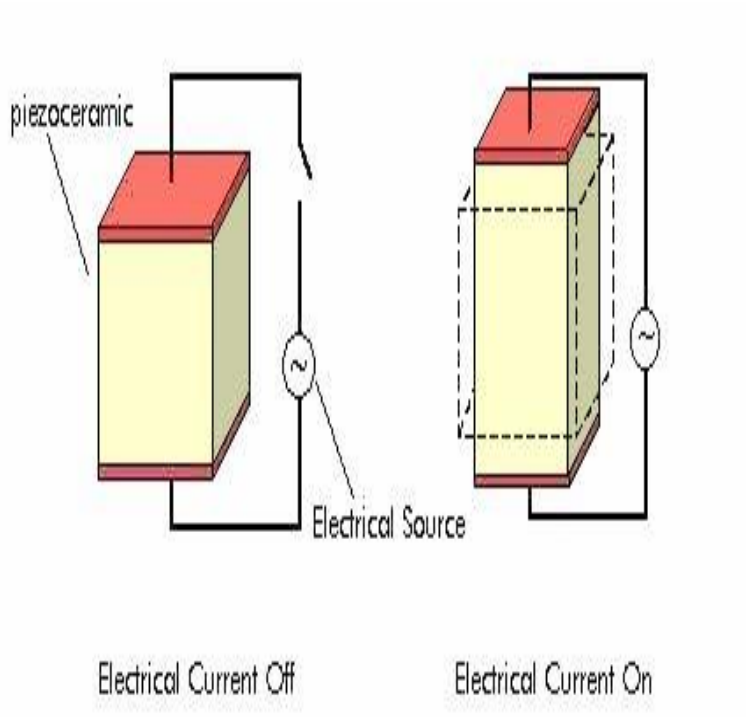
- Materials that produce a voltage when stress is applied.(An applied mechanical stress will generate a voltage)
- Ex: Quartz, Tourmaline, Rochelle salt, $BaTiO_3$, $GaPO_4$, PZT
- The piezoelectric effect describes the relation between a mechanical stress and an electrical voltage in solids.
- In physics, this effect can be described as the link between electrostatics and mechanics.
- An LED is wired to a piezoelectric transducer. The LED briefly lights when the device is flicked & shows that electricity has been generated by stress and strain.





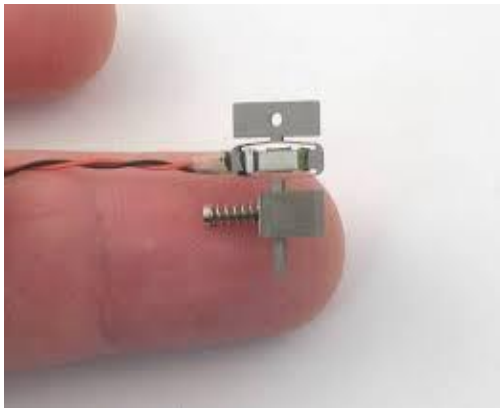
Reverse Piezo electric effect

- An applied voltage will change the shape of the solid by a small amount (up to a 4% change in volume).
- Quartz watches, Piezo electric US oscillator



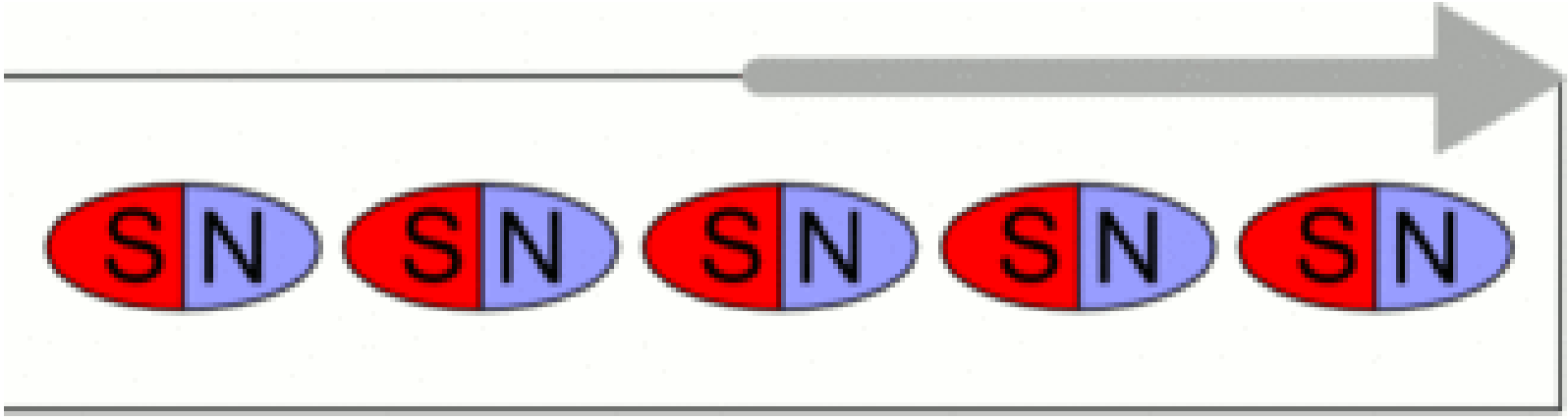
Applications of piezo electric effect

- In lighters or portable sparkers with a piezo fuse a sudden and strong pressure is used to produce a voltage. The spark then ignites the gas.
- A piezo motor is based on the change in mechanical shape of a piezoelectric material when an tension is applied. The material produces ultrasonic or acoustic vibrations and produces a linear or rotary motion.
- Piezo elements are used in acoustic instruments. They are inserted in stringed instruments such as guitar, violin or Mandolin. The dynamic deformation/vibration of the cords is converted into a small alternating voltage.



Magnetostrictive Materials

- Magneto striction is a property of ferro magnetic materials that causes them to change their shape or dimensions during the process of magnetization.
- The effect was first identified in 1842 by James Joule when observing a sample of iron.
- Ex: Fe, Co,Ni, Terfenol – D
- Applications: US transducers, SONAR, sensors



Magnetostrictive Materials-Applications

- **Actuators and Sensors**

  Magnetostrictive transducers - Convert magnetic energy in to mechanical energy

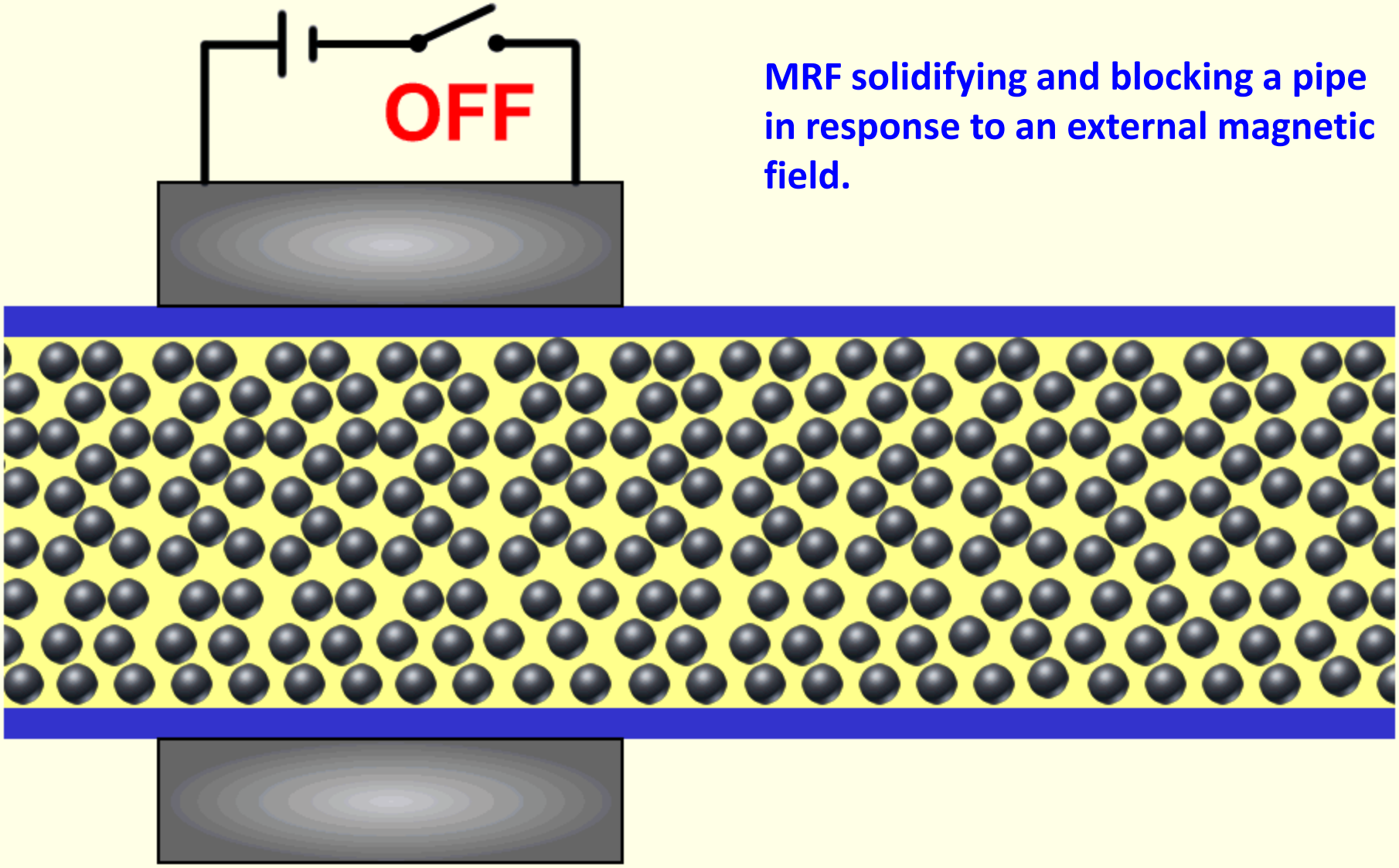
- **Vibration Speaker Technology**

  use the highest power Smart Material . Install in seconds - peel and stick - no screws or mounting issues

  High quality sound without design compromise- No wires- no boxes.

Magneto-Rheological Fluid (MRF)

- A MR fluid is a smart fluid which usually consists of 20-40 percent iron particles, suspended in mineral oil, synthetic oil, Silicone oil, water or glycol.
- When subjected to a magnetic field, the magnetic particles inside increase the fluid's viscosity, rendering it as a viscoelastic solid.



MRF solidifying and blocking a pipe in response to an external magnetic field.

"OFF" position – the MR fluid is not magnetized & the particles inside, distributed randomly, allow the fluid to move freely, acting like a damper fluid.

"ON" position – the particles become energized and align into fibrous structures and restricts the movement of the fluid

MRF APPLICATIONS

✓MR dampers/MR shock absorbers

- MRF is used in dampers/shock absorbers to continuously control the damping characteristics by varying the power of the electro magnet.
- Best for vehicle suspensions which adopt to road conditions. The nature of the road is monitored through sensors in the vehicle.
- Delphi corporation-Audi,Cadillac,Chevrolet,Ferrari,Lamborghini…
- Millen works-Military vehicles, LUV,SUV…

✓MR dampers for aviation

- In aviation damper control is done by special algorithms.
- To isolate vibrations from aircraft structure & crew the algorithm controls the yield point shear stress of MRF with electric current
- When MR effect takes place the fluid becomes stiff and when this happens at right time the damper activates and helps in attenuating any undesired shock or vibration.