Piezoelectric Working Principle The piezoelectric effect is the ability of certain materials to generate an electric charge when subjected to mechanical stress.o Most synthetic materials contain toxic lead (PZT). Applications of Piezoelectric Effect a) Sensors and Transducers o Microphones – Convert sound vibrations into electrical signals.Piezoelectric Effect The piezoelectric effect is divided into two types: a) Direct Piezoelectric Effect (Sensing) o When a mechanical force (pressure, vibration, or stress) is applied to a piezoelectric material, it generates an electrical charge.b) Inverse Piezoelectric Effect (Actuation) o When an electric field is applied to a piezoelectric material, it undergoes mechanical deformation (expansion or contraction).Electric Field Induced Deformation (For Actuators) o When an external voltage is applied, the atoms realign.Mechanical Stress Application (Compression/Tension) o When stress is applied, the atomic lattice of the piezoelectric material shifts. c) Energy Harvesting o Piezoelectric Energy Harvesters – Convert mechanical vibrations into electrical energy.o This effect is used in ultrasonic transducers, actuators, and precision positioning devices.o Ultrasonic Sensors – Used in medical imaging (ultrasound), sonar, and object detection.b) Actuators o Inkjet Printers – Piezoelectric elements control ink droplets.o Precision Positioning Devices – Used in robotics, microscopes, and aerospace.The principle is widely used in sensors, actuators, and energy harvesting systems.o Accelerometers – Used in vehicles, mobile phones, and earthquake detection.o Wearable Piezoelectric Generators – Used in self-powered sensors.Advantages & Limitations Advantages: o No need for external power (passive sensors).Limitations: o Generated voltage is small; requires amplification.This effect is reversible, meaning that applying an electric field to the material can cause it to deform mechanically.o This effect is used in pressure sensors, accelerometers, microphones, and energy harvesters.o The material's atomic structure shifts in response to the electric field, creating movement.Charge Collection & Output o The generated charge is collected by electrodes attached to the material.o Ultrasonic Transducers – Used in industrial cleaning and medical imaging.o This causes a displacement of positive and negative charge centers, resulting in an electric potential difference.o This charge can be converted into a usable electrical signal.o Smart Roads & Shoes – Convert vehicle or human motion into electrical power.o Piezoelectric materials can degrade over time.o The displacement of positive and negative charges within the material creates an internal electric field.Working Mechanism 1.o High sensitivity and quick response.1.3.2.3.4.5.