

The background features a dark blue gradient with a fine, starry texture. On the left side, there is a large, semi-circular scale with numerical markings from 140 to 260 in increments of 10. Several circular diagrams are scattered across the scene, some containing curved arrows that suggest motion or rotation. The overall aesthetic is technical and futuristic.

PIEZOELECTRICITY

WHAT IS PIEZOELECTRICITY?

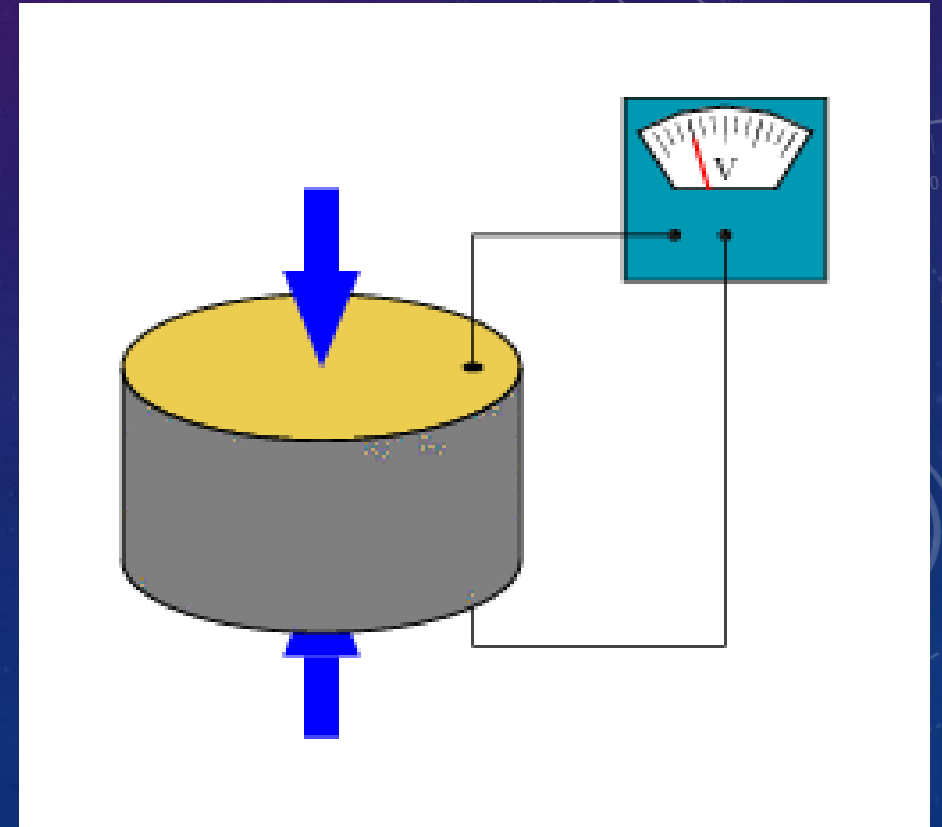
Piezoelectric materials produce an electric voltage when deformed mechanically—such as by squeezing or tapping.

The reverse effect is also true.

If we apply a voltage to the material, it deforms.

One early application of piezoelectric materials was for sonar in WWI.

Other applications include: sensors, actuators, artificial muscles, light-up shoes, and many more.



PIEZOELECTRICS AND ENERGY HARVESTING



Imagine charging your phone as you walk, thanks to a paper-thin generator embedded in the sole of your shoe.

One of the most exciting advancements in the field of materials science is using piezoelectric materials **to harvest energy from everyday occurrences**, like walking, climbing stairs, opening and closing doors—any sort of movement.

This can be done by placing piezoelectric materials where they experience a great number of **mechanical deformations**.

Then, the **electric potential created is stored in batteries** for later use.



ENERGY HARVESTING APPLICATIONS



Piezoelectric Sidewalks and Highways

- In France, piezo sidewalks power a town's street lights as people walk over the piezo elements and deform them.

- In Israel, the same principle has been scaled up to a stretch of highway that converts the energy from cars driving over the piezo elements in the road to collect power for a nearby small town.



ENERGY HARVESTING APPLICATIONS

Piezo-Clothing

- Georgia Tech researchers created tiny flexible piezoelectric generators that can be embedded in fabric.
- As you move throughout the day, clothes made with this fabric could generate enough power for small electronic devices such as calculators and phones.



Piezo-Cars

- A Jaguar concept car has a thin coating of piezoelectric materials on the outside of the body.
- When the car moves down a road, the air moving past it deforms the piezoelectric materials, generating electricity to recharge the car battery.
- This design has the potential to develop into electric cars with unlimited range!



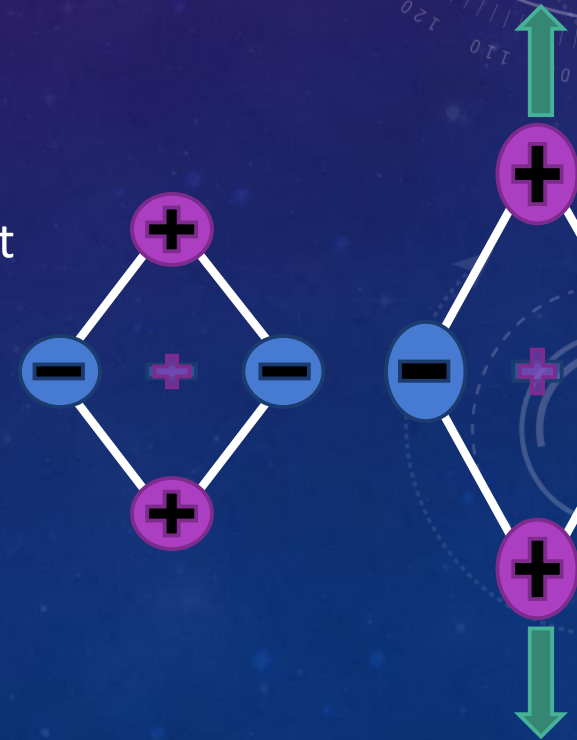
WHY ARE ONLY SOME MATERIALS PIEZOELECTRIC?

To answer this question, let's look at the materials on the atomic level.

The crystal structure of a material—**how the atoms and charges are arranged**—determine if it is piezoelectric.

First, let's look at non-piezoelectric materials:

- These materials have **symmetric atomic structures**. If we flip them in any direction, the positive and negative charges are in the same locations.
- If we average the locations of the positive and negative charges, to find what are called the centers of charge, we notice that these locations overlap.
- This overlapping causes the charges to cancel out and **no electricity is generated**.
- When we deform the material by stretching it, the positive and negative centers of charge do not change, and still no electricity is generated. **Thus, the material is non-piezoelectric.**

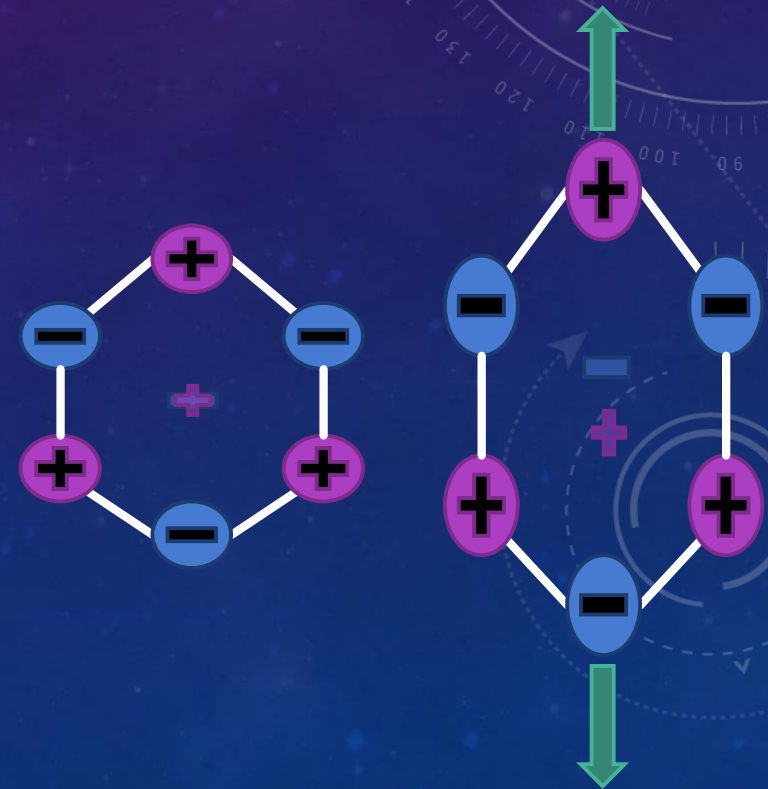


WHY ARE ONLY SOME MATERIALS PIEZOELECTRIC?

If symmetric materials are non-piezoelectric, that means that **non-symmetric materials are piezoelectric.**

Lets look at the structure of a piezoelectric material:

- At first glance, the structure appears to be symmetric. If we flip it around, the shape may look the same, but the positions of the positive and negative charges may change. Thus, it is **not symmetric.** →
- Again, when we find the centers of charge for this material, they overlap and no electricity is generated.
- However, **when we deform the material by stretching it**, the positive and negative centers of charge no longer overlap.
- Since these centers of charge do not overlap and cancel each other out, **some electricity is generated!** This material is **piezoelectric.** ↗



IS ENERGY REALLY CREATED?

While devices using piezoelectric materials are called generators, **no energy is actually created!**



In fact nowhere in the entire universe is energy ever created! This is one of the fundamental laws of physics.

If this is true, then from where is this electricity or energy coming?

- Even though energy cannot be created, it can be converted from one type to another. In the case of piezoelectric materials, **mechanical energy**, from applying some force to deform the material, is converted into **electrical energy**.
- The reverse effect enables piezoelectric materials to convert electrical energy back into mechanical energy, making them very useful materials.

The background is a dark blue gradient with a subtle pattern of white stars and technical diagrams. On the right side, there are several circular diagrams resembling gauges or dials with numerical scales (e.g., 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210) and arrows. On the left side, there are dashed circular arrows. The central text 'QUESTIONS?' is white with a soft purple glow and a dark shadow.

QUESTIONS?