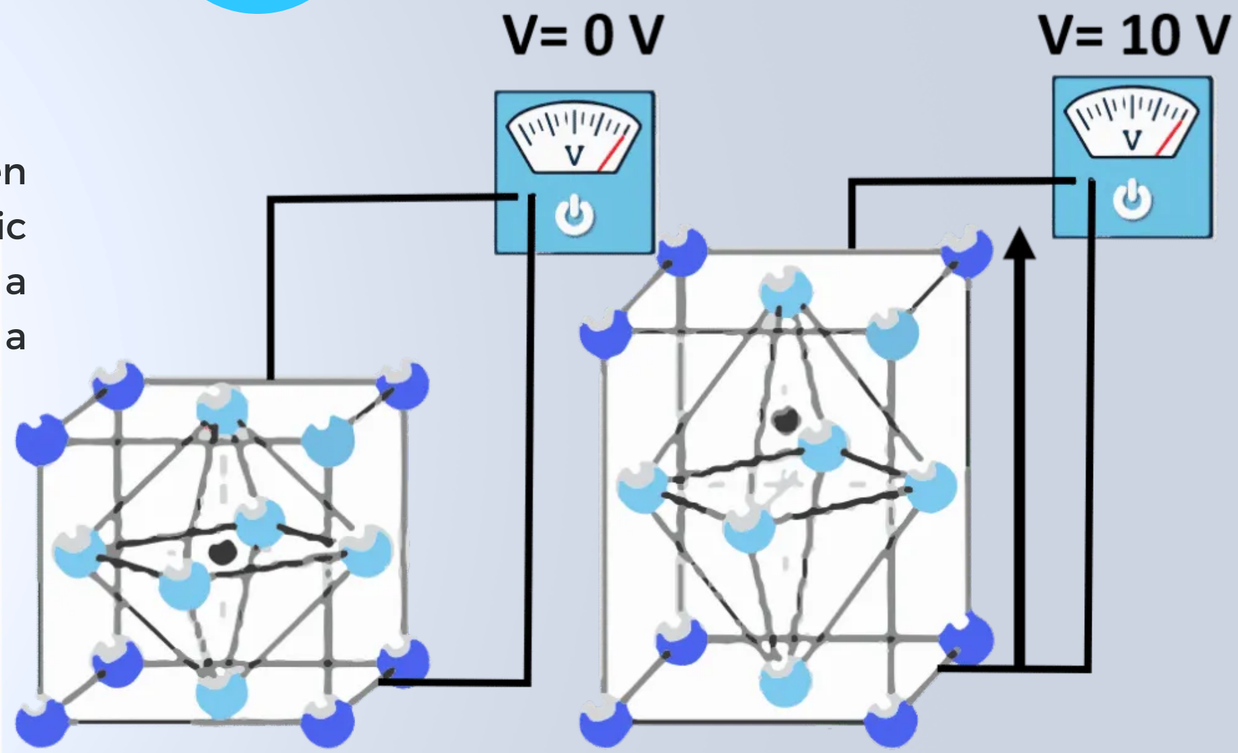
FUNDAMENTAL
KNOWLEDGE

PIEZOELECTRIC MEMS
FOR ENERGY HARVESTING

WHAT IS PIEZOELECTRICITY ?

Certain materials tend to accumulate electric charges when a mechanical stress is applied to them. The piezoelectric effect is an effect that simply describes the fact that a pressure applied to a piezoelectric material will generate a voltage.

The lead zirconate titanate (or PZT) crystals will generate measurable piezoelectricity when their static structure is deformed by about 0.1% of the original dimension. Conversely, those same crystals will change about 0.1% of their static dimension when an external electric field is applied to the material.

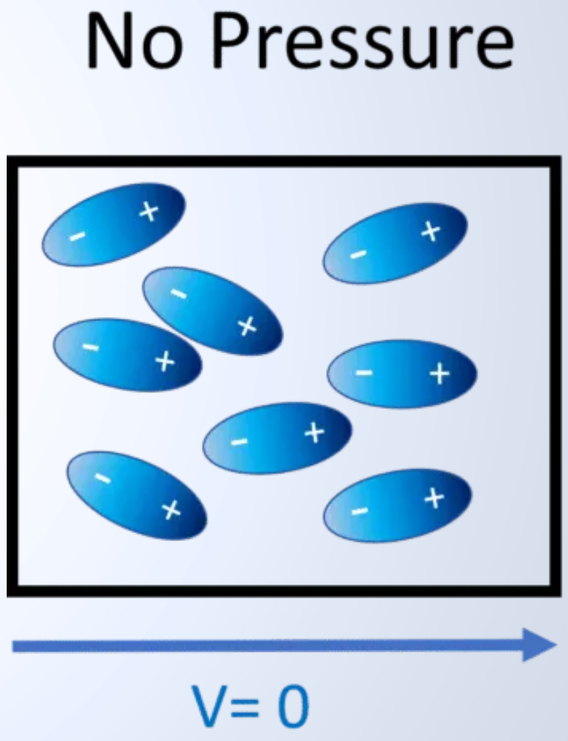


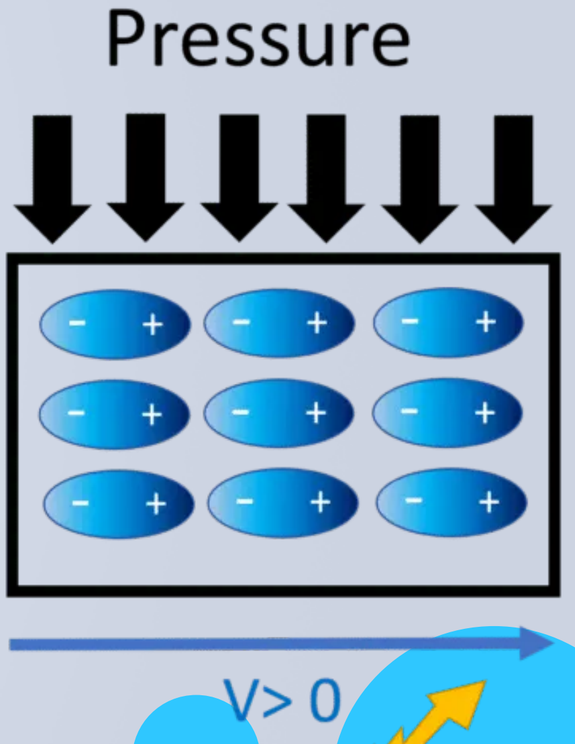
HOW DOES PIEZOELECTRICITY APPEAR UNDER PRESSURE?

Materials (like everything in the world) are composed of molecules which are arranged in a certain way.

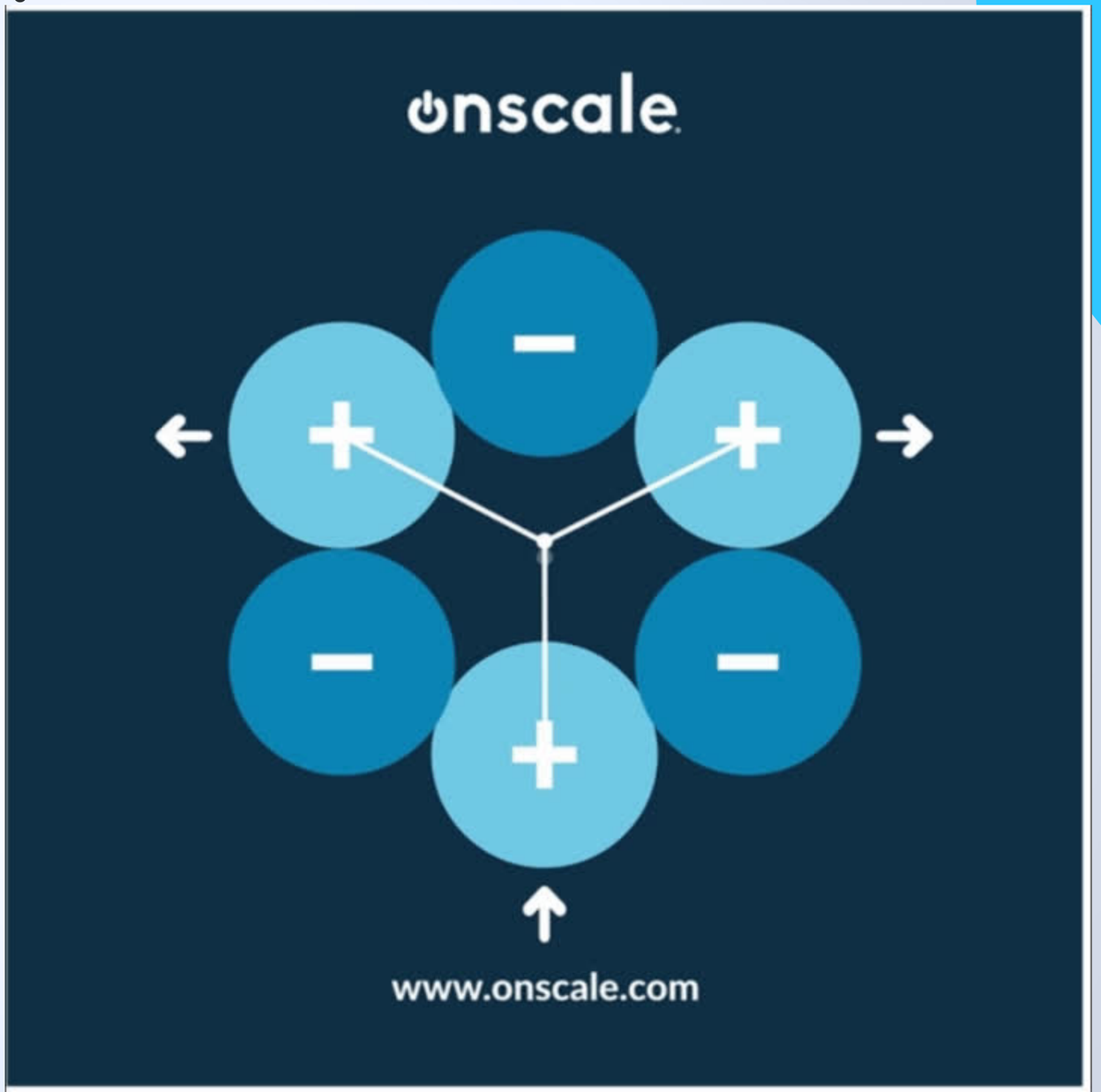
When the material is in a free state (without any pressure), those molecules will be arranged in a certain way which corresponds to an equilibrium of the mater and in which the charges of the molecules cancels itself if we look at the whole.

When a pressure is applied however, those molecules change position and align into a dipolar state in which the global charge isn't null anymore and 2 sides of the materials become polarized.





WHAT HAPPENS WHEN THE PIEZOELECTRIC CRYSTAL IS COMPRESSED?

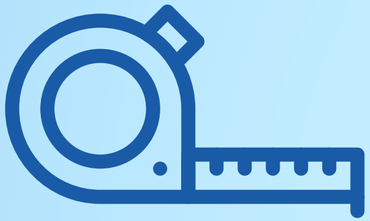


Reference Video

PIEZOELECTRIC MEMS FOR ENERGY HARVESTING

MOTIVATION

MEMS CHALLENGES IN POWER SUPPLY



SIZE

Traditional power sources are generally big in size. They are difficult to scale down.

LIMITED ENERGY

Limited energy storage in traditional power supplies hampers the ability of MEMS to operate continuously over extended periods.

MAINTENANCE

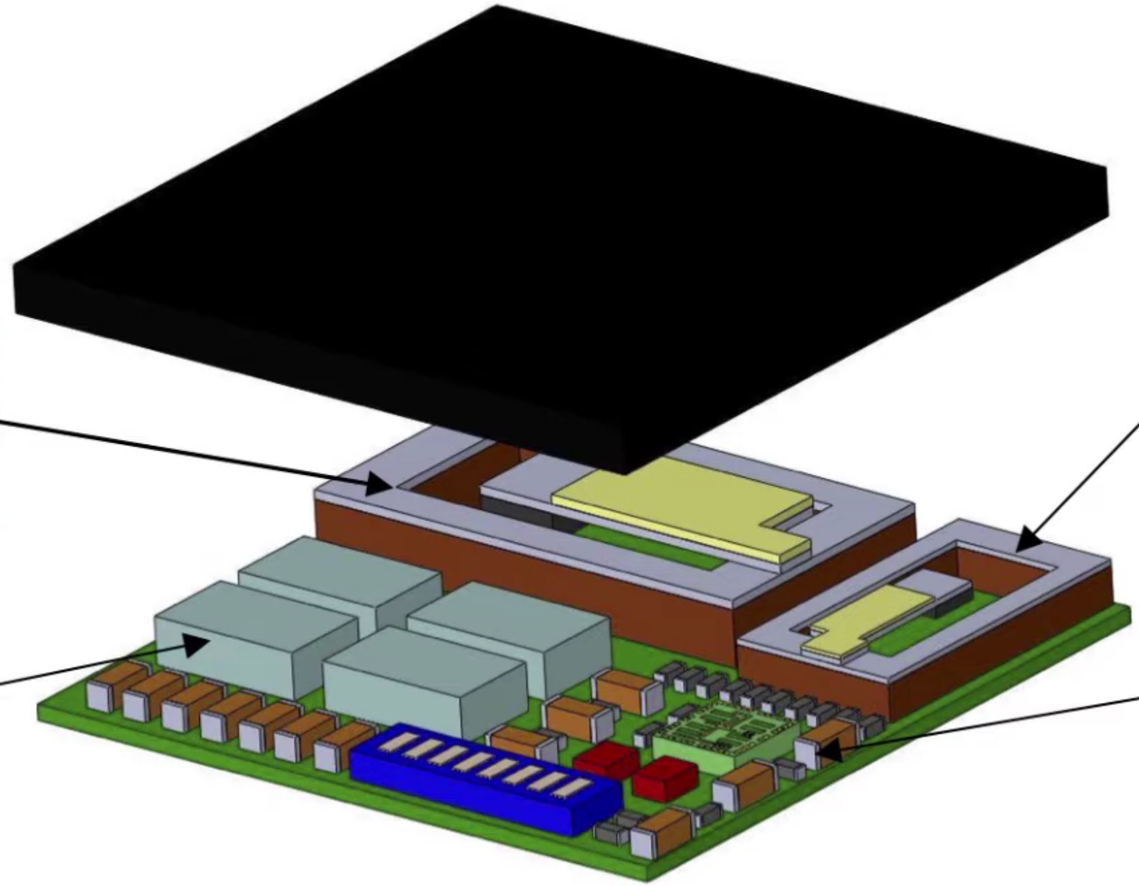
Maintenance challenges in MEMS, particularly in remote or inaccessible locations, hinder long-term reliability and continuous operation.

HOW PIEZO CAN SOLVE THIS?

Utilizing piezoelectric vibrators can address maintenance challenges and power constraints in MEMS devices. By integrating piezoelectric energy harvesting mechanisms, these devices can harness ambient vibrations to generate electrical power, reducing reliance on traditional power supplies and mitigating the need for frequent maintenance. The scalability and efficiency of piezoelectric technology make it a promising solution for sustaining MEMS operations in challenging environments, ensuring extended reliability and minimizing the limitations associated with traditional power sources.

System In a Package (SIP) Integration of IoT Wireless Sensors

1.50



Piezoelectric Energy Harvesters

Sensors

Passive Components

Integrated Circuit

HOW THIS WORKS?

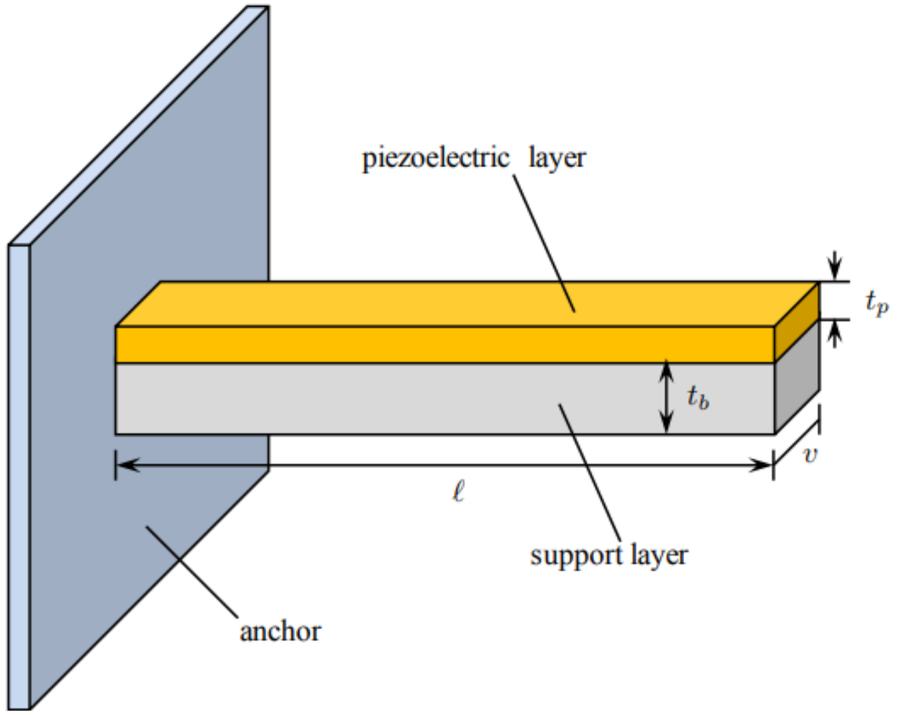
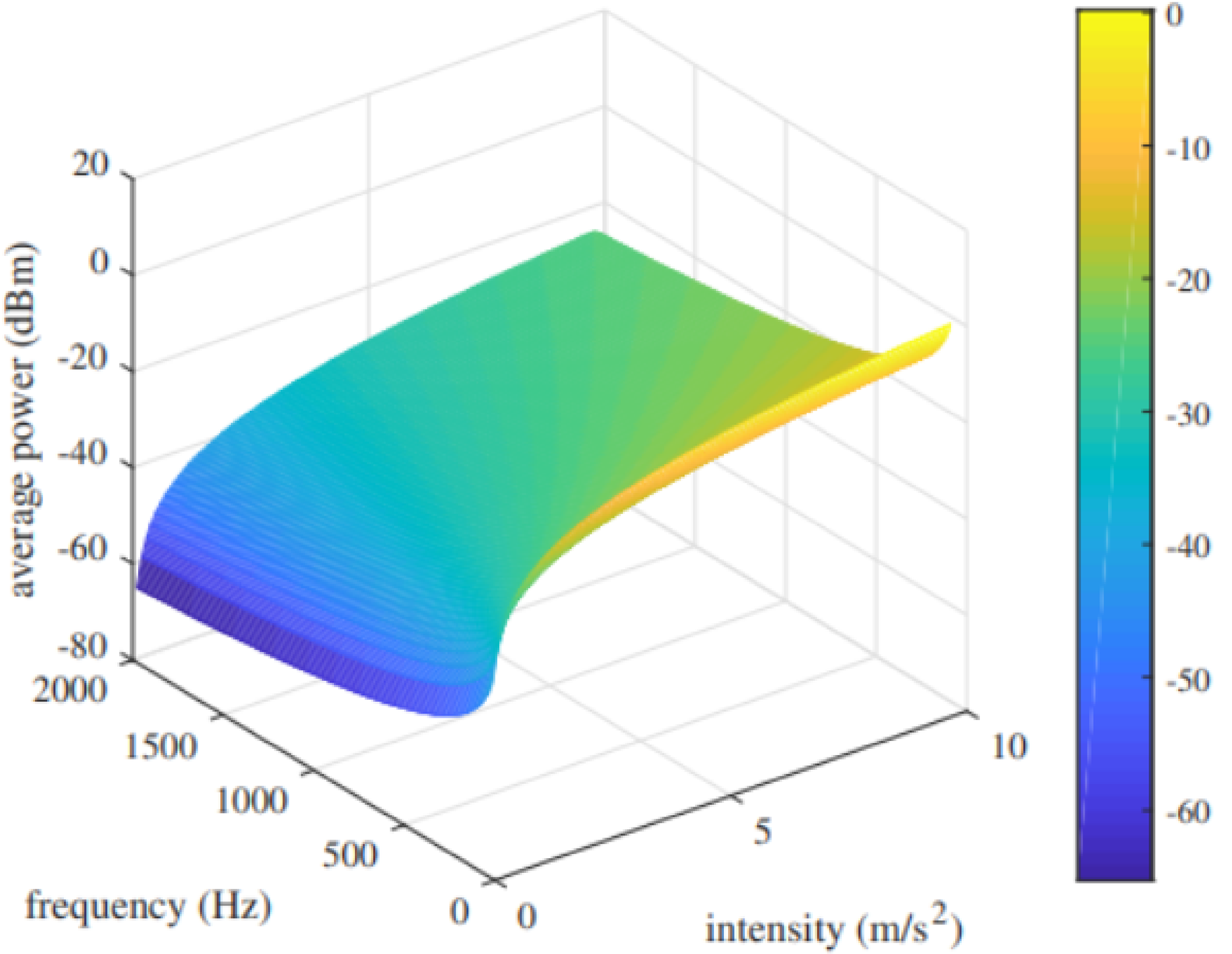
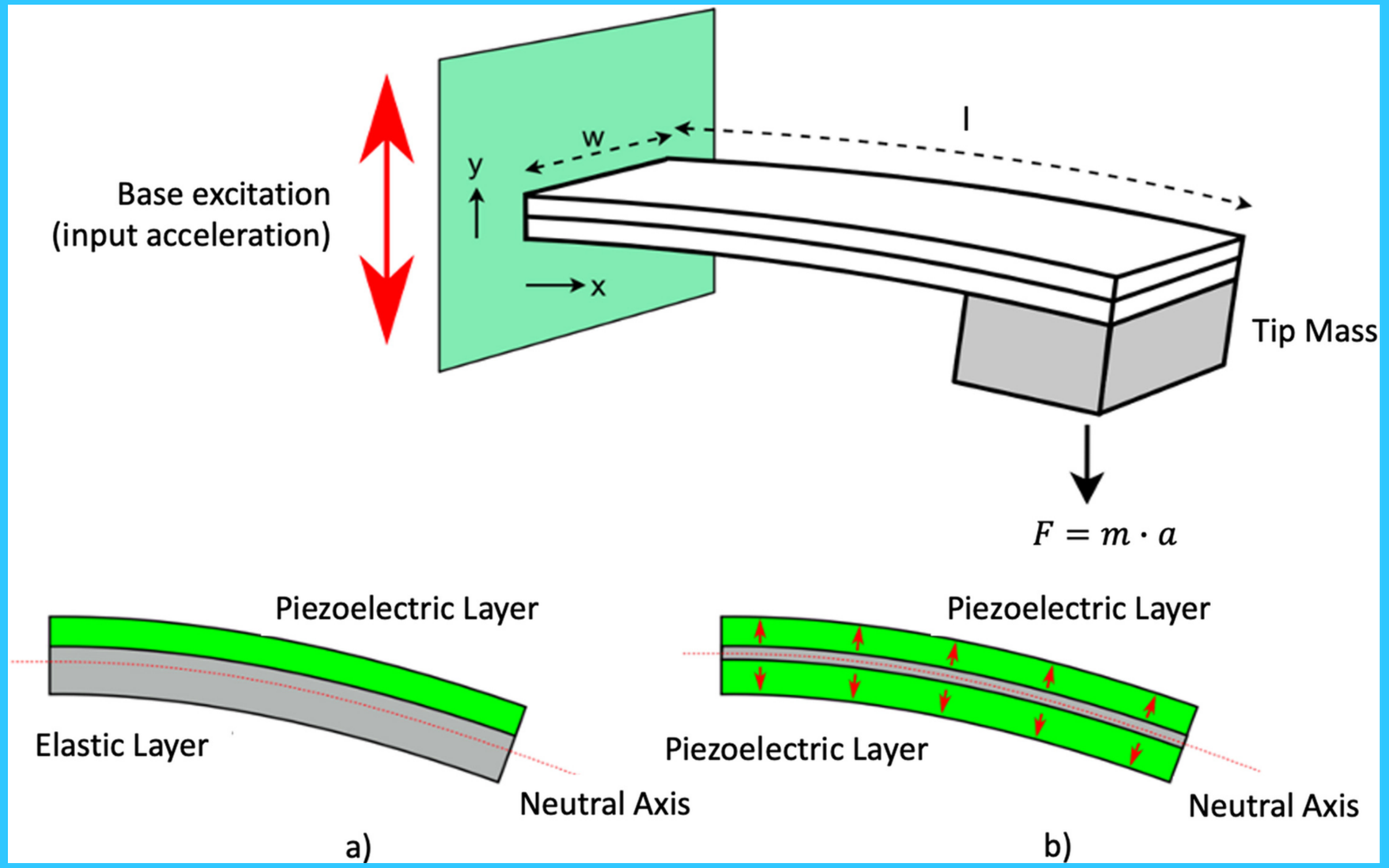


Diagram of the unimorph cantilever beam structure.

- The goal is to produce energy harvesters that can take the the aerodynamic vibrations and produce electrical energy.
- the simplest configuration of vibration harvester, a unimorph composite beam.
- We can change the resonant frequency of the cantilever beam by changing the length of the beam
- Peak voltage, current and power .occur at low frequencies and high intensities

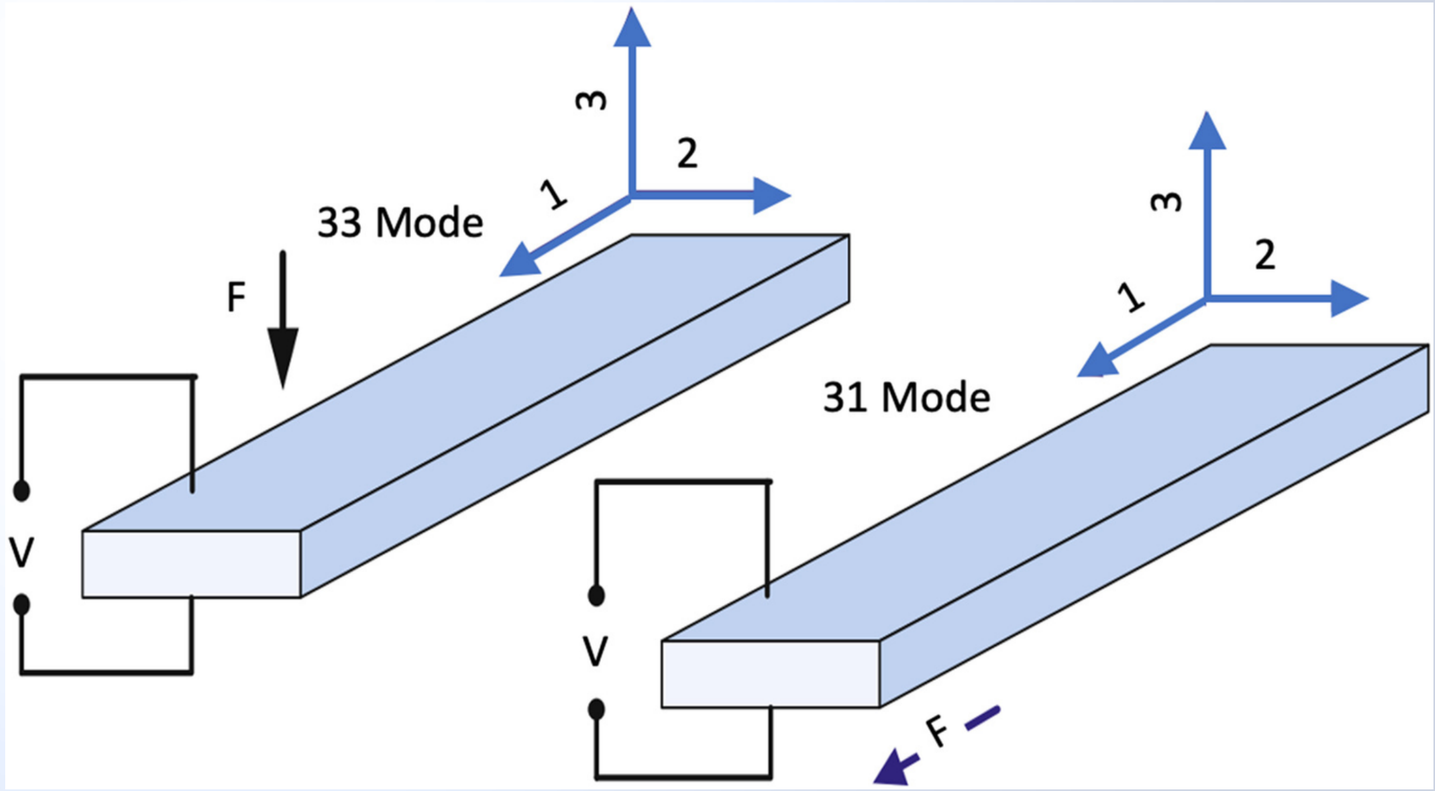


Average power for a single cantilever.

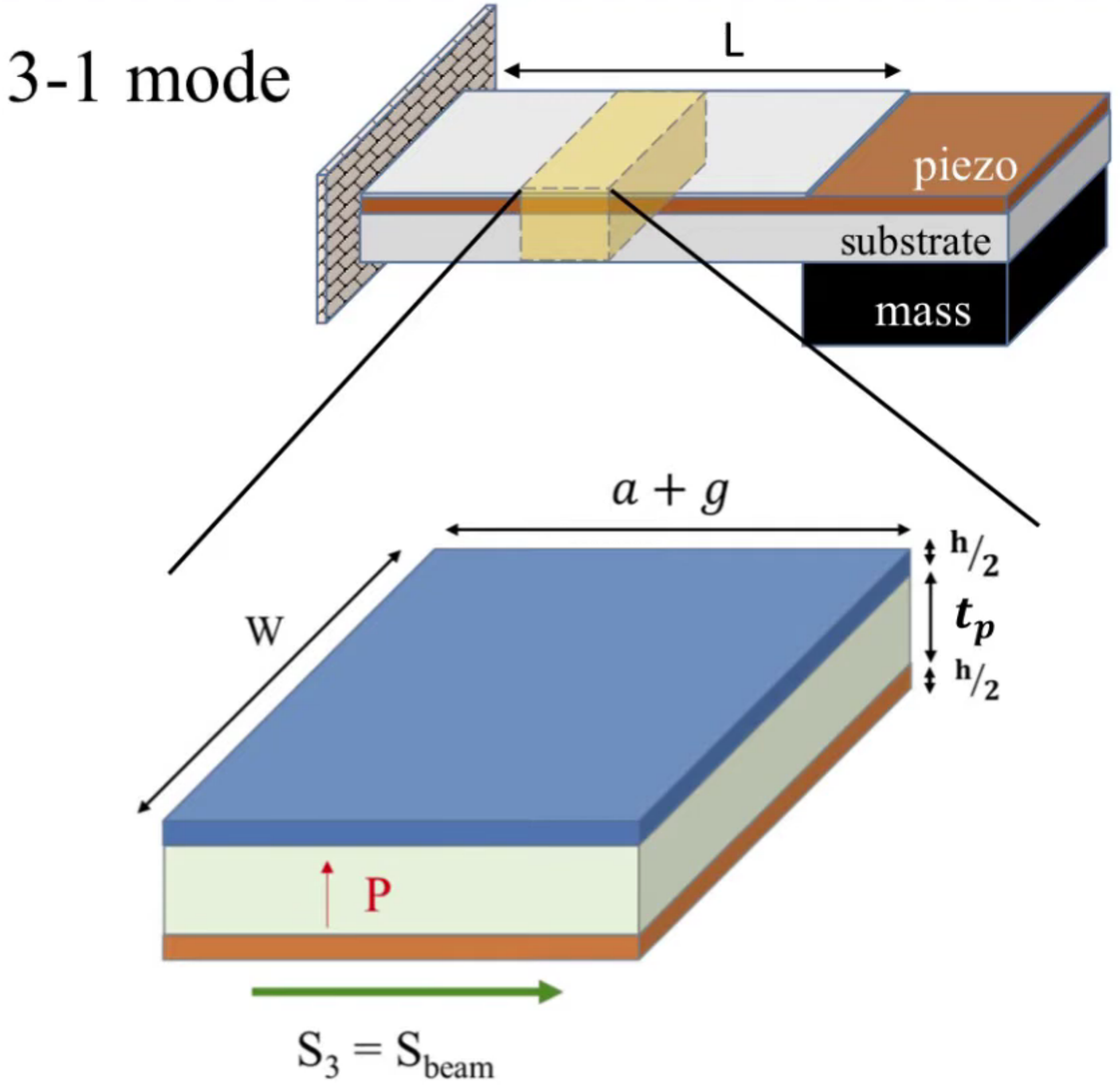


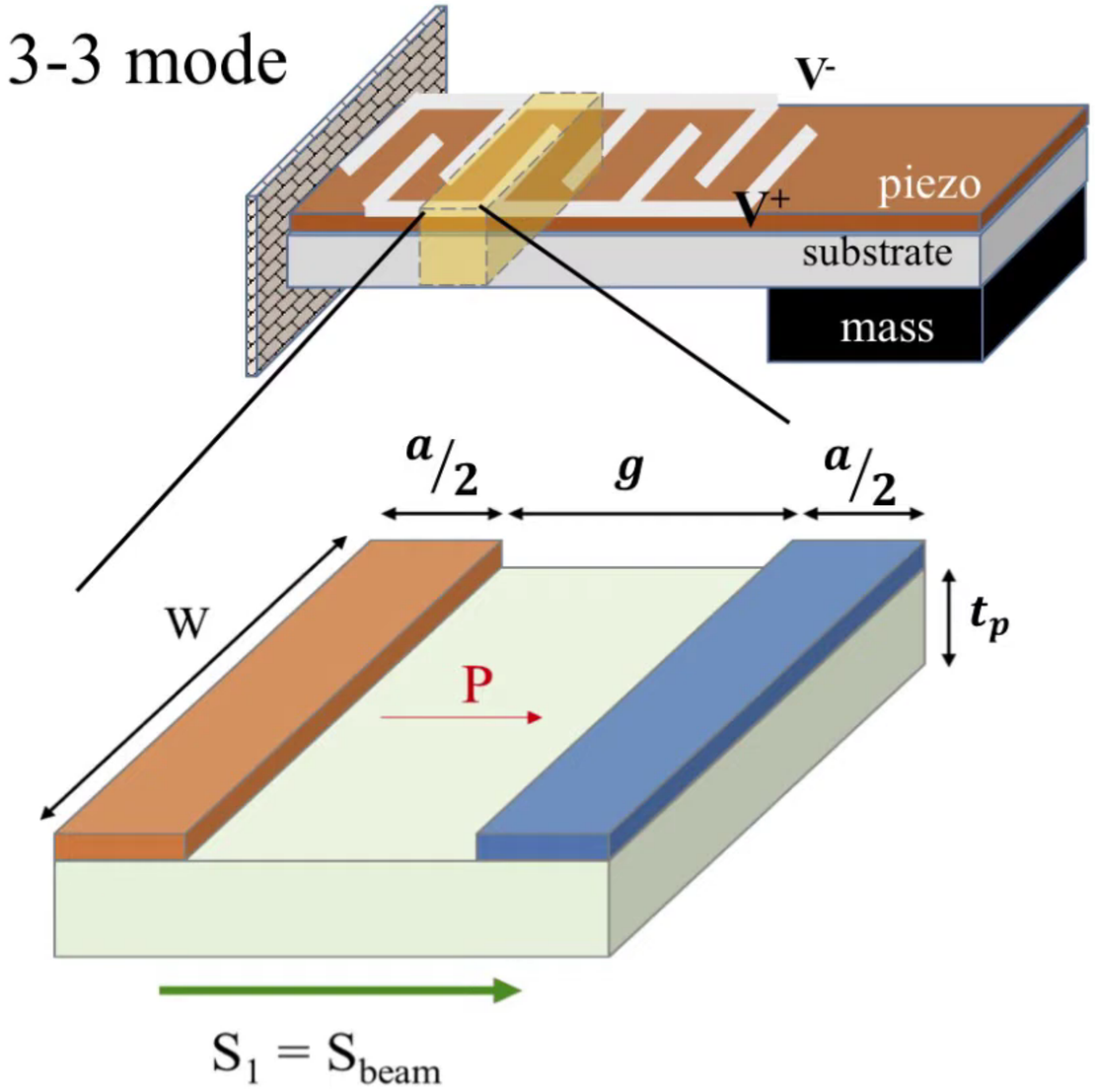
The most widely used device structure for piezoelectric energy generators, since it can produce large mechanical strain during vibration. A seismic mass is usually attached at the tip of the cantilever to adjust the resonant frequency to the available environment frequency, which is usually below 100 Hz.

DIFFERENT OPERATION MODES OF PIEZOELECTRIC



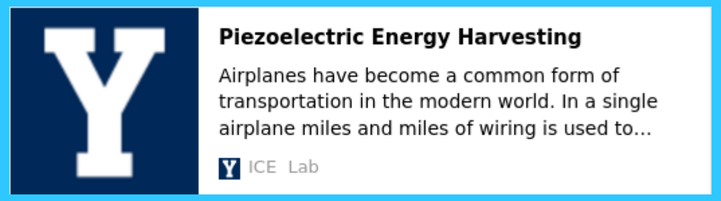
3-1, 3-3 mode EH model

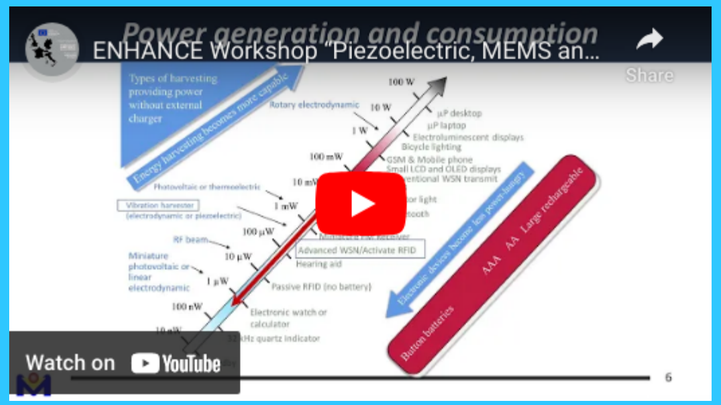


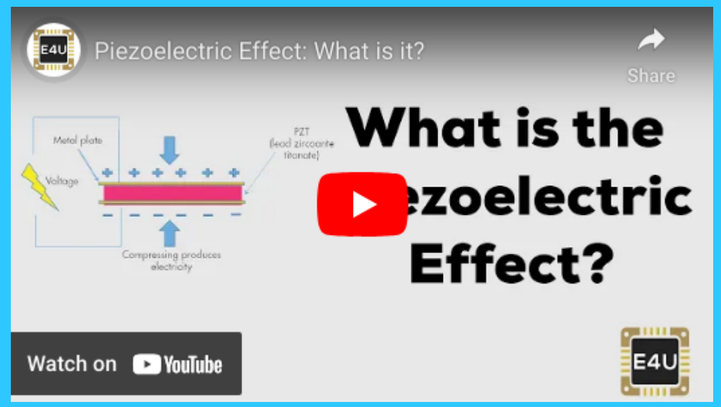


Kim, Donghwan *et al*, *Sensors and Actuators A: Physical* 219 (2014): 112-122.

REFERENCES







https://www.sciencedirect.com/science/article/pii/S2211285520311411

THANK YOU

Public view link for this presentation

SAUMYA
SHAH