Piezoelectric Transducer

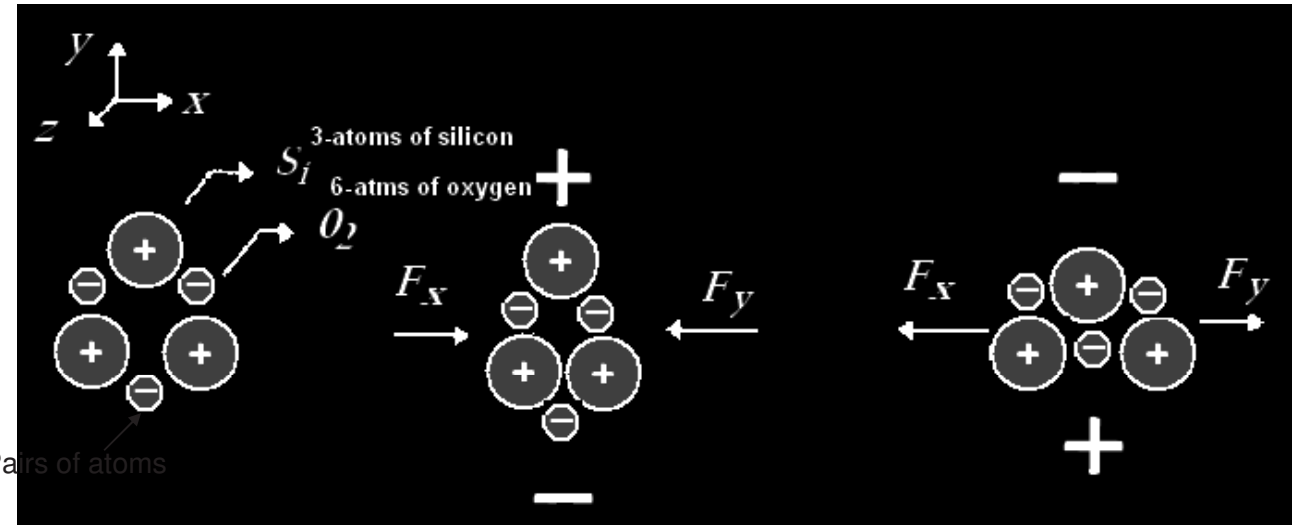
Certain material are characterized that they generate electric voltage when they are deformed by subjecting to mechanical force or stress.

The best known material is quartz crystal (SiO_2), Barium titanate, lead zirconium titanate (PZT) or poly vinylidene fluoride (PVDF)

Piezoelectric materials are characterized by their ability to output a proportional electrical signal to the stress applied to the material.
This property makes piezoelectric materials useful as a primary sensors.

Piezoelectric materials (piezo = pressure) possess the property that a voltage applied to them will produce a pressure field on the atoms in their lattice (a stress) with an accompanying overall contraction or expansion in one or more dimensions of the material (a strain).

These material can be cut along its axes in x, y and z directions.



View along the Z-axis

An asymmetric atomic structure will distort in an applied electric field. By the piezoelectric property of the material, electrical excitation is changed into motion and pressure, the necessary elements for acoustic waves.

The sensor is governed by Newton's law of motion $F = ma$.

- The force experienced by the piezoelectric crystal is proportional to the seismic mass times the input acceleration.

- The more mass or acceleration, the higher the applied force and the more electrical output from the crystal.

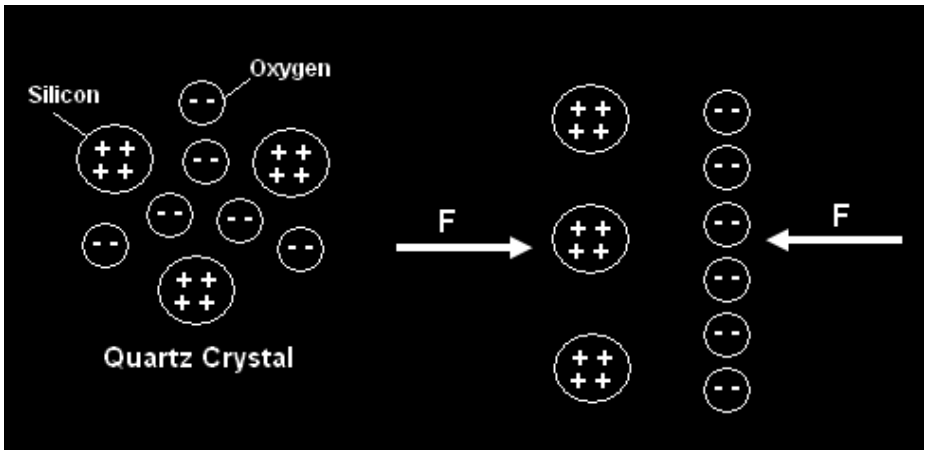
Voltage Generation

- In a single crystal cell there are three atoms of silicon and six atoms of oxygen.

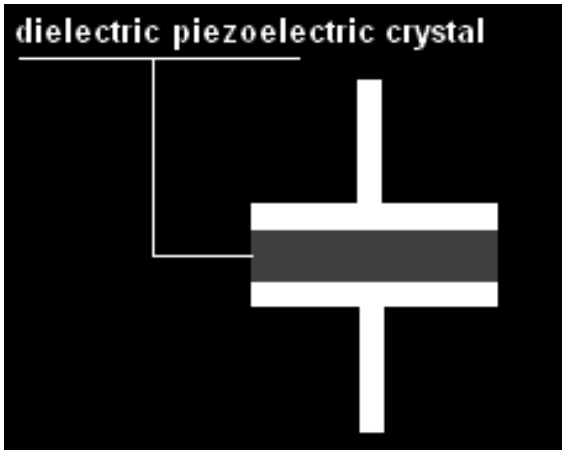
- Each silicon atoms caries four positive charges, and oxygen atom carry two negative charges.

- A pair of oxygen atom carries 4 negative charges , when there is no force applied on the quartz crystal, the quartz cell is electrically neutral.

- When <u>compressive forces are applied along the x- axis</u>, the hexagonal lattices become deformed. The forces shift the atoms in the crystal in such a manner the positive charges are accumulated at the silicon atom side the negative charges at the oxygen pair side.



- The crystal tends to exhibit electric charges along the y-axis .
- If the crystal is subjected to a tension along the x-axis, a charge of opposite polarity is produced along the y-axis.
- To transmit the charge that has been develop, conductive electrodes are applied to the crystal at the opposite side of the cut.
- The piezoelectric material acts as a capacitor, with the piezoelectric crystal acting as the dielectric medium. The charge is stored because of the inherent capacitance of the piezoelectric material.



Two opposite faces of the transducer are plated with conductive metal films; a voltage generator V is attached to the electrodes to produce an electric field

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