

Harnessing Piezoelectricity for daily use::From footwear to lamps

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Introduction

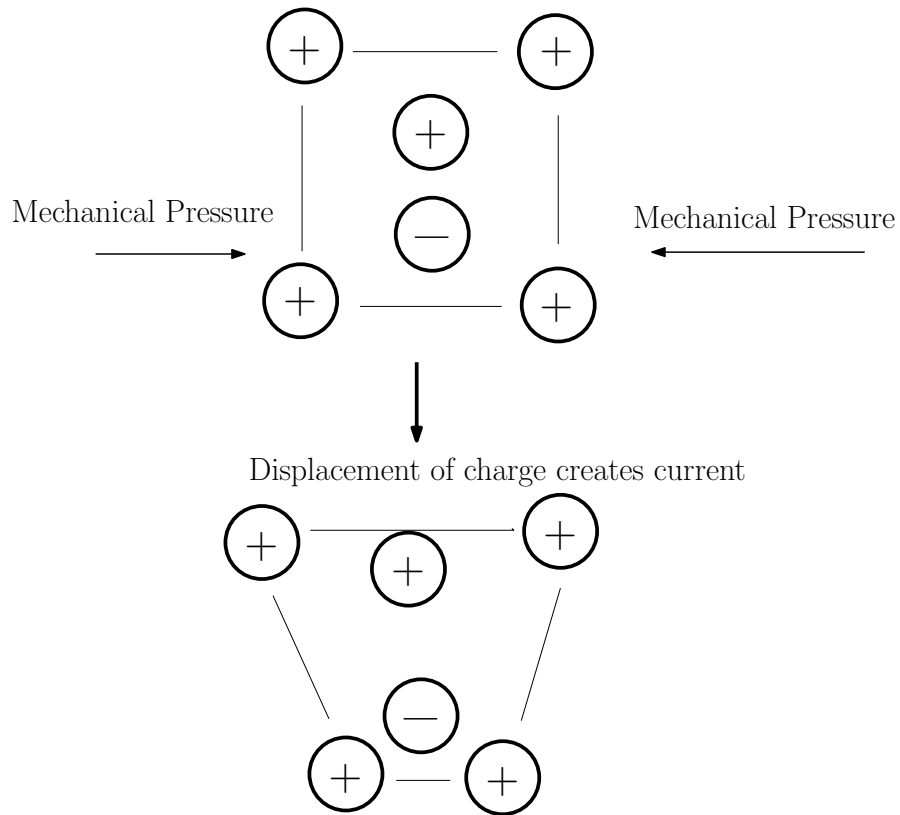
'Piezo' is a Greek word meaning pressure or press. Thus the term 'piezoelectricity' or 'piezoelectric charge' means electric charge derived from materials such as crystals or biological materials when mechanical stress is applied on it. In other terms the internal generation of electricity results from the applied force on a piezoelectric material.

To quote a Youtube channel, "Somethings only work when hit on" by ScienceLinx[Sci16](Youtube Channel). Similarly piezoelectric objects convert the mechanical energy received to electric energy which can be harnessed and used for various purposes.

Naturally occurring crystals like Quartz, Berlinite, Sucrose, Rochelle salt, Topaz and Lead Titanate (PbTiO_3) generally display this property of piezoelectricity. But even biological elements like bone, DNA and various proteins display the same property under appropriate condition.

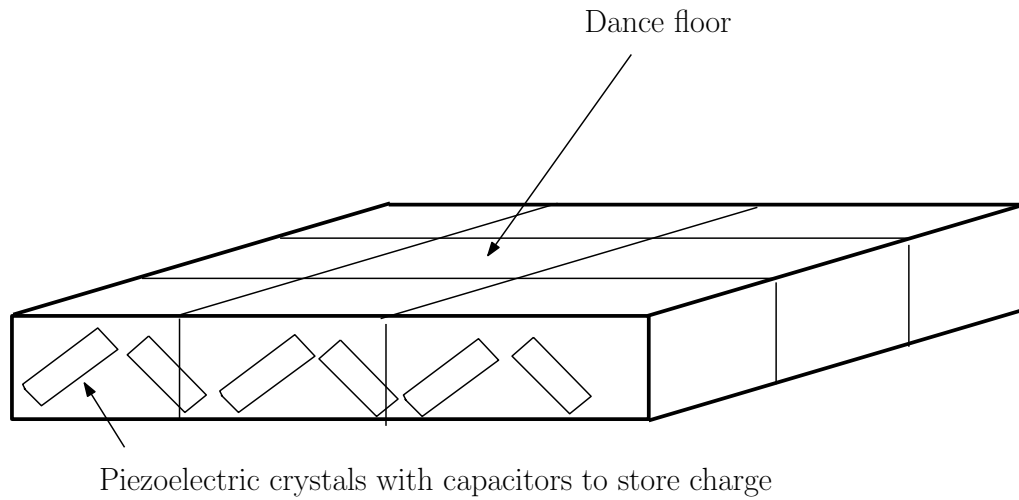
Background

So how does a material produce electricity on application of mechanical force? This can be better explained using a diagram, which shows that in the internal lattice positions are actually positive and negative charges and if there are forced to come close to each other (or to move away from) then they affect the movement of other charges which creates an electric current.



Source:ScienceLinx

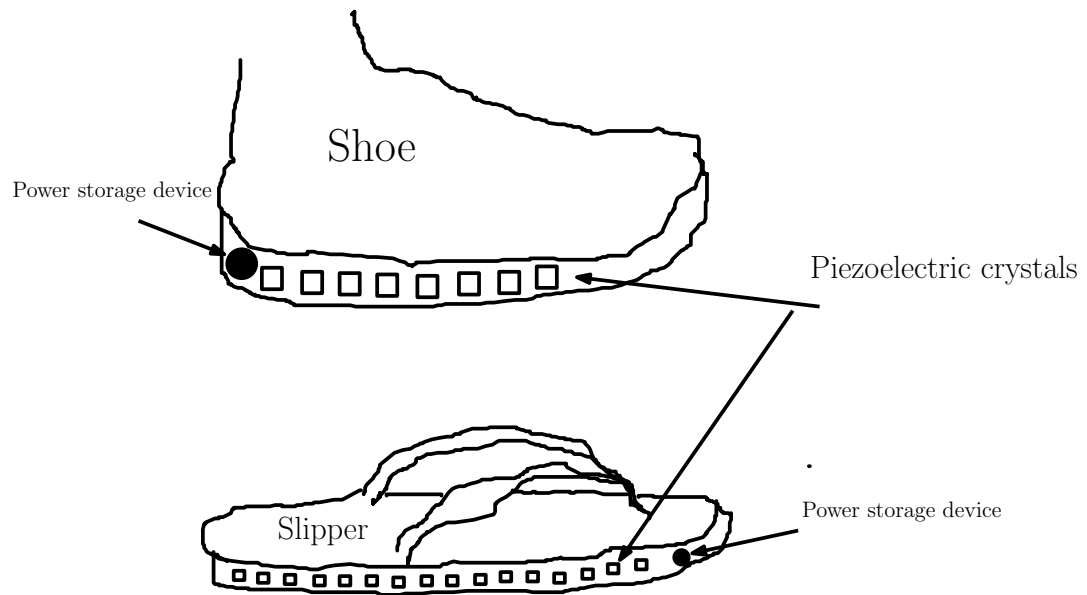
For example, lead zirconate titanate crystals will generate measurable piezoelectricity when their static structures is displaced/deformed by 0.1 percent of the original dimension. Now from this we understand that it is not required to press/hit or create pressure on a crystal to a workload level. Simple movements and daily mechanical pressures are sufficient enough to generate piezoelectricity. Professor Beatriz Noheda Pinuaga from the Zernike Institute for Advanced Materials wants to use it on a dance floor where people can dance and based on the mechanical stress of the foot on the floor [Sci16]. This is generate significant amount of piezoelectricity that can be harnessed. But people who aren't good at dancing (read me) might get offended.



Source:ScienceLinx

Purpose and Scope

The purpose of the usage of piezoelectric crystals in things that experience high and repeated mechanical stress can be well seen when such devices are placed under the sole of a shoe or a slipper[Fac06][Kea09]. On average a person takes nearly 8000-10000 steps a day and each step can cause a mechanical stress on these piezoelectric materials which produces energy. Voltages up to 20 volts can be generated from the surface area of a thumb on 5-6 repeated presses[Sci14]. On average 1000 steps can generate nearly 80 watts of power and there is already an US patent present on shoes that have piezoelectric receptors embedded onto them. I am suggesting to use such receptors in sandals/slippers and use it in the remote parts of Africa where they have no connection to electricity.



The purpose is that the villagers ,especially the kids who play/roam around the village probably walk and run more than any adults do and once the power banks in their slipper are charged it can be used to light a study lamp for the kids to study at night. But for us to achieve such a thing we have to overcome the challenges involved, first of all the best available piezoelectric material is lead, but again lead is harmful to humans and the environment. Thus we need to come up with certain other synthetic or natural material that can be used as a piezoelectric crystal with better efficiency than lead. Also the problem of storage of excess power than the power capacity of the power bank/capacitors or batteries have to be addressed. We also need to keep in mind our audience and make an affordable product for them to use and prosper.

The usage of piezoelectricity can be endless once we have a viable product in our hands. We can make use of the pumping of heart itself to run a pacemaker. Can be used in the key press of game controllers to charge the controller itself.

Intended Audience

Our intended audience is basically the electric power deprived sections of the world. We want to use this simple but effective technology to build a better future and level the playing field. Also for general purpose ,if a single person generates enough power for his or her personal devices and power requirement, then it will cause less and less stress on power generation projects like hydro and nuclear and would help us build a greener future.

The thought of this specific audience in Africa and other parts of the world is

more encouraging because similar such endeavours have been successful in this part of the world. Similar thing has been achieved by placing gyroscopic device in a soccer ball, where electricity is generated on rotation of the ball, and is stored in an in-built battery. These batteries are then used to light bulbs at night or reading lamps so that the children can study. This idea has been realized in poor villages in Africa where there is no electricity supply, but the kids are really enthusiastic and keep on playing soccer throughout the day and thus charge the battery, which can be used at night.

References

- [Fac06] Bradbury Face. *Footwear incorporating piezoelectric energy harvesting system*. 2006.
- [Kea09] SJoseph A. Keating. *Foot-Powered Footwear-Embedded Sensor-Transceiver*. 2009.
- [Sci14] Lucid Science. *Piezoelectric Generator*. 2014.
- [Sci16] ScienceLinx. *Energy from movements: piezoelectric crystals*. 2016.