

Alternate Source of Energy in Metro Trains Using Piezoelectric Materials

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Abstract— Energy conservation is a process of conquering circulatory waste energy or heat and converting it into usable power which has been continuously attracting more and more researchers interest because of the limitations of traditional power sources. The foremost aim will be to extract usable power which can run various devices having low power requirement such as mobile devices and wireless sensor networks.

In airports and railway transports, there is a wide need of replacing the existing source of energy by alternate source of energy. When the roof of the metro trains are engineered with a piezoelectric technology then the electric current produced by the pressure and vibrations of hanging straps hanged inside the metro trains are captured by sensors and converted into electrical charges. However the voltage developed is very few volts but practically it is possible and can be amplified with the use of other systems.

Keywords— Piezoelectric material; lead zirconate titanate; PZT; composite; foot traffic; electrical energy; mechanical energy; piezoelectricity; piezo harvester.

I. INTRODUCTION

Rapid rise in the field of microelectronics, electronic devices are shrinking in size day by day. Moreover, their power requirements are not shrinking. Hence there is an increase need to develop devices which doesn't consume more energy and could be accessible from any corner of the world. Lots of efforts have been made previously on energy conversion. Three common mechanisms used for energy scavenging are electrostatic, electromagnetic and piezoelectric. Extraction of energy from human activities and processes such as walking, breathing, body heat etc. Power generated from body heat or motion can potentially power a fan. Piezoelectricity is the phenomenon through which we convert mechanical energy into electrical energy (direct piezoelectric effect). Naturally occurring materials such as quartz, Rochelle salt, etc show this phenomenon. Man-made materials (ceramics) like lead zirconate titanate (PZT), (polymers) polyvinylidene fluoride (PVDF) also exhibit this phenomenon. Piezoelectric materials are so versatile that they there application can be easily formed like gas lighter, telephone buzzers, missiles etc.

Their basic ability to detect vibrations, piezoelectric materials has become most commonly used. Currently a wide variety of piezoelectric materials are available and we have used it for sensing. Using piezoelectric materials to harvest energy requires a mechanism to store the energy.

II. FUNDAMENTALS OF PIEZOELECTRICITY

A piezoelectric substance produces an electric charge when a mechanical stress is applied. Conversely, a mechanical deformation is produced when an electric field is applied on it.

This effect is seen in crystals that do not have centre of symmetry. In order to produce the piezoelectric effect, the crystal is heated under the strong electric field. This heat allows the molecules to move more as shown in figure 1.

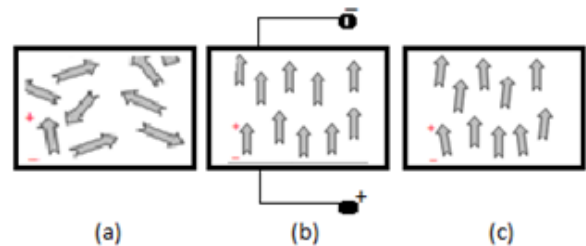


Fig. 1. Polarization material to generate piezoelectric effect.

The piezoelectric effect can be observed in the crystals.

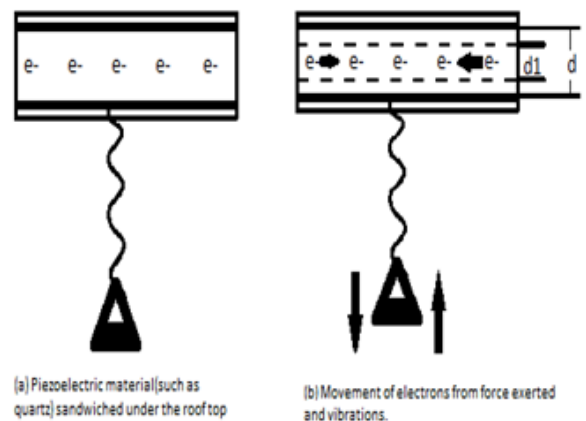
III. WORKING THEORY OF PROPOSED SYSTEM

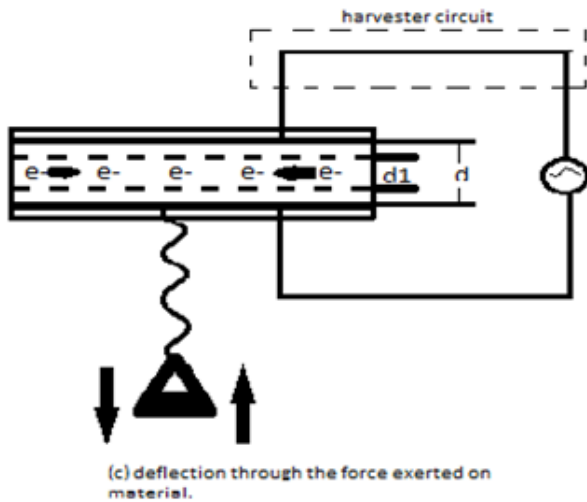
The working description of this project can be categorized in three steps.

- i) When a force is exerted or pressure is applied by a hanging straps attached to the roof of the metro trains which are engineered by a piezoresistive materials. There will be a mechanical deformation by a vibration produced
- ii) This mechanical deformation of piezoresistive material will be proportional to the voltage generated or supplied due to movement of electrons.
- iii) This mechanism will be repeated throughout which act as a alternate source of power for a small power consuming devices.

The energy scavenging technique can be used to convert energy into usable electricity. It includes a current source connected parallel to capacitor and piezoresistive element.

IV. DESIGN OF PROPOSED SYSTEM





V. CONCLUSION

The device which is developed will be self sustaining and suitable to environment by being dependent on piezoelectric material by decreasing the input energy and high cost. This would bring a new revolution in the field of electric development as it can generate multiple time electric energy

without any special efforts. The research comprised of special electric and magnetic field usage which do not acquire energy.

REFERENCES

- [1] Erhart, Jiří, "Piezoelectricity and ferroelectricity: Phenomena and properties," (PDF). *Department of Physics, Technical University of Liberec. Archived from the original on May 8, 2014.*
- [2] A. M. Flynn and S. R. Sanders, "Fundamental limits on energy transfer and circuit considerations for piezoelectric transformers," *IEEE Transactions on Power Electronics*, vol. 17, no. 1, pp. 8–14, 2002.
- [3] S. Roundy and P. K. Wright, "A piezoelectric vibration based generator for wireless electronics," *Roundy, Wright, Smart Mater. Struct.*, vol. 13, no. 5, pp. 1131–1142, 2004.
- [4] *Power Electronic Circuits for Vibration based energy harvesting using piezoelectric devices*, by Heath Hoffmann, Associate Professor, Department of Electrical Engineering and Computer Science Engineering, University of Michigan.
- [5] A. Manbachi and R. S. C. Cobbold, "Development and application of piezoelectric materials for ultrasound generation and detection," *Ultrasound*, vol. 19, issue 4, pp. 187–196, 2011.
- [6] Phillips, James R. (2000-08-10)," *eeProduct Center. TechInsights. Archived from the original on 2010-10-06.*
- [7] G. Gantschi, "Piezoelectric sensors," *Springer Berlin, Heidelberg, New York*, pp. 3 – via Google Books, 2002.