

Design and Simulation of MEMS Based PZT Energy Generator.

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Abstract

At present, a great deal of research effort has been directed to find eco-friendly and renewable sources of energy. With the rising costs of crude oil and petroleum, along with the derogatory effects that they pose to the environment, this sort of approach is of utmost importance. This has also led to the search for alternate methods of transforming the various forms of energy into electrical form. Popular renewable energy sources such as hydropower, solar power and wind power require massive financial investments, give comparatively much lower power output, and have a low scale of efficiency. Nuclear power offers a cleaner source of energy, however, the cost involved in the setting up of nuclear power plants and its subsequent maintenance outweigh its benefits. In recent years, there has been growing interest in harnessing the power of mechanical vibrations and pressure to generate electricity. Piezoelectric materials are by far, one of the most efficient transducer elements to accomplish this task. Over the last decade many piezoelectric elements, both natural and artificial, have been found. They have, however, been mostly used for applications with a low power generation, in the range of μW to mW . Analysis is done on piezoelectric energy harvester to generate electricity by using MEMS simulation tool COMSOL Multiphysics. The proposed model works on the principle of piezoelectric effect. Piezoelectric devices convert mechanical vibrations into displacement (voltage) and in turn they produce electrical energy (Figure 1). The PZT sensor is modeled using the Euler Bernoulli method which is the very efficient and accurate. The design consists of a piezoelectric block (quartz crystal) enclosed within an aluminum block (Figure 2). The pressure is applied to this crystal to generate the voltage. The dimension of the aluminum block is fixed where as the length of the piezoelectric crystal is varied. The model gives the measurement of voltage based on the applied pressure (Figure 3). The graph of Length vs. voltage is plotted for different readings of length of the piezoelectric crystal.

Reference

- 1) Timothy Egghorn ,Analytical Models to Predict Power Harvesting with Piezoelectric Materials
- 2) Jedol Dayou , Man-Sang, C. , Dalimin, M.N. & Wang, S. Generating electricity using piezoelectric material.

Figures used in the abstract

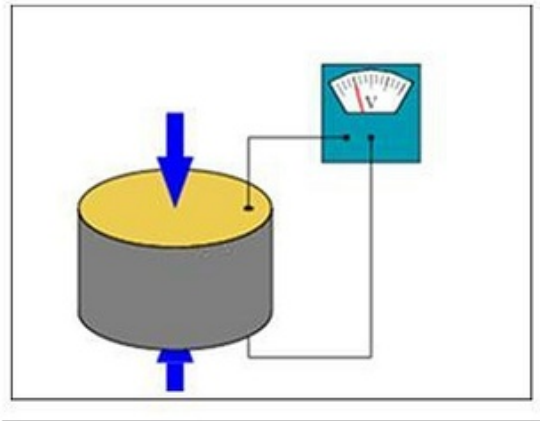


Figure 1: Simplified demonstration of the piezoelectric effect

Figure 1: Piezoelectric Effect.

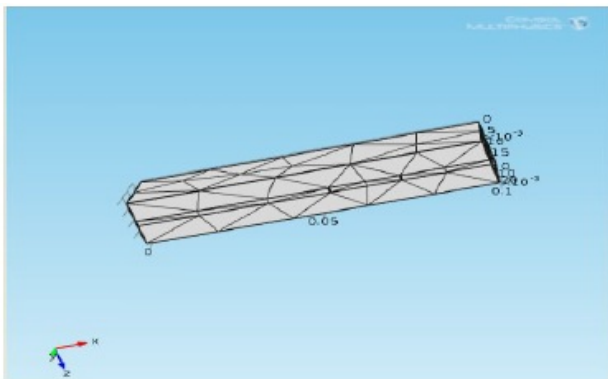


Figure 2: Meshed.

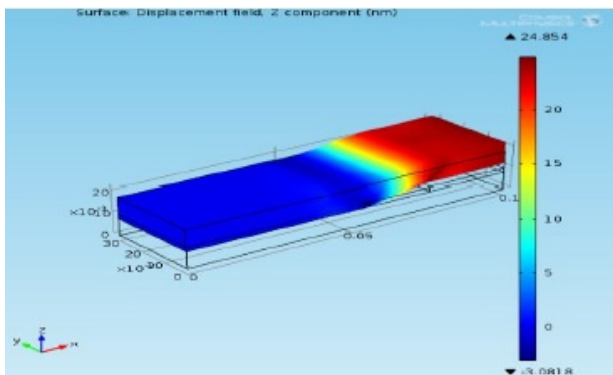


Figure 3: Final Output model in COMSOL Multiphysics.

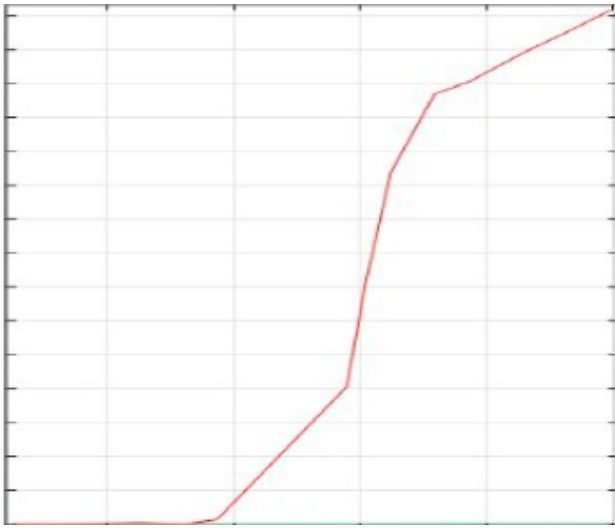


Figure 4: Output Graph- Length vs. Voltage.