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FBM-SEREMBAN INTERNATIONAL INNOVATION COMPETITION (FBM-SIIC)

# INNOVATION IN ACTION: TURNING IDEAS INTO REALITY

# Chapter 59
# Flexible Piezoelectric Energy Harvester

Ali Hussaini Ab.Aziz, Anis Salsabila Ahmad Hafizullah,
Shahino Mah Abdullah

Faculty of Science and Technology, Universiti Sains Islam Malaysia, Bandar Baru Nilai, 71800 Nilai, Negeri Sembilan, Malaysia

**shahinomah@usim.edu.my*

**ABSTRACT**
We produce energy in each of our steps, and in this project, that energy can be measured and used for benefit. This project mainly focuses on the use of a 3D-printed insole for shoes. A piezoelectric film device is integrated into the insole's vital points including the heel, the ball, and the middle of the foot. The piezoelectric film device is made with Polyvinylidene fluoride (PVDF) strips that are less than one millimetre in thickness to provide comfort to users as well as generating energy while walking. The design of the insole is customizable for the best comfort of users. Each capacitance and voltage produced by the steps can be measured by using a standard LCR meter. This project has promising potential for the sustainable energy production in many ways. The insole can also be applicated into healthcare uses, where we can determine the most efficient way to take a step. With an appropriate patent protection, regulatory compliance, and partnerships, this technology can benefit medical facilities, everyday safety, and a cleaner tomorrow.

**Key Words:** Piezoelectric, energy, 3D, Insole, PVDF.

## 1. INTRODUCTION

Pressure sensors introduce a significant role in technological advancement nowadays. Beginning with the first invention of simple devices by Evangelista Torricelli in the 17th century, he invents the first barometer in 1643. This device is used to monitor and measure atmospheric pressure using a column of liquid known as mercury (M.P. Mondol.2014). Further advancements are made in pressure sensing, and it evolves rapidly into a more critical component for various industries such as automotive, aviation, and the medical department. After the revolution of the Internet of Things (IoT) in worldwide industries, we see pressure sensors become a demanding sensing element and attract many interests as it proves to be beneficial in healthcare monitoring, smart homes, and industrial production.

Malaysia's conventional way of producing energy is a growing challenge. The dominance of fossil fuels has been the bulk of Malaysia's power generation since decades. It is a general conscious that the use of fossil fuels leaves poisons all over the world, and with the ongoing economy war, we may fall short for whatever it takes to pay the cost. With the integration of The Ministry of Science's Dasar Teknologi Nuklear Negara (DTNN), it falls short on whether the nuclear power can reach throughout the whole country and to consider the cost of Uranium and other fuels, considering that the fuels are found in only certain countries. This creates a need a small and reliable energy emitter, where people can bring everywhere they go as long as there is Earth to step on.

## 2. LITERATURE REVIEW

The solvent casting method was a technique that was proven to fabricate thin films. There were various materials that could be used in order to fabricate thin films, which were mostly used polymers like PVDF and composites. Firstly, in making this technique, it started by dissolving the polymer in a volatile solvent to create a homogeneous solution. Then, the solution was poured onto a flat substrate and left to dry according to its required temperature; this allowed the solvent to evaporate. The main factors that affected the film's characteristics were the solvent type, polymer concentration, evaporation rate, and the surrounding environment. In fabricating films, the solvents depend on the polymer solubility and based on film feature requirements. A solvent Dimethyl Formamide was usually used in fabricating films. The features measured were thickness, crystallinity, or surface shape. Advanced techniques involved co-solvents, such as plasticizers, or various drying conditions, which helps improved the film's homogeneity, clarity, and mechanical or electrical properties. (Parida et al., 2023) Previously, solvent casting was used to fulfill industrial needs that demand high-precision films. As an example, in the photographic and optical sectors. then, the applications were applied to electronic gadgets, medicinal films, and biopolymers. The advantages in using solvent casting technique are due to its ability to make films with good flatness, linearity, and isotropic optical characteristics. Many developments have been made, such as extrusion but solvent casting remained essential for applications that need higher quality. This method is still relevant for LCD displays or piezoelectric devices. (Parida et al., 2023)

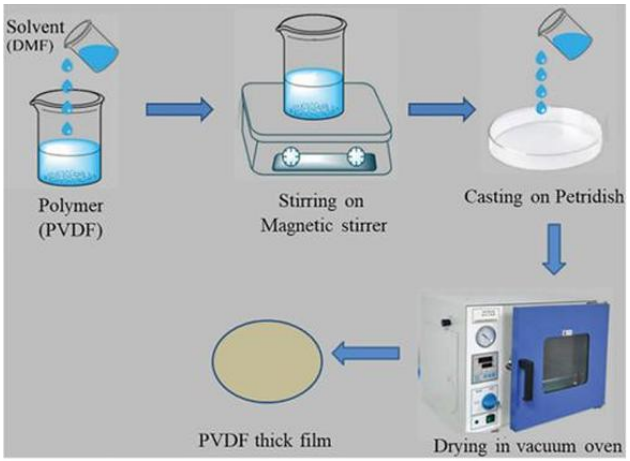


Figure 1: PVDF thick films synthesized by solvent casting method

## 3. METHODOLOGY

### 3.1 Testing Pressure Sensor Sample

The capacitance and resistance of the PVDF is tested by using and LCR meter. This systematic approach allowed for a comprehensive understanding of the performance characteristics and behaviours of the pressure sensors under various conditions. Two aluminium strips were used as electrodes to conduct charge made by the pressure sensor.

Figure 2: LCR meter with the pressure sensor

### 3.2 3D Printed Insole

Most of the required equipment such as the 3D printer was already prepared and available at the SMART laboratory, which was administered by the Faculty of Science and Technology (FST). The design of the insole is created by using *Tinkercad*. The software is user friendly and easy to customize for the precise adjustments for in ergonomic comfort tailored for the user's comfort. The filament used for the project is Thermoplastic polyurethane due to its flexibility and eco sustainability.

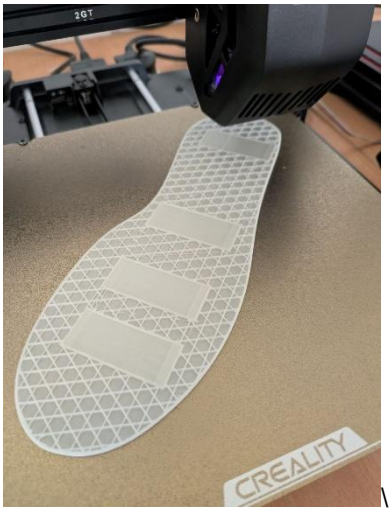


Figure 3: 3D printing of insole

## 4. RESULTS

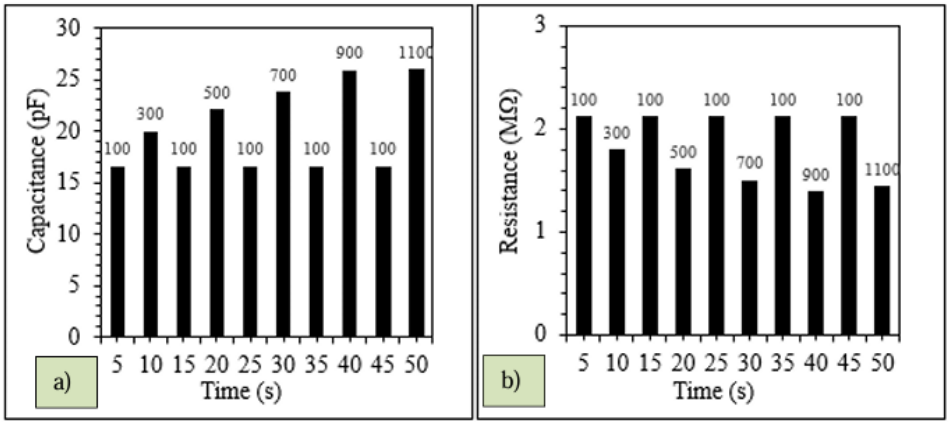


Figure 4: Pure pvdf graph analysis for a) capacitance and b) resistance under varies load

## 5. CONCLUSION

Ultimately, it is crucial to identify and implement the most efficient and sustainable methods of energy generation to meet growing global demands while minimizing environmental impact. As traditional fossil fuels continue to deplete and contribute to climate change, the transition to renewable energy sources—such as solar, wind, hydro, and bioenergy—becomes not just an option, but a necessity. Investing in innovative technologies, improving energy storage solutions, and adopting smart grid systems will play a pivotal role in ensuring a stable and eco-friendly energy supply for future generations. By prioritizing sustainability now, we can

reduce carbon emissions, enhance energy security, and pave the way for a cleaner, more resilient energy future.

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