CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
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Project Number
38406

Project Title
Energy Harvesting Utilizing a Wind-Driven Triboelectric Generator

Abstract

Objectives/Goals
The growing interest in remote sensing leads to my research for making sensors self-powered. Sensors are crucial for monitoring of structural integrities of bridges, railroads, oil and gas pipelines, or alarming of fire danger. Operating intermittently, the advanced sensors only require ~10-100uW of power. While solar power needs direct sunlight, the ubiquitous flow of wind could power the sensors day and night. The goal of this project is to build a model energy harvesting device to generate electricity from the kinetic energy of airflow utilizing the Triboelectric effect. The energy stored can then be used to power the sensors.

Methods/Materials
The small-scale energy harvester was designed to utilize Triboelectric Charging from the friction between Teflon and copper. The inner surface of a hollow cylindrical stator was coated with strips of copper tapes. One end of a thin Teflon film was attached to the outer surface of a rotor. The kinetic energy of wind was converted to electricity in two steps. The propeller blade converted the kinetic energy of wind into mechanical energy of rotation. Next, as the rotor spun inside the stationary cylinder, the suspended end of Teflon films rubbed against the copper tapes, and the frictional contact and separation between them generated Triboelectric charges. The charges were easily collected from the conducting copper on the stator, and a bridge rectifier converted AC to DC. After troubleshooting multiple prototypes, the low-cost energy harvester was tested with a varied number of Teflon films and different air speeds.

Results
The prototype produced promising results both indoor and outdoor. At a moderated airflow of ~5m/s from a box fan, it generated a ~6V DC output and charged a 100uF capacitor to 4V within 150 seconds delivering more than 10uW of power. The harvested energy was then used to power a sensor (BME 280) to generate weather data which was read using an Arduino Uno Microcontroller. In the outdoor setting under inconsistent, unmeasured wind speed, the device generated ~13.1V of DC output.

Conclusions/Discussion
The low-cost, small-scale, Triboelectric generator harvested kinetic energy from moderate airflow (5m/s) producing 10uW of power and operated a weather sensor without any batteries. This technology could enable the broad deployment of self-powered, remote sensors.

Summary Statement
I designed, built, and tested a novel, low-cost, small-scale, wind-driven, Triboelectric generator harvesting kinetic energy of airflow using friction between Teflon and copper to power battery-free, remote sensors for their wider adoption.

Help Received
I would like to thank my mentor at Schmahl Science Workshops, Dr. Youssef Ismail, for his feedback. Also, I would like to thank my parents for purchasing the materials and allowing me to use household materials during prototype development.