CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Nicholas C. Batterman

Project Number

36137

Project Title

Forehead Powered Headlamp

Abstract

Objectives/Goals

The goal of this project was to create an effortless, dependable, hands-free source of light by using body heat in order to power an LED that functions continuously at a reasonable brightness. It could be used in emergency situations where reliable back-up light is needed or any remote location where no other energy source is available.

Methods/Materials

The thermoelectric headlamp uses Peltier tiles to run without batteries, fuel, solar power, or other manual effort to power it. The Peltier headlamp relies on the Seebeck effect which produces a voltage difference when two types of semiconductors have a temperature difference between them. Sustaining a bright light for a useful period of time requires maintaining sufficient temperature differentials between the Peltier plates. This project will demonstrate that enough body heat can be efficiently transformed into electricity using Peltier tiles in order to effectively power a hands-free headlamp.

Results

Generating adequate voltage to operate a light requires stepping up the low output voltages of common Peltiers. The highest output is obtained when the Peltiers are mounted directly on the forehead. The typical output voltage of a single tile, powered from forehead heat, averaged 50 millivolts (mV). This required using a step-up converter in order to raise the voltage to at least 2 volts required to power the LED. During experimentation, substantial variation in output current, voltage, and internal resistance of the Peltiers was found. Various combinations of low internal resistance Peltiers were tested in series and parallel with the best results occurring when wired in series. The output dropped off rapidly because it was difficult to maintain a temperature difference between the two plates of the Peltiers. Several configurations of copper heatsinks and Acetone based evacuated heat pipes were tested in order to maximize the temperature differential and maintain the output for long periods of time.

Conclusions/Discussion

The results have shown that the heat of the forehead produces sufficient electricity to constantly power an LED headlamp by maintaining an adequate temperature differential. The objective towards building a usable flashlight that runs solely on the heat of the forehead was met.

Summary Statement

I created a continuously running headlamp powered by the heat of my forehead using Peltier thermoelectric generators and cooled with a heat pipe.

Help Received

Parents purchased several supplies; Neighbor lent gas torch and temperature gun; Friend lent commercial vacuum.