CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Charlotte MacAvoy

Project Number

J1313

Project Title

Exploring New Alloys for Low Cost Thermoelectric Generation

Abstract

Objectives

The purpose of my project was to create sintered alloys and test their efficiency in converting heat into electricity to build a thermoelectric generator that would be cheaper than a commercial Peltier device.

Methods

25 different sintered alloys and pure cakes were synthesized and tested for the electrical output (in mV) in three trials at a known temperature difference of 74K. Sintering was used to combine the materials (Cu,Bi, Fe,Fe(2)O(3),Zn,ZnO,Sn,Al,Ni,Graphite)as an alternative to a high heat oven. The sintered cakes were tested for electrical output (in mV) on a custom testing apparatus built with a 74K temperature difference. In the application module, four cakes of Cu+Bi+ZnO+Fe were used to build a low cost thermoelectric generator (TEG).

Results

Combining materials to create alloys resulted in a higher electrical output compared to pure materials when subjected to a temperature difference. When testing the pure materials, copper had the highest average electrical output of 59 mV. The alloy with the highest electrical output was the 7:3 Cu:Bi alloy averaging 176 mV for 74K delta T. When testing over time, the electrical output of the Peltier module dropped to 58 mV while the electrical output of the Cu+Bi+ZnO+Fe stayed consistent at 438 mV for a 74K delta T.

Conclusions

The sintered alloys performed better than pure substances because of the ability to combine low thermal conductive materials and high electrical conductive materials. Combining materials with different atomic masses--therefore creating an alloy with a disturbed vibrational state--lowered the thermal conductivity of the alloy. Materials with lower melting points and larger particle size sintered more effectively together and contributed to larger electrical output. The Cu+Bi+ZnO+Fe TEG module had a lower thermal conductivity than the Peltier module contributing to its longer lasting electrical output.

Summary Statement

Different sintered alloys were synthesized and tested to transform heat into electricity and then a TEG was built with the best performing alloys that could effectively covert heat energy into electricity.

Help Received

My parents paid for the supplies and made sure I used safety equipment properly. I designed, built, and performed the experiment myself.