Simulation of a Thermoelectric Spiral Structure

A. Arevalo[1], J. P. Rojas[1], D. Conchouso[1], M. M. Hussain[1], I. G. Foulds[2]

[1]Computer, Electrical and Mathematical Sciences and Engineering (CEMSE), King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia

[2]The University of British Columbia, School of Engineering, Okanagan Campus

Abstract

Energy efficiency and harvest, speed and performance, flexibility and portability are key elements for innovation in the current consumer electronics markets. Thermoelectric Generators can convert energy from heat gradients into electricity. Every source of heat from an electronics device can potentially be used as a source of energy. This generators have the advantage of: being silent, compact, simple and scalable fabrication, can power small devices like wristwatches. Our thermoelectric generators are conceived in a flexible polymer substrate, that has been coated with Bismuth Telluride layer. The spiral design allows for an expandable generator that can see a larger heat gradient when it is elongated away from the heat source. Parallelization of many thermoelectric spirals is used to generate relevant power.

Thermoelectric generators are solid-state devices that convert the difference in heat into electricity. The difference of such devices with dynamic heat engines, is that the thermoelectric generators don't have moving parts and therefore are completely silent. Its use has been reliable for more than 30 years [1-3]. The generators can be competitive in small applications because its fabrication is simple and scalable. These devices have also been miniaturized to harvest body heat for powering a wristwatch.

In this work we are simulating our current thermoelectric designs fabricated on a polyimide patterned film with a 1µm sputtered Bismuth Telluride layer. We use COMSOL Multiphysics software to look at the temperature distribution along the spiral structure and the generated voltage across do to the temperature difference.

Reference

[1] G. J. Snyder, et al., Complex thermoelectric materials, Nature,Volume 7, pp 105-114 2008.

[2] G. J. Snyder, “Thermoelectric Energy Harvesting,” in Energy Harvesting Technologies, Springer, 2008.

[3] G. A. T. Sevilla, et al., “Flexible and Semi-Transparent Thermoelectric Energy Harvesters from Low Cost Bulk Silicon (100),” Small, 9(23), 3916-3921 (2013).

Figures used in the abstract

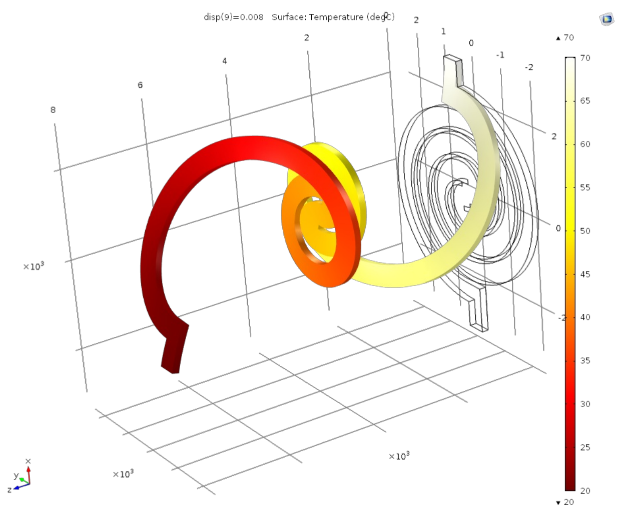

Figure 1: Heat distribution in an extended spiral from 20˚C to 70˚C, and extension of 1mm.

Figure 2

Figure 3

Figure 4