Thermoelectric Generators with Double Cooling and Novel Thermoelectric Materials

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Abstract

Recent developments (1) in thermal metamaterials that enhance the response of thermoelectric generators (TEG) have revived the interest in TEG research. The COMSOL Multiphysics® software offers the unique opportunity to model TEGs with various cooling systems (air, water, etc) and developing practical prototypes for commercial use. Our project models the Seebeck and Thomson effects on a TEG (Bismuth Telluride, Lead Telluride, Spark Plasma Sintered Cu2Te and nanostructured BiSbTe) with a dual cooling system (forced air and circulating water) and heat sink. We tested the model for a variety of novel thermoelectric materials that display high thermoelectric properties at various temperatures. Experimental data has been acquired under different hot face temperature values and cooling conditions and the results are also reported. Depending on the load, currents as high as 1.6A can be sustained by a 5.6cmx5.6cm Bismuth Telluride TEG with a dual water and air cooling system and a maximum temperature difference of 200 degrees C. The COMSOL® model was developed using examples found in the COMSOL® online support files. It generates temperature distribution, isothermal surfaces and electric potential values for a variety of cooling conditions and temperature differences as well as performance parameters for the various thermoelectric materials (2-4). Under cooling conditions BiSbTe shows better the best thermoelectric performance for temperatures below 550K. Other configurations will be studied such as the replacement of Cu as the contact material with novel high conductivity materials (5). Two undergraduate students participated in this study. Both students value COMSOL® as an important asset to their successful internship applications and plan on developing more projects in COMSOL®. The engineering physics program is seeking external funding to offer a summer 4-week internship with experimental and COMSOL® modeling projects.

Reference

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Figures used in the abstract

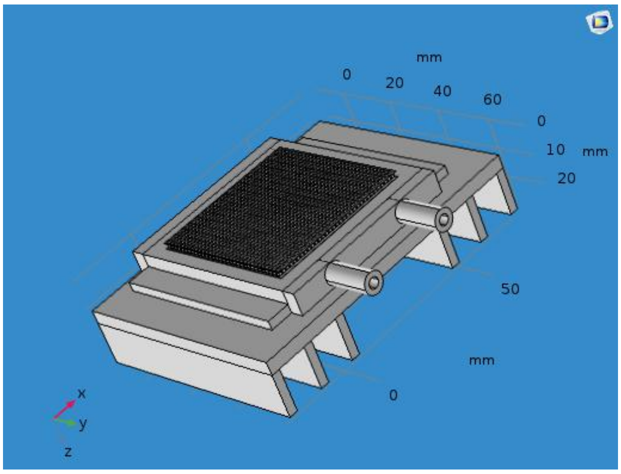

Figure 1: Thermoelectric generators with dual cooling system, air and circulating water, a heat sink and a themal metamaterial