Multiphysics Simulation of Micro-Thermoelectric Generators Based on Power Factor Optimized Materials

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Abstract

Thermoelectric generators (TEGs) which convert heat into electrical energy due to Seebeck effect, have recently attracted a great attention as green and sustainable energy sources. One of the challenges in the field of thermoelectric devices is the design optimization in order to make use of TEGs in variant industrial applications. Finite element methods are used to simulate TEGs and study their electrical and thermal properties to achieve maximum power output.

In this work we present the simulation of micro-thermoelectric generators (μTEGs) using COMSOL Multiphysics® with its Heat Transfer and AC/DC Module. We study the thermoelectric efficiency of modules based on power factor optimized CuNi as n-type and antimony as p-type material. A model of a μTEG on a Si heat sink with Au contacts has been designed where a heat flux is applied at the top contacts to create a temperature gradient over the thermoelectric legs. We present studies on the influence of the heating power on the thermoelectric efficiency as well as the temperature and voltage distribution in the device. To obtain the optimal operation point of the device a load resistor was added to the simulation model and matched to the internal device resistance to maximize the power output.