Evaluation of Efficiency Factors of Commercial Thermoelectric Materials Using COMSOL Multiphysics® Software

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Abstract

There is a need to evaluate the performance of all available commercial thermal electric (TE) materials in the same temperature range; because, the figure of merit (ZT) has no specific units and cannot be used independently, to precisely design, and determine the best TE materials for the fabrication of Micro thermometric generators (µTEG). To do that, we have used COMSOL Multiphysics® software and designed a single leg of a µTEG model. This model was then used to analyze the efficiency factors, and power per unit area of eight different TE materials in the same temperature range. The results showed that, when the temperatures are between 375 K and 550 K, the TE materials with higher efficiency factors are n-type SiGe and p-type SiGe, while at higher temperatures, between 550 K and 780 K, the TE materials with higher efficiency factors are PbTe-PbI2, PbTe-CdTe, and PbTe-SrTe-Na. The TE materials with lowest efficiency factors at both higher and lower temperatures are PbS, PbTe, and PbSe.

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Figures used in the abstract

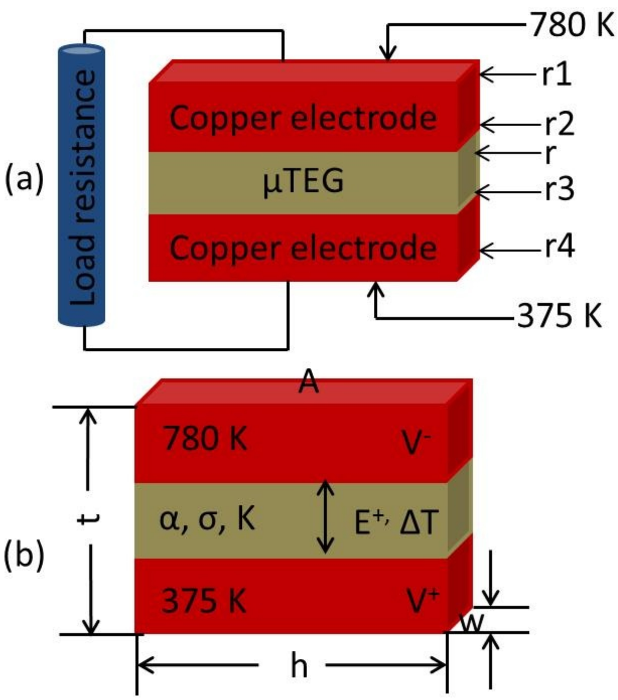

Figure 1: The schematic diagram which shows the single leg of µTEG, (b) the schematic diagram which shows the parameters used for simulation analysis of each µTEG.

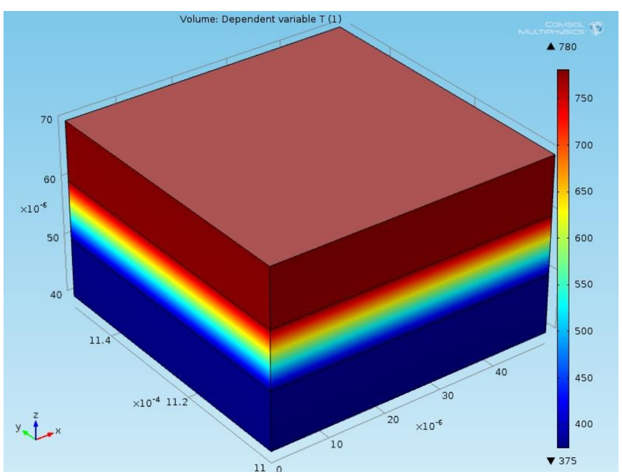

Figure 2: The simulation results which show temperature distribution in a three-dimensional model of a single leg µTEG when the applied temperature was set from 375 K to 780 K.

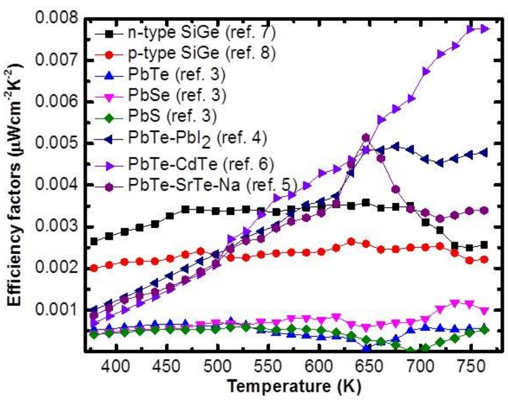

Figure 3: The efficiency factors calculated across eight TE materials when the temperature gradient (ΔT) along the thickness was 15 K.

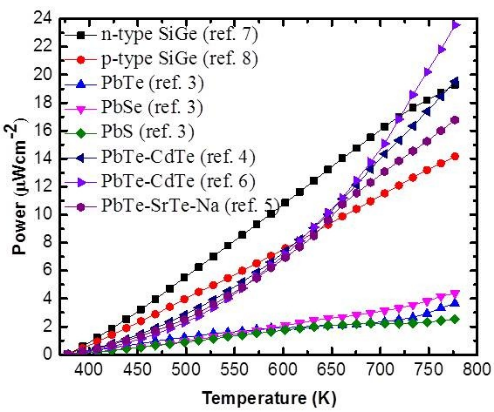

Figure 4: The power generated along the thickness of eight TE materials versus temperatures.