Electronic Supplementary Material (ESI) for Energy & Environmental Science

Supplementary Material

A - Summary of Experimental STEG Results

Author	Year	Efficiency	TE Material	γ_{op}	γ_{th}	T_h (°C)	T_c (°C)
Telkes [1]	1954	0.63%	ZnSb/BiSb (experimental)	1	1	80	35
Telkes [1]	1954	3.35%	ZnSb/BiSb (experimental)	50	1	260	20
Rush [2]	1964	0.7%	Bi_2Te_3 (commercial)	-	-	-	-
Goldsmid [3]	1980	1.4%	Bi_2Te_3 (commercial)	1	100	90	35
Goldsmid [3]	1980	0.5%	Bi_2Te_3 (experimental)	3	-	150	30
Amatya & Ram [4]	2010	3%	Bi_2Te_3 (commercial)	66	-	-	-
Suter [5]	2010	0.08%	Perovskite (experimental)	300	11	625	75
Kraemer [6]	2011	4.6%	Bi_2Te_3 (exp, nanostructured)	1.5	200	200	20

TABLE I: A summary of experimental data from previous STEG studies.

B - Temperature Gradients Across the Absorber

Vertical Temperature Distribution

As discussed in the Methods section, the absorber surface temperature (T_{abs}) and the TE hot side temperature (T_h) will differ slightly. However, approximating these temperatures as equal makes for much simpler calculations. In order to justify this assumption, we have calculated the difference between T_{abs} and T_h as a function of T_h for several levels of incident flux. This calculation was performed for a 5 mm thick absorber with a κ_{abs} of 55 W/mK (an approximate value for graphite at 1000°C). The TE material has a κ_{TE} value of 1 W/mK and a constant zT of 1. We see that there is at most a 3.6% difference between T_{abs} and T_h.

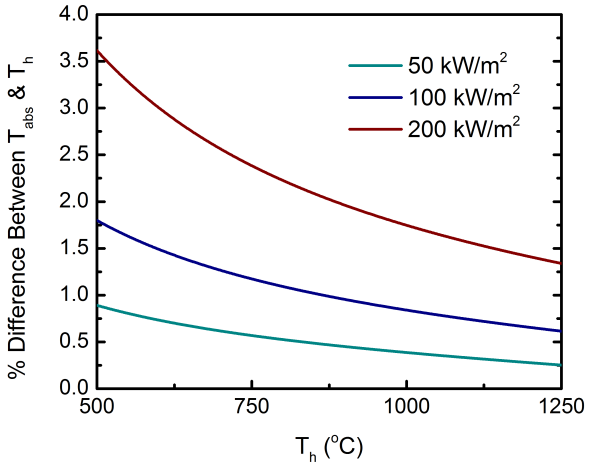

Fig. 1: Vertical temperature distribution across the absorber

Horizontal Temperature Distribution

The issue of temperature uniformity across the absorber has been addressed by Kraemer, et al. [6] . In this work the absorber is approximated as a annular fin, and the radial temperature distribution can be calculated using modified Bessel functions of the first and second order. Here, we assume that T_h is uniform across the TE leg, which has a diameter of 1 cm. We then plot the temperature difference over the entire absorber, which has a diameter of 5 cm (using the same absorber thickness and thermal conductivites as above). This 25-fold thermal concentration value is quite large for the thermal length values considered here.

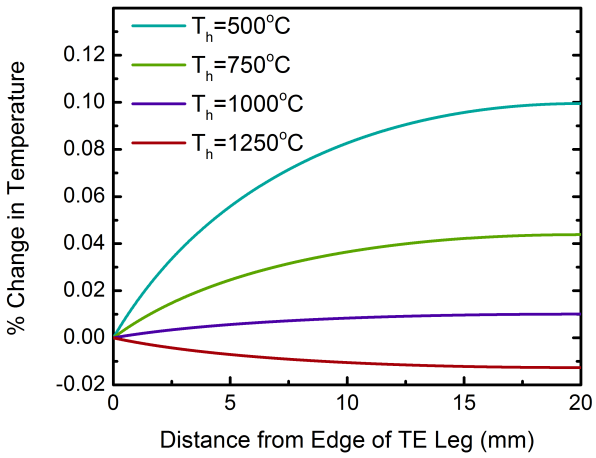

Fig. 2: Horizontal temperature distribution across the absorber

[1] Telkes, M. Solar Thermoelectric Generators. *Journal of Applied Physics* **25**, 13 (1954).

[2] Rush, R. E. Solar flat plate thermoelectric generator research (1964).

[3] Goldsmid, H. J., Giutronich, J. E. & Kaila, M. M. Solar Thermoelectric Generation Using Bismuth Telluride Alloys. *Solar Energy* **24**, 435–440 (1980).

[4] Amatya, R. & Ram, R. J. Solar Thermoelectric Generator for Micropower Applications. *Journal of Electronic Materials* **39**, 1735–1740 (2010).

[5] Suter, C., Tomes, P., Weidenkaff, A. & Steinfeld, A. Heat Transfer and Geometrical Analysis of Thermoelectric Converters Driven by Concentrated Solar Radiation. *Materials* **3**, 2735–2752 (2010).

[6] Kraemer, D. *et al.* High-performance flat-panel solar thermoelectric generators with high thermal concentration. *Nature Materials* **10**, 532–538 (2011).