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ABSTRACT

Thermionic Enhanced Near Field Thermophotovoltaics

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Thermophotovoltaics (TPV) is the direct conversion of thermal radiation into electricity through the photovoltaic effect. Very recently, TPV devices have demonstrated heat-to-power conversion efficiencies up to 40% [1]. However, current devices must operate at extreme high temperatures (>1200ºC) to produce a significant power. Thus, boosting the power density of TPV is essential to make it competitive at heat source temperatures lower than 1000 ºC. A record output power density of 0.75 W/cm2 has been recently measured at a moderate emitter temperature (~ 460 ºC) by using a near-field TPV (NF-TPV) arrangement, where a nanoscale separation between the (cold) TPV cell and the (hot) emitter enables a ~ 6-fold enhancement of the far-field power [2]. However, the very high current densities impose serious constrains on the TPV cell design, which must be either very small or comprise a very dense front metal grid to avoid excessive ohmic losses. In this study, we describe a thermionic-enhanced NF-TPV conceptual device [3] in which electrons are thermionically emitted from the emitter to the TPV cell, establishing a wireless electric connection that avoids the use of front metal electrodes in the cell, and thus, results in negligible ohmic losses and higher power densities. Simulations show that high efficiency and power densities are attainable simultaneously at moderate temperatures (< 1000 ºC) [4]. Preliminary experimental results will be also presented that demonstrate the main operational principles of the concept in the far-field.

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