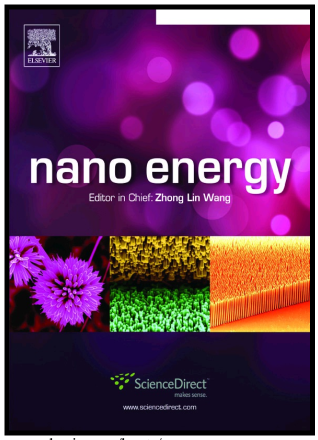
Author's Accepted Manuscript



www.elsevier.com/locate/nanoenergy

High-Performance Near-field Thermophotovoltaics for Waste Heat Recovery

Bo Zhao, Kaifeng Chen, Siddharth Buddhiraju, Gaurang Bhatt, Michal Lipson, Shanhui Fan

PII: S2211-2855(17)30600-6
DOI: https://doi.org/10.1016/j.nanoen.2017.09.054
Reference: NANOEN2230

To appear in: *Nano Energy*

Received date: 8 August 2017
Revised date: 25 September 2017
Accepted date: 26 September 2017

Cite this article as: Bo Zhao, Kaifeng Chen, Siddharth Buddhiraju, Gaurang Bhatt, Michal Lipson and Shanhui Fan, High-Performance Near-field Thermophotovoltaics for Waste Heat Recovery, *Nano Energy,* https://doi.org/10.1016/j.nanoen.2017.09.054

High-Performance Near-field Thermophotovoltaics for Waste Heat Recovery

Bo Zhao[1], Kaifeng Chen[1], Siddharth Buddhiraju[1], Gaurang Bhatt[2], Michal Lipson[2], and Shanhui Fan[1,a)]

[1]Department of Electrical Engineering, Ginzton Laboratory
Stanford University, Stanford, California 94305, USA
[2]Department of Electrical Engineering, Columbia University,
New York, New York 10027, USA

Abstract

The US industries reject nearly 20%-50% of the consumed energy into the environment as waste heat. Harvesting this huge amount of heat can substantially improve the energy usage efficiency. For waste heat in the medium temperature range (~500-900 K), traditional solid-state waste heat recovery techniques like thermoelectric generators and thermophotovoltaics (TPVs) are still suffering from relatively low efficiency or power density. In this work, we analyze a near-field TPV system consisting of a plasmonic emitter (indium tin oxide) and a narrow-bandgap photovoltaic cell (InAs) that are brought to deep sub-wavelength distances for high-efficiency and high-power-density waste heat recovery. We show that despite the inclusion of realistic nonradiative recombination rates and sub-bandgap heat transfer, such a near-field TPV system can convert heat to electricity with up to nearly 40% efficiency and 11 W/cm^2 power density at a 900 K emitter temperature, because of the spectral reshaping and enhancement by the thermally excited surface plasmons and waveguide modes. Thus, we show that for waste heat recovery, near-field TPV systems can have performances that significantly exceed typical thermoelectric systems. We propose a modified system to further enhance the power density by using a thin metal film on the cell, achieving a counterintuitively “blocking-assisted” heat transfer and power generation in the near-field regime.

[a)] Author to whom correspondence should be addressed. Electronic mail: shanhui@stanford.edu