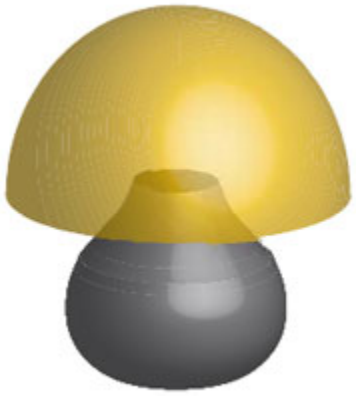
Docket #: S12-299

High efficiency thermal radiation extraction for thermophotovoltaic cells, efficient heating and other applications

Researchers in Prof. Shanhui Fan's laboratory have invented a thermal extraction device that is designed to enhance power emission from thermal radiators up to 10x compared to conventional structures. They achieve this efficiency (far exceeding that of a blackbody of the same area) by placing the emitter in optical contact with an extraction device, thus enabling all internal modes to contribute to far field radiation. The invention is applicable in a variety of radiative heating and cooling applications, including enhancement of the radiation available for conversion to electricity in thermophotovoltaic cells.



Schematic of thermal extraction. *Thermal extraction using a hemispherical refracting dome placed at the opening of a high-index thermal cavity, which in practice may be simply the surface of an emitting solid. The dome is transparent and does not emit or absorb any thermal radiation. Many other geometries are also*

possible.

Stage of Research
The inventors have experimentally demonstrated a four-fold enhancement of the far-field thermal emission of a carbon-black emitter with emissivity of 0.85.

Applications

- **Radiative temperature management** - radiative heating and cooling, thermal heating
- **Solar energy** – heat to electric conversion in thermophotovotaic cells

Advantages

- **Enhanced power conversion** - device can improve power emission 4-10x compared to conventional thermal radiators
- **Lower operating temperature** of radiative heating elements
- **Energy efficiency** for end user applications

Publications

- Z. Yu, N. Sergeant, T. Skauli, G. Zhang, H. Wang and S. Fan, "Enhancing far-field thermal emission with thermal extraction", *Nature* Communications, vol. 4, art. No. 1730 (2013).

Patents

- Published Application: 20140102686
- Issued: 10,544,999 (USA)

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