Thin Film Thermophotovoltaic Cells

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OTHER INFORMATION

KEYWORDS

thermophotovoltaics, thin films, heat absorption, thermal emissions, high temperature

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Energy**
  - Lighting
  - Other
  - Solar
- **Environment**
  - Other
- **Materials & Chemicals**
  - Nanomaterials
  - Other

ABSTRACT

Researchers at the University of California, Davis (“UC Davis”) have developed an optical absorber/emitter for thermophotovoltaics application with a tunable emission wavelength.

FULL DESCRIPTION

Thermophotovoltaic cells convert thermal energy into electricity by transferring heat into light photons captured by traditional solar cells. Typical applications include capturing wasted energy from heat loss in industrial processes (e.g., steam engine turbines), heat shields, nuclear materials, etc. The major limitations of state-of-the-art thermophotovoltaic systems are that they normally operate at a high temperature, greater than 900oC, and they are manufactured using a complicated 2d or 3d nanofabrication process. The developed nanostructures are complex, making conventional thermophotovoltaic designs impractical to build at the large scales often required for industrial applications and limiting their useful service life.

Researchers at UC Davis have developed a thin-filing-coating/substrate two-layer thermal absorber/emitter structure configured with controllable emission properties at ultra-high operating temperatures. The thermal absorber/emitter structure is composed of a substrate made of a first material and a thin-film layer/coating made of a second material that is disposed on the substrate. Use of a single thin-film layer/coating provides control and tuning of the emission properties of the overall two-layer structure. Both materials selected for the absorber/emitter structure possess high melting points to withstand extreme temperature variations. Note that the simple two-layer design of the absorber/emitter structure reduces the likelihood of thermal failure and the use of a single coating on the substrate makes it easier to choose thermally matched materials. Moreover, for the properly selected materials, the thin-film layer or coating can serve two functions: (1) as a protective barrier/interface; and (2) as the primary optical layer. Furthermore, the absorber/emitter structure can be easily scaled up for commercial applications.

APPLICATIONS

- Design/manufacture of more efficient thermophotovoltaic energy generation systems
- Effective energy recovery from heat loss in a range of industrial applications
- Suitable for applications in aerospace heat shields, turbine designs, nuclear materials, satellites, and thermal cloaking

FEATURES/BENEFITS

- Single-layer, ultrathin films can be manufactured using a simplified and scalable process
- Tunable wavelength response
- Up to 400% increase in heat→energy conversion efficiency compared to state-of-the-art systems
- Operable across a range of temperatures (e.g., above 1500°C) with increased product durability

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20250088132	03/13/2025	2022-506

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Mechanical Power Generation Through Passive Radiative Cooling

- Thin Films
- **Nanotechnology**
- Materials
- Other

RELATED CASES

2022-506-0

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