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Licensing Opportunity

TTO – Technology Transfer Office

Solar Thermophotovoltaic Device

Ref. Nr

6.2602

Keywords

Solar thermophotovoltaics, high-efficiency solar cells, heat spreading, renewable energy

Intellectual Property

PCT/EP2024/081056

Publication

N/A

Date

18/12/2025

Description

Conventional silicon photovoltaic cells are limited by the Shockley-Queisser limit, achieving only about 33% efficiency without solar concentration. This is due to their inability to utilize the full solar spectrum: photons below the bandgap are wasted, and excess energy from high-energy photons is lost as heat. Attempts to overcome this with multi-junction cells or low-bandgap materials (e.g., GaSb, InGaAs) have led to complex and costly fabrication processes, restricting scalability.
The technology introduces a solar thermophotovoltaic (STPV) device designed to surpass traditional efficiency limits by converting concentrated sunlight into thermal radiation optimized for photovoltaic conversion. The system integrates:

- Absorber Layer: Captures concentrated sunlight and converts it into heat.
- Emitter Layer: Closely coupled to the absorber, emits thermal radiation tailored to the PV cell's bandgap.
- Photovoltaic Cell: Positioned to receive emitted radiation and generate electricity.
- Heat Spreading Layer with Microchannels: A breakthrough feature that ensures uniform temperature distribution across the absorber/emitter surfaces, overcoming the inefficiencies caused by localized heating.

Advantages

- Efficiency Beyond Shockley-Queisser Limit: Utilizes full solar spectrum via thermal re-emission.
- Uniform Heat Distribution: Microchannel-based heat spreading minimizes thermal gradients.
- Compatibility with Silicon PV Cells: Reduces reliance on expensive III-V semiconductors.
- Scalable and Cost-Effective: Employs standard photolithographic techniques for microchannel fabrication.
- High-Temperature Stability: Materials and fluids withstand up to 3000 K.
- Passive or Active Heat Management: Options include thermosyphon or micropump systems.

Applications

- Utility-Scale Solar Power Plants: Enhanced efficiency for concentrated solar systems.
- Industrial Heat-to-Power Conversion: Integration into high-temperature processes.
- Remote and Off-Grid Energy Solutions: Compact, high-output renewable energy source.
- Space Applications: Efficient energy harvesting in extraterrestrial environments.
- Hybrid Renewable Systems: Combination with conventional PV for peak performance.