Diamond-Based Isothermal PETE Solar Topping Device for Enhanced Dual Energy Conversion

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Inventors

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Background

Photon-enhanced thermionic emission (PETE) is a process that harnesses both the light and heat of the sun to generate electricity and increases the efficiency of solar power production by more than twice the current levels. In thermionic emission conversion (TEC), a temperature difference generates current across a vacuum that separates a heated cathode (positively-charged electron emitter) from a cooled anode (negatively-charged electron collector). PETE increases current by combining the photoelectric effect with TEC, relying on solar radiation to heat the cathode. Concentrated photovoltaic (CPV) systems use lenses and curved mirrors to focus sunlight onto highly efficient multi-junction PV cells, but gain little benefit over ordinary photovoltaics because the concentrated sunlight raises temperatures high enough to degrade the performance of the PV cell. PETE devices are currently being employed to help reap the benefits of CPV. However, at the higher temperatures incurred by CPV systems, the temperature difference needed by prevailing PETE devices requires extensive engineering to maintain.

Invention Description

Researchers at ASU have developed an isothermal PETE conversion device that optimizes CPV efficiency by installing low-work-function diamond-doped films as emitter and collector electrodes. Diamond has a wider optical bandgap and a lower electron emission threshold, which means that it absorbs a wider range of the solar spectrum and emits more electrons under TEC and the photoelectric effect. Unlike conventional TEC, this device operates at a uniform temperature (isothermally), and the vacuum gap instead functions by aligning conduction bands to create a direct path for low-work electron transfer. The device's absorption region is also specially configured to concentrate electrons at the surface of the diamond film, further enhancing electron transfer. The collective innovations generate a much stronger current and substantially increase electrical output. Additionally, heat transfer fluid transfers excess heat outside the device that can be used for secondary energy conversion.

Intellectual Property Status:

Pending

Potential Applications

- CPV Systems
- PETE Devices
- Solar Power

Benefits and Advantages

- **Efficient**
  - Absorbs a wider range of the solar spectrum.
  - Electron emission does not require as much work.
- **Effective** – Substantially increases electrical output.
- **Innovative** – Diamond delivers better performance at higher temperatures.
- **Practical** – Fluid transfers excess heat outside the device for secondary energy conversion.

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