Thermophotovoltaics With Storage

A concentrated solar thermophotovoltaics (TPV) with liquid silicon thermal storage

Georgia Tech inventors have created a concentrated solar thermophotovoltaics (TPV) system with liquid silicon thermal storage that utilizes the most efficient and lowest cost component technologies and links them together using a liquid metal heat transfer fluid (LMHTF). The system design involves capturing sunlight at high temperature (above the melting point of silicon) in the sensible heat of liquid tin. Then the tin is used to melt a large container of silicon, which serves as a thermal battery. When electricity is desired, liquid tin is used in a heat exchanger to carry the heat from the solidifying silicon battery to a dense array of TPV modules, which can convert the upper portion of the emission spectrum to electricity. The remaining energy in the spectrum is reflected back to the emitter via silver backed mirror. This technology that can use liquid metal (i.e. molten tin) as a high temperature liquid heat transfer fluid, can now solve the power density mismatch problem in TPV and enable a high efficiency design.

Summary Bullets

- **Lower Production Costs** – Can provide fully dispatchable solar electricity at a cost competitive with conventional generation at a potentially reduces cost of 70%, making it highly competitive with fossil fuel plants
- **Higher efficiency design** – By packing the PV densely within the array, thermal losses are minimized an an improved in efficiency by almost a factor of two is possible with existing InGaAs PV Cells

Solution Advantages

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Potential Commercial Applications

- High power solar devices
- Utility scale power production

Background and More Information

Several obstacles have prevented conventional thermophotovoltaics (TPV) systems from reaching widespread commercial success. Among these are the high costs for high performance III-IV semiconductor substrates and cells; low system efficiencies due to small system sizes and edge effects, and inefficient spectral control; the absence of storage, which forces TPV to compete directly with less expensive flat plate PV; and a large mismatch in power density between the highly concentrated sunlight input needed to reach high temperatures (> 1000 °C) and the order of magnitude lower power density infrared light output from the emitter to the TPV cell. The idea of TPV has been around for decades, but a fundamental mismatch in power density between the incoming light and reradiation to the PV module has prevented a highly efficient design from emerging. As a result there is a need for improved systems and methods to address the above mentioned deficiencies.

Inventors

- Asegun Henry
  Assistant Professor - Georgia Tech School of Mechanical Engineering

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Publications

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Images

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