Spectrally-engineered Solar Thermal Photovoltaic Devices

Technology #16647

Applications

Concentrated solar power, portable or off-the-grid power generators, and combined heating and power are fields that would benefit from this technology.

Technology

This technology is a compact, planar solar thermal photovoltaic device that includes a spectrally-engineered absorbing surface to efficiently absorb concentrated sunlight and deliver it to a spectrally-selective emitter. The planar area ratio between the absorber and the emitter has been optimized for a specific solar irradiance (i.e. optical concentration) to achieve high thermal efficiency. To be compatible with the planar processing techniques, the area ratio optimization is achieved by patterning the active area of the absorber with respect to the emitter. An optimized module consisting of a multi-wall carbon nanotube absorber and a one-dimensional Si/SiO2 photonic crystal emitter shows thermal efficiencies exceeding 50% on a 1x1cm device, and enables thermal efficiencies approaching 80% for a scaled-up 10x10cm device with moderate optical concentrations (<1000x), facilitating solar-to-electrical efficiencies exceeding 20%."

Problem Addressed

To generate power from sunlight, the most common approaches are either photovoltaic (PV) or thermal solar. However, since power generation using PVs is intermittent and typically only uses a portion of the solar spectrum efficiently, and the solar thermal approach is best suited for utility-scale power plants, there is a need for hybrid technologies.

Advantages

- Enables fabrication of spectrally-engineered surfaces as absorbers and emitters for solar thermal photovoltaic devices via conventional planar techniques
- Thermal resistance between the absorber and the emitter is minimized by integrating the absorber and the emitter on the same conductive substrate for effective thermal spreading
- Leverages the benefits of both solar cells and concentrated solar power approaches

Categories For This Invention:

Energy
Solar
Solar Thermal Conversion

Intellectual Property:

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Spectrally-engineered solar thermal photovoltaic devices
Issued US Patent
9,929,690

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Publications:

How to Tap the Sun's Energy Through Heat as Well as Light
MIT News
January 19, 2014
A Nanophotonic Solar Thermophotovoltaic Device
Nature Nanotechnology
2014
Role of Spectral Non-idealities in the Design of Solar Thermophotovoltaics
Optics Express
2014
Metallic Photonic Crystal Absorber-Emitter for Spectral Control in High-Temperature Solar-Thermophotovoltaics
Advanced Energy Materials
2014
Solar Thermophotovoltaic Energy Conversion Systems with Two-dimensional Tantalum Photonic Crystal Absorbers and Emitters
Solar Energy Materials and Solar Cells
2014

External Links:

Harnessing the Full Potential of the Sun
https://www.youtube.com/watch
Photonics and Modern Electro-Magnetics
http://www.rle.mit.edu
NanoEngineering Group
http://web.mit.edu/nanoengineering/
Device Research Laboratory
http://drl.mit.edu/

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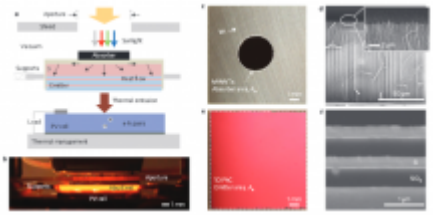
Image Gallery:



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