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Low-Cost and High-Efficiency Tandem Photovoltaic Cells

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Inventors

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Background

Of all the solar cells, CdTe thin-film solar cells have the shortest energy payback time by offering the best energy conversion efficiency relative to manufacturing costs. They use very little semiconductor material and are relatively simple to manufacture, but they do not reach the higher energy conversion efficiencies of traditional crystalline Si solar cells. While integrated structures combining both CdTE and Si have been proposed, materials challenges make their integration to form a high efficiency tandem cell very difficult. While recent developments have been able to accomplish integration by depositing single crystal CdTe via molecular beam epitaxy or vacuum deposition, these manufacturing processes are too expensive to produce a solar module that can compete with conventional energy sources. Therefore, there is a need for a tandem solar cell that is energy efficient and inexpensive enough to reach grid parity.

Invention Description

Researchers at ASU have designed a new, high-efficiency, tandem solar cell that successfully combines II-VI polycrystalline materials and silicon to reach grid parity. The design consists of a wide bandgap polycrystalline top subcell, a specially designed tunnel junction, and a crystalline or amorphous Si bottom subcell. Polycrystalline structures are much easier to manufacture but are generally less efficient than monocrystalline structures due to their irregular crystal formation. However, this design overcomes the disadvantages of polycrystalline materials by using ultrathin absorbing regions in both subcells. Not only do these ultrathin layers decrease the material and process costs of manufacturing, but they also improve energy efficiency by reducing the number of defects that contribute to non-radiative recombination. A novel tunnel junction between the two subcells also increases energy efficiency by using point contacts to minimize optical absorption and lower series resistance. This design is estimated to be energy efficient and cost-effective enough to produce solar modules that can compete with conventional energy sources and reach grid parity.

Intellectual Property Status:
Pending

Potential Applications

- Photovoltaic Solar Cells
- Remote Solar Hybrid Systems

Benefits and Advantages

- **Cost Effective**
  - Requires less overall semiconductor material to manufacture.
  - Polycrystalline layers are easier to apply.
  - Shorter payback period.
- **High Efficiency** –Absorbs up to 28% of sun's light.
- **Grid Parity** – Energy efficient and cost effective enough to compete with conventional energy sources.
- **Novel Tunnel Junctions** – Point contacts reduce optical loss and lower resistance.
- **Ultrathin Absorber Regions**
  - Higher built-in electric field for better carrier extraction.
  - Reduced defects in polycrystalline bulk and at surface and grain boundaries.
  - Low non-radiative recombination rate.

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