Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Richard King

Contact

Shen Yan
shen.yan@skysonginnovations.com

Multijunction Solar Cell with Thin-Film Polycrystalline Low-Bandgap Bottom Cell

There is a need for solar cells with highly efficient light-to-electricity conversion and lower cost. Multijunction cells, which include multiple light-absorbing materials, each of which converts a given wavelength range of the solar spectrum, can be used to provide greater conversion efficiency than single-junction thin-film solar cells.

However, fabrication of multijunction cells presents a variety of challenges:

- Difficult to source semiconductor materials that simultaneously have desirable properties (e.g., suitable bandgaps to partition the solar spectrum, low recombination rates, low material cost, and low fabrication costs).
- Difficult to find materials and processes to electrically interconnect subcells of different bandgaps in the multijunction cell. Sought-after properties include: high electrical conductivity, high optical transmittance for light that needs to reach the subcells beneath, materials compatibility such that the interconnect materials do not damage adjacent cell materials, and low material and fabrication costs.
- If the different subcells are each processed independently for later integration into the multijunction cell, the fabrication cost is multiplied manyfold.
- If additional contacts or terminals are made to each subcell (e.g., to avoid the problem of current balancing the subcells, or to avoid problems related to materials compatibility, electrical conductance, and optical transmittance of the interconnect layers), then it can be difficult to access the contacts between subcells without incurring excessive series resistance, cell shadowing, and other losses.

Thus, there is a need for multijunction cell designs which circumvent one or more of these problems.

Research at Arizona State University has led to multijunction thin-film solar cell designs with low manufacturing cost, including tandem (2-junction) solar cells capable of one-sun efficiencies over 25%. These multijunction solar cells may have one or more of a polycrystalline, thin-film, low-bandgap bottom cell, transparent back contact on the top cell, transparent back contact on the bottom cell, and bifacial operation of the bottom cell. In addition to higher efficiency, advantages of the innovation include avoidance of:

- Issues with subcell current imbalance, whether due to constantly changing spectral conditions or manufacturing variation

- Excessive materials and fabrication cost of processing and integrating subcells on separate substrates
- Potential incompatibility between subcell and interconnect materials

Potential Applications:

- High-efficiency, low-cost solar photovoltaic modules
- Renewable electricity generation