

National Aeronautics and
Space Administration



TECHNOLOGY SOLUTION

Power Generation and Storage

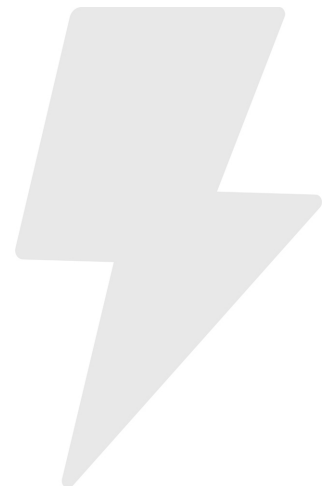
High-Efficiency Solar Cell

[Selenium Interlayer for multi-junction photovoltaic cell for both space and terrestrial applications](#)

Innovators at NASA's Glenn Research Center have developed a high-efficiency multi-junction solar cell that uses a thin interlayer of selenium as the bonding material between wafers. Selenium is a unique semiconductor in that it's transparent to light at photon energies below the band gap (infrared), enabling light to pass from the multi-junction top cell to the silicon-based bottom cell. The innovation allows a multi-junction solar cell to be developed without the constraint of lattice matching, and with a low-cost, robust silicon wafer as the supporting bottom substrate and bottom cell. This approach enables a cell that is simultaneously lower in cost, more rugged, and more efficient than existing space-based photovoltaic cells. This high-efficiency solar technology takes advantage of inexpensive silicon wafers and provides a more robust design for next-generation solar cells in space. For terrestrial applications, it can provide unprecedented efficiencies for auxiliary power units in vehicles, solar roof tiles, power plants, and smart grid systems.

BENEFITS

- High efficiency: Expected conversion efficiencies of 30% to over 40%
- Low-cost materials: Substrate material is a low-cost silicon wafer as compared to materials used for space-based photovoltaic cells
- Easy to manufacture: Photovoltaic cells can be manufactured on a large scale
- Low environmental impact: Zero greenhouse gasses are emitted
- Robust: The cell features a rugged design for space applications



THE TECHNOLOGY

This NASA Glenn innovation is a novel multi-junction photovoltaic cell constructed using selenium as a bonding material sandwiched between a thin film multi-junction wafer and a silicon substrate wafer, enabling higher efficiencies. A multi-junction photovoltaic cell differs from a single junction cell in that it has multiple sub-cells (p-n junctions) and can convert more of the sun's energy into electricity as the light passes through each layer. To further improve the efficiencies, this cell has three junctions, where the top wafer is made from high solar energy absorbing materials that form a two-junction cell made from the III-V semiconductor family, and the bottom substrate remains as a simple silicon wafer. The selenium interlayer is applied between the top and bottom wafers, then pressure annealed at 221°C (the melting temperature of selenium), then cooled. The selenium interlayer acts as a connective layer between the top cell that absorbs the short-wavelength light and the bottom silicon-based cell that absorbs the longer wavelengths. The three-junction solar cell manufactured using selenium as the transparent interlayer has a higher efficiency, converting more than twice the energy into electricity than traditional cells. To obtain even higher efficiencies of over 40%, both the top and bottom layers can be multi-junction solar cells with the selenium layer sandwiched in between. The resultant high performance multi-junction photovoltaic cell with the selenium interlayer provides more power per unit area while utilizing a low-cost silicon-based substrate. This unprecedented combination of increased efficiency and cost savings has considerable commercial potential.

This is an early-stage technology requiring additional development. Glenn welcomes co-development opportunities.



Glenn's high-efficiency solar cell can be used for electric vehicle charging stations



Glenn solar cell provides unprecedented efficiencies for solar roof tiles

APPLICATIONS

The technology has several potential applications:

- Space-based and military power systems
- Unmanned aerial vehicles
- Satellites
- Solar aircraft
- Auxiliary power units for vehicles
- Electric vehicle charging stations
- PV distributed generation for smart grid systems
- Building-integrated photovoltaics
- Utility-scale PV power plants
- Communications systems

PUBLICATIONS

Patent No: 9,117,948; 9,418,844

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More Information

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