Three-Dimensionally Textured Photovoltaic (PV) Cells (#2922)

A light-trapping solution to significantly increase absorption

These novel carbon nanotube (CNT)-based textured PV cells permit greater energy absorption—a significant advantage over traditional PV cells that offers multiple benefits for both terrestrial and space-based applications. Developed at Georgia Tech, these 3D PVs can be scaled to form large, periodic arrays of vertically aligned CNTs. Common thin-film PV materials (e.g., cadmium telluride [CdTe], copper zinc tin sulfide [CZTS], or perovskite) are deposited on the upper side of each array. These innovative materials act as a 3D scaffolding of sorts—a structure that provides a light-trapping effect that produces more power at off-normal angles without requiring additional sun-tracking machinery.

Specifically, the 3D geometry enables multiple photon impingements and therefore an increased number of interactions between a photon and a photoabsorber. The result is a greater likelihood of absorption and a resulting increase in photocurrent and power output as compared with similar planar cells.

For space-based applications in particular, the increased power output should yield an increased energy output as the sun subtends all zenith/beta angles. Such arrays are being tested for efficacy on the International Space Station as part of the Materials International Space Station Experiment (MISSE)-11, MISSE-12, and NanoRacks External Platform (NREP)-1 missions.

Benefits/Advantages

- **Powerful**: Improves probability of absorption via a novel light-trapping geometry
- **Practical**: Eliminates the need for heavy, complex, costly, and failure-prone mechanical systems required by traditional planar PV cells to track the sun
- **Reliable**: Improves photon absorption probability even at off-normal azimuth angles, leading to more predictable performance across all seasons for terrestrial applications

Potential Commercial Applications

Georgia Tech’s technology is well suited to increasing the power and reliability of both space-based and terrestrial applications that benefit from solar-generated power, including:

- Earth-orbiting satellites
- Space missions within Mars’s orbit
- Specialty space-based power systems
- Solar vehicles
- Solar farms

- Concentrator photovoltaics

Background/Context for This Invention

Solar energy is the only renewable source that can provide the majority of the 10 TW deemed necessary for the global economy by 2035 (source: M.I. Hoffert et al., *Nature*, 395(6705): 881-884, 1998). While PV research has made tremendous strides since its introduction in the 1950s, an order-of-magnitude decrease in the PV price per watt is still needed in order to compete economically with conventional fossil fuels and other non-renewable power sources. Viable technologies will need to be highly efficient while minimizing PV cell production costs. Space-based applications for solar energy add the requirement of low weight to the mix, since spacecraft payload weight is of critical importance. Georgia Tech's innovation addresses all of these needs with a method that significantly increases the energy absorption and power potential of PV cells while eliminating the need for heavy and costly sun-tracking machinery.

Dr. W. Jud Ready
Adjunct Professor - Georgia Tech School of Material Science and Engineering

More Information

U.S. Patent Issued - 8,350,146

Publications

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/three-dimensionally-textured-photovoltaic-pv-cells

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot