



CASCADE 2027 NON-CONFIDENTIAL SUMMARY »

Scalable Heavy-Atom-Free Photon Upconversion Systems for Solar Energy Applications

Overview

Traditional solar panels face a physical efficiency cap because they cannot capture low-energy light particles, known as sub-gap photons, which simply pass through the device without being converted into electricity. To capture this wasted energy, researchers use photon upconversion to transform multiple low-energy particles into a single higher-energy particle that the panel can process. Current upconversion methods usually rely on heavy-atom sensitizers containing precious metals like platinum or iridium, which are prohibitively expensive and difficult to scale for widespread industrial use. Our technology provides a method for converting low-energy, near-infrared light into higher-energy visible light using sustainable, metal-free organic materials, with the potential to enhance solar panel efficiencies and increase return on investment (ROI) for solar systems.

Description

This technology introduces a completely heavy-atom-free NIR-to-visible photon upconversion system using a specialized organic molecule known as the thionated squaraine, both in fluid solution, in solid-state composite architectures, and integrated into lab-scale photovoltaics. These molecules act as sensitizers that absorb NIR light and transfer that energy to an emitter (such as rubrene), which then releases yellow, higher-energy light. This process, known as Triplet-Triplet Annihilation (TTA), allows the system to harvest light that would otherwise pass unused through a device. By removing the requirement for rare metals or toxic additives, this system offers a more sustainable path for industrial scaling. The technology is designed for integration into various devices, including solar cells and tools used in high-precision additive manufacturing. With NIR photoresponse, this innovation fills a clear market gap for stable, non-toxic energy-conversion materials that are compatible with existing commercial manufacturing processes.

Technology Readiness Level (TRL)

TRL 4 — System or subsystem components tested in a laboratory environment.

COMOTION REFERENCE »

BDP 8325

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Value Proposition

- **Enhanced energy conversion:** This technology enhances the efficiency of solar energy systems and light-sensitive devices by capturing portions of the light spectrum that are typically wasted, increasing the conversion efficiency and electrical output of solar panels.
- **Manufacturing:** With no toxic or costly heavy metals and a scalable synthetic method, this innovation fills a clear market gap for stable, non-toxic energy-conversion materials that are compatible with existing commercial manufacturing processes.
- **Superior photostability:** The system demonstrates high operational stability, maintaining its performance for over 35 hours of continuous illumination, which addresses a common failure point in alternative organic upconversion dyes that often bleach within a few hours.

Intellectual Property Position

[US20230357630A1](#) – Patent issued/granted September 1, 2026 (status update pending in Google Patents).

Market Opportunity

- Next generation solar panels are actively developed in a race to enhance individual panel efficiency and increase the return on investment for installation of solar systems. These systems include perovskite solar cells, tandem perovskite/silicon solar cells, and enhancement layers for standard solar materials such as frequency conversion materials including upconversion materials.
- Pain points for many of these types of cells include expensive and toxic metals, device stability, and interfacial defects.
- Consolidation in the solar manufacturing space means that there are relatively few large competing firms seeking advantages in the market, either by reducing manufacturing costs or increasing output for their existing panels.
- Advantages of this technology include no requirements to re-engineer panels; no heavy or toxic metals adding to panel costs; and capture of currently unutilized solar spectrum.

References

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