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770.658.8820

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Recyclable Organic Solar Cells On Substrates Comprising Cellulose Nanocrystals (CNC)

Category: Renewable Energy and Sustainable Materials

Contact: Gennaro Gama, PhD Phone: 470.936.4641

Summary

This innovation harnesses the properties of cellulose nanocrystals (CNC) - a renewable, sustainable material derived from wood - to create substrates for recyclable, efficient organic solar cells. These substrates are not only biodegradable but also exhibit excellent mechanical and optical properties, such as high tensile strength, low density, and transparency. The solar cells built on these CNC substrates demonstrate promising electrical performance with a power conversion efficiency of 2.7% (unoptimized prototype), coupled with the capability to be easily recycled at room temperature without harmful residues. State-of-the-art organic solar cell prototypes can reach power conversion efficiencies over 18% due to the availability of new active layers.

Development Stage

Prototype complete and tested.

Problem Statement & Solution

Sunlight is one of the most abundant natural and renewable sources of energy available. However, the way we produce the technology to harvest it can be expensive and damaging to the environment. Traditional silicon-based solar cells are expensive to produce due to the extensive process required to refine and process the material. This process in itself is also not environmentally friendly, as it requires a significant amount of energy and resources. Additionally, once the material is configured into panels, they are rigid, limiting their ability to be integrated into a variety of structures. The panels are also fragile and brittle, which impacts their handling, transportation, deployment and installation, durability, and longevity. Furthermore, their recycling and disposing at the end of life cycle can be expensive and environmentally harmful.

Researchers at the Georgia Institute of Technology employed cellulose nanomaterials to develop novel photovoltaic devices that are an alternative to existing technologies. This technology will reduce environmental impact, provide a sustainable solution for energy production, and solve the challenge of integrating solar cells into various applications due to the flexibility, low cost, abundance, and light weight of CNC substrates.

Advantages

- Solar cells are recyclable through a low-energy, room temperature process.
- CNC substrates are made from renewable sources- are abundant, low-cost, and fully biodegradable.
- Exhibit ideal optical properties with high transparency and low roughness.
- Demonstrate superior mechanical properties, enhancing durability and performance.
- Compatible with existing organic semiconductor processing techniques, allowing for up to 350°C processing temperatures.

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Commercial Applications

- Low-cost, lightweight, and flexible power supplies for consumer electronics and home appliances.
- Short-lived, disposable, or biodegradable power sources for low-cost printed electronics and architecture.
- Renewable energy solutions for wearables and Internet of Things (IoT) sensor applications.
- Applications in conjunction with textiles and garments, wearable electronics.
- Building-Integrated Photovoltaics (BIPV) for sustainable construction and design.

Lead Inventor: Bernard Kippelen, PhD

Intellectual Property Status: US Patent Issued- US9203030B2

Scientific Publication(s): Zhou, Y., Kippelen, B., et al.: Recyclable organic solar cells on cellulose nanocrystal substrates. Scientific Reports, 3, 1536 (2013).