Recyclable Organic Solar Cells on Cellulose Nanocrystal Substrates (#6304)

A substrate for organic solar cells made of cellulose nanocrystals (CNC) synthesized from renewable feedstocks. CNC composite films combine a low density with a high tensile strength, a high elastic modulus, and a low coefficient of thermal expansion

Researchers from the School of Electrical and Computer Engineering at Georgia Tech have developed a substrate for organic solar cells made of cellulose nanocrystals (CNC) synthesized from renewable feedstocks. CNC composite films combine a low density with a high tensile strength, a high elastic modulus, and a low coefficient of thermal expansion. Upon process optimization, they can withstand up to 350°C, which makes them compatible with organic semiconductors processing. Their very low roughness (1.8 nm) and their good transparency make CNC substrates well suited for photovoltaic applications.

With a power conversion efficiency of 2.7%, the electrical performance of the first organic solar cells on CNC substrates is encouraging, especially when compared to similar devices made on glass and with more optimization options to explore. Those solar cells are easily recycled at room temperature, first immersing them in water, in which the CNC substrate disperses. The photoactive layer is then removed in chlorobenzene, leaving as solid residues the metal electrodes (Ag and MoO_3). Furthermore, burning of the solar cells leaves only a residue of ashes with metal components, which is an improvement over toxic fumes generated by plastic combustion.

Benefits/Advantages

- Solar cells are recyclable through a low-energy process at room temperature
- CNC substrates are fully biodegradable and made of renewable sources such as wood
- CNC substrates have ideal optical and morphological properties combining high transparency with a very low roughness
- CNC substrates exhibit excellent mechanical properties: low density, high tensile strength, high elastic modulus and low coefficient of thermal expansion

Potential Commercial Applications

This invention could be useful in applications requiring low-cost, light weight and/or flexible power supply, such as consumer electronics and home appliances. It could be used where a short-lived, disposable or biodegradable power source is needed in applications ranging from printed electronics, architecture (BIPV) to wearables or even to power sensors for Internet of Thing applications.

Background/Context for This Invention

Solar energy is one of the most abundant renewable energy available, and photovoltaic systems have become economically viable. However, from a life-cycle perspective, more advances are needed to make solar cells a fully environmentally friendly source of energy. Silicon and thin-film solar cells are difficult and expensive to recycle, and organic solar cells are usually made on plastic substrates, which generate additional steps in the recycling process.

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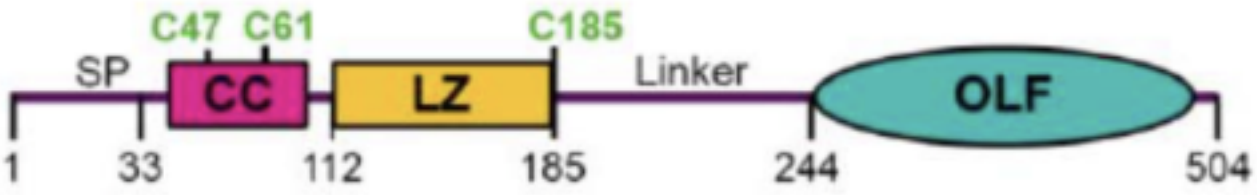
More Information

U.S. Patent Issued - 9,203,030

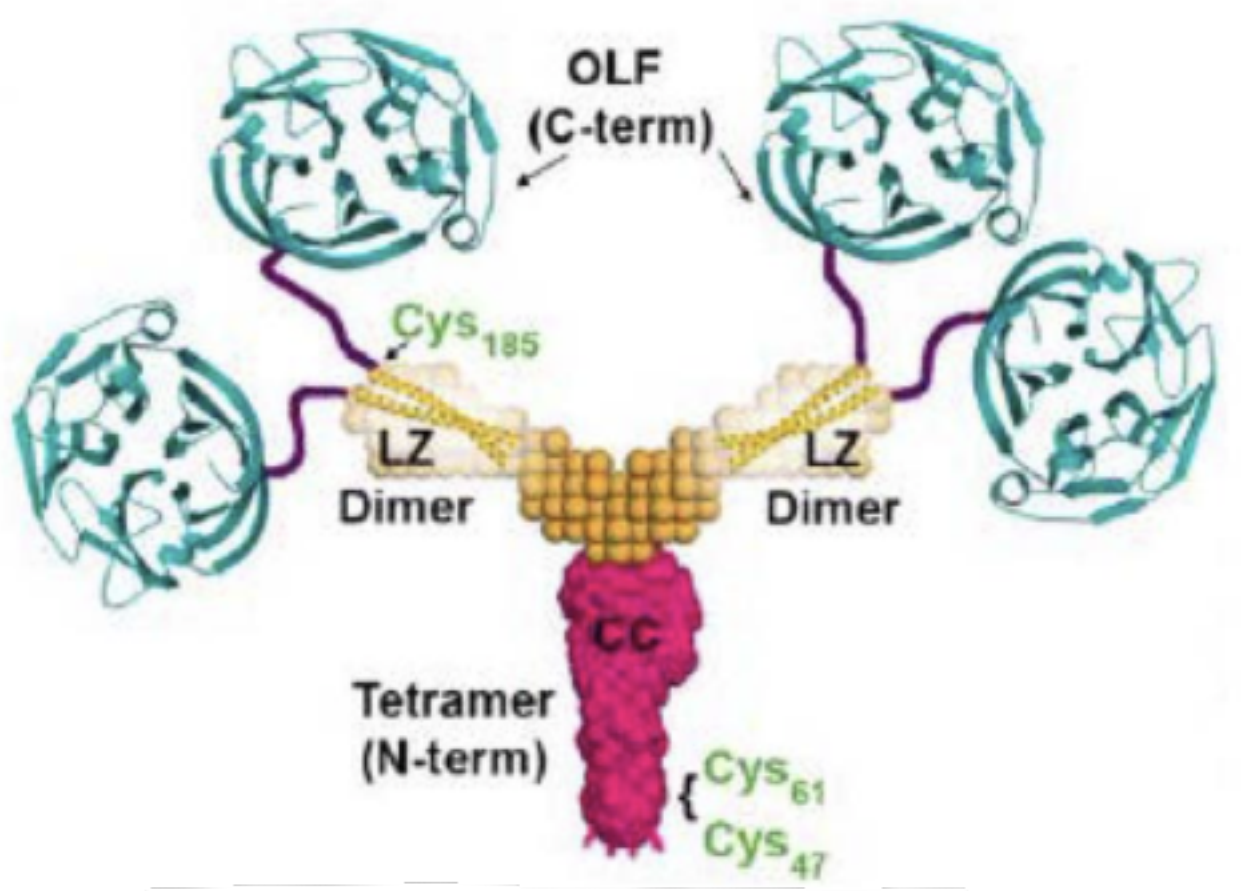
Publications

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/recyclable-organic-solar-cells-cellulose-nanocrystal-substrates

Images:



The gene structure depicting the domains of myocilin, including signal peptide, location of key cysteine residues, and its coiled-coil, leucine zipper, and olfactomedin domains.



The myocilin quaternary structure based on solution X-ray scattering, X-ray crystallography, and chemical cross-linking experiments.