Engineering a Cost-Effective and Biodegradable Cellulosic Battery Composition

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Recent years have seen the increased usage of lithium batteries as a compact and efficient power source for many consumer applications. From electronics to electric vehicles, these batteries have increased in demand by nearly 700% in the past ten years alone. However, the lithium battery presents several detrimental effects which make its widespread usage concerning. From the release of toxic chemicals to the use of expensive metals, this battery is often rendered unsustainable, dangerous, and costly to produce. This study focuses on producing an inexpensive and biodegradable battery cell composition utilizing organic waste materials and demonstrating performance statistics comparable to the traditional lithium battery. Cellulosic fibers extracted from pineapple crown leaf were selected as a bio-based binding agent within the electrodes of the cell. Testing revealed that the most effective prototype contained equal amounts of cellulosic fibers in both electrodes, with a 1:2 ratio of graphene, (serving as the active material) from cathode to anode. Xanthan gum was also utilized as an additional bio-based conductive binder. This prototype was statistically comparable to the traditional lithium battery in terms of voltage, amperage, power, and resistance, as well as being over five times less expensive to manufacture. The overall objective of this study was met through the successful creation of a novel battery cell composition utilizing inexpensive waste materials. With further development, the material compositions observed in this study could potentially be implemented into many of the same applications as the traditional lithium battery as an economical and sustainable alternative.

Awards Won:

Air Force Research Laboratory on behalf of the United States Air Force: Glass trophy and USAF medal for each recipient
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Regeneron ISEF Category, FOR 2023 ONLY: EBED WILL HAVE TWO
China Association for Science and Technology (CAST): Award of $1,200
University of Texas at Dallas: Scholarship of $5,000 per year, renewable for up to four years
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