CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
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Project Number
S0612

Project Title
Design of Biodegradable Energy Source to Power Wearable Electronics

Abstract

Objectives/Goals
Power sources such as batteries and capacitors are used everywhere in our electronic devices. Most are, however, rigid, heavy, and cannot be disposed off easily. A power source that is flexible, lightweight, and biodegradable would have broad applications in the field of wearable and medical (sensors) electronics. This work was aimed at developing an energy power source with low cost biodegradable components.

Methods/Materials
To create the power source, the conducting polymer poly(3,4-ethylenedioxythiophene) - poly(styrenesulfonate) (PEDOT:PSS) commonly used in electronic board circuits was selected because it behaves like a solid electrolyte with both ionic and electronic conduction properties thus with the potential of behaving like a battery and capacitor. To enhance its energy storage capabilities, additional components known to change PEDOT:PSS microstructure, were tested at various ratios: glycerol, polyethylene glycol, and dimethyl sulfoxide. In addition, the plant-based cellulose were added to the mixture in an attempt to create a strong and stable structure. The newly created composites were compared for capacitance and resistance. Composite preparation protocol included a pre-heating step of the mixture to increase reagent homogenization, casting of the slurry into plates followed by baking. All measurements were performed in triplicate using a capacitance and resistance meter once the slurries had solidified into hydrogels.

Results
A novel power source was created using biodegradable materials only. The highest energy storage performance (capacitance in the range of 1000 nF) was obtained with PEDOT:PSS mixed with cellulose and glycerol (ratio: 0.7, 0.7, 12.5 v/v%, respectively) in 3.5-cm diameter discs, a level sufficient to operate a light bulb when fully charged demonstrating its potential application.

Conclusions/Discussion
Unlike batteries and capacitors currently available, this composite is produced from simple materials, paper and polymers not requiring any dangerous chemicals or heavy metals and the preparation process is simple, cheap and possibly scalable to produce larger waffles with higher capacitance. Given its current properties, this power source should be capable of powering small devices such as glucose sensor, pacemakers, and computer components.

Summary Statement
I created an efficient biodegradable energy power source composite.

Help Received
I designed the experiments and created the composite myself. My physics teacher, Mr. Danssaert, provided me with some materials (circuit board, capacitor) and my San Diego Science Fair coordinator teacher, Mr. Haas, supported me with encouragement. I used a bench at the laboratory of Vetica Labs to