

Paper Based Batteries

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Abstract

Recently, Papers are being used as a component for batteries for storing energy and as an energy source. Because of its properties, papers are the best choice for a skeleton, dielectric, separating and to contain the electrolytes for the paper batteries. The fabrication process for these batteries are rather low cost and simple. In this review, we will go through with the accomplishments and applications of the paper batteries.

Keyword: Paper battery, Power supply, Microsystems

Introduction

Problems that are occurring related to power sources in the systems these days are various, for example adaptability, portability, size, limited life, leakage and other environmental effects and because of the greater facilities and qualities of paper based batteries, they are more in demand and are a centre for the research and development.

In place of rigid materials like glass and silicon, paper have come up in use recently. In the fields like MEMS and bioMEMS which create automated, cheap and complex systems. The most interesting and important factor is the power supply for the Microsystems. Devices like ink-jet printers not necessarily need on board supplies. Most of Microsystems (remote and distributed) don't need local power supplies.

The thin-film lithium ion batteries (Paper based) have high energy density, they are used in memory devices, active transdermal electrodes, and personal hazardous gas sensors.

Micro power sources like paper based batteries are very much compatible to the disposable electronic devices due to longer life time than any other batteries. Miniature power sources are required for the micro internal combustion engines. Higher density and low cost solar cells are also an alternative for paper batteries but they require a complex micromachining.

Literature Review

In recent days paper and paper based substrates are better alternatives for glass and silicon based substrates (Metters et al., 2013; Maxwell et al., 2013). The choice being paper is because of 1) Paper is cheap and available everywhere .

2) Paper burns easily ,hence disposing the batteries with it is easier and cheap. 3) Paper is flexible, can have required thickness and density and its is lightweight as well. 4)Papers don't harm nature and they are recyclable. 5) Papers provide surface area for electrolytes and reagents can be soaked in it. (Steckl, 2013; Zhang et al., (2012); Yetisen et al., 2013) .Papers can be used as a skeleton for formation and support for paper like nano composite film and makes it easier for it to scale up for commercial purposes. (Shao, 2012)

With the enhancement in paper researches(paper electronics and paper based batteries), these batteries and power storage devices have been in more interests because power source directly integrated onto paper are easier for system integration for production(Lee,2006).

Paper batteries with CNTs as electrodes

They are made up of cellulose paper. Cellulose is a organic compound which cant be digested by humans and is extracted from paper and pulp. A carbon nano tubes (CNT) is cylinder formed by rolled sheet of carbon atoms and is small at nano levels. They have higher conductive properties than those with best conduction and these tubes are stronger than the steel. They can be formed as single or multi layered.

Properties of Carbon Nanotubes:

- 1) Ratio of Width: Length: 1:107
- 2) High tensile Strength (Greater than Steel).
- 3) Low Mass density & High Packing Density.
- 4) Very Light and Very Flexible.
- 5) Very Good Electrical Conductivity .
- 6) Low resistance (~33 ohm per sq. inch).
- 7) Output Open Circuit Voltage: 1.5-2.5 V

ADVANTAGES OVER EXISTING BATTERIES:

1. Biodegradable & Non Toxic: its main ingredients are environment friendly so they are preferable.
2. Biocompatible: it means that they are compatible with animal or human cells if placed over them.
3. Easily Reusable & Recyclable: they are carbon based allotrope and cellulose, so they are easily disposable.
4. Durable: It has a shelf life of three years (at room temperature). Under extreme conditions it can operate within -75° to +150°C.

Paper batteries with Zinc and copper as electrodes

The electrodes with zinc and copper in thin film paper batteries that work on electrochemical potential difference of metals. Zinc and Copper are used as the electrodes and the paper is used as the separating material between the two. Two different methods are used to fabricate thin film paper batteries:

- 1) Physical vapor decomposition on thin films
- 2) Chemical sintering of metal micro particles

Zinc and Copper both have high conductivity (lower than 1/ohm-cm) with smooth surface area, good compatibility with paper and flexibility. The metal particle dispersion is a technique most suitable for the fabrication of these thin film batteries. These batteries are high performance energy storage and conversion devices.

Paper has been chosen for the separating and dielectric element for these batteries mainly because it has porous nature and has high chemical and physical stability. Zinc and Copper are chosen because of the simpler processes of fabrication.

Urine activated Paper batteries

Urine activated paper batteries is made up of several layers as such Copper (Cu) layer, Copper chloride (CuCl) filter paper and Magnesium (Mg) layer. All this set up is placed between two layers of plastic and later laminated into a urine activated paper battery by passing through the heated rollers at 150 degree celcius.

Magnesium (Mg) and Copper Chloride (CuCl) act as anode and cathode respectively. The Copper (Cu) layer is an electron collection terminal. When a drop of urine of a human is putted on the slit in the battery, it gets soaked in the paper and act as an electrolyte between magnesium (Mg) and Copper (Cu) layer, the chemical reactions produces potential difference that causes the electrons to flows from magnesium layer to the copper layer and hence producing electricity.



Final equation is:-



The standard voltage produced by this process is noted as 2.49 volts.

Conclusion

There are many possibilities for the usage ,research and development of application of paper batteries. The future of batteries needs paper as an significant element to upgrade the properties of the batteries and the paper acts as an supporting element for the fabrication of them as well.

Microelectronics has started using these batteries as a longer life time power supply for the systems in recent years. The application of these batteries are mostly based in devices which are actually disposable or made up of micro systems to need a battery with compatibility with them.

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