

A HYBRID ELECTRONIC COMPONENT : PAPER BATTERY

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ABSTRACT

A paper Battery is a flexible, ultra-thin energy storage and production device formed by combining carbon nano tubes with a conventional sheet of cellulose-based paper. A paper battery acts as both a high-energy battery and super capacitor, combining two components that are separate in traditional electronics. This combination allows the battery to provide both long-term, steady power production and bursts of energy. Non-toxic, flexible paper batteries have the potential to power the next generation of electronics, Medical devices and hybrid vehicles, allowing for radical new designs and medical technologies. The Paper explain about the Need for paper battery, construction methods, components and applications

Keywords:- Paper Battery, nano tubes, capacitors, components, electronics, and capacitors.

INTRODUCTION

A paper battery is an ultra-thin, environmentally friendly and flexible energy storage battery made of carbon nano tubes and paper or cellulose. The functioning of paper Batteries is similar to that of a normal chemical battery. In normal cases, conventional batteries may be easily damaged by corrosion and also sometimes they required a bulky housing. But the paper batteries are non-corrosive, non-toxic and light-weight than the normal batteries.

Paper Battery= Carbon Nanotubes + Cellulose (Paper).

1. Carbon nanotubes:

Carbon is accomplished with many allotropes. Some renowned form of carbon allotropes are diamonds, graphite etc. Currently different forms of allotropes of carbon have been ascertained and researched like carbon nano tubes [1],[2]. In Carbon nanotubes, each carbon atom is amalgamating with all other three carbon atoms in order to form a nanosize cylindrical structure. The nanosize cylindrical structure along with its novel properties makes the carbon nanotube conceivably beneficial in wide range of applications in materials science, electronics, nanotechnology and optics. The carbon nanotube unveils outstanding strength along with its distinctive electrical properties also the carbon nanotube is an effective heat conductor too.

Properties of Carbon Nano tubes Used In the construction of Paper Battery:

- The Carbon Nano tubes are flexible and very light weight.
- Carbon Nano tubes offers high tensile strength.
- Carbon Nano tubes are good conductors of electricity.
- Carbon Nano tubes have high packing density and low mass density.
- Carbon Nano tubes provides low resistance.

2. Cellulose

Properties of Cellulose Used In the construction of Paper Battery:

- Cellulose is a biodegradable and bio compatible material.
- Cellulose provides low shear strength.
- Cellulose offers high tensile strength.
- Cellulose has magnificent absorption capacity and porosity.
- Cellulose is nontoxic.
- Can be easily recyclable and reusable.

NEED FOR PAPER BATTERY

The ordinary Electro-Chemical battery faces many problems like:

1. **Limited life time:** The primary batteries can't be recharged like secondary batteries. They irreversibly convert chemical energy into the electrical energy. Although the secondary batteries may be rechargeable, the life time may be very short and also they are very costlier than the primary ones. The paper battery provides a better advantage of all these problems.
2. **Environmental Influence:** The extensive use of batteries can generate environmental pollutions like toxic metal pollutions etc. But the Paper batteries are environmentally friendly and can decompose very easily without any abuse.
3. **Leakage:** If by chance any leakage of batteries occurred, the chemical released may be very dangerous to the environment and also to the nearby metals which are in contact with the batteries. But there is no toxic chemical in the paper batteries.

CHARACTERISTICS OF PAPER BATTERY

1. **First Method:** First fabricate the cathode and anode with Zinc and manganese dioxide respectively. With the help of a standard silk screen printing press, these batteries are printed on to the surface of a paper. After that this printed paper is infused with the carbon nanotubes (electrode). Now let this printed paper to dip into the electrolyte (Ionic liquid solution). [3]

- Cathode – Zinc
- Anode - Manganese dioxide
- Electrode - Carbon nanotubes
- Electrolyte - Ionic liquid solution

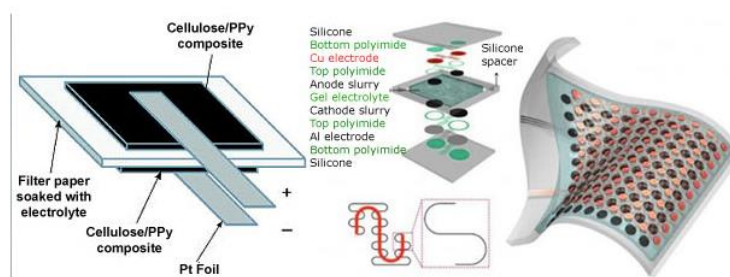


Fig 1. Structure of Paper Battery

2. **The second method:** This method is little complex than the first method. Here silicon is used as the substrate. And the nanotube grows on this substrate. Cellulose is used to fill the gaps in the matrix substrate and also to form a combination with the nanotubes. When the matrix dried, the amalgamated nanotubes and cellulose is striped off. Thus we can create paper sheets having layers of Carbon nanotubes. By combining these two sheets together, we can construct a super capacitor with an ionic solution like urine, sweat or human blood as an electrolyte.

3. **The Third Method:** This method is comparatively simple and can be fabricate in the laboratory.

- First take a rectangular shaped Xerox paper.
- Now made a coating of ionic solution in to this paper surface.
- Then spread the specially prepared carbon nanotubes ink over this ionic coated Xerox paper.
- The other side of the Xerox paper is laminated with a thin film or layer of lithium.
- Aluminum rods are used to transfer current between the 2 electrodes.

WORKING PRINCIPLE OF PAPER BATTERY

The internal performance of paper batteries is identical to that of a traditional battery by generating a voltage about 1.5V. We can recall the working principles of a traditional batteries where ions (+ ve charged particles) and electrons (- ve charged particles) moves between the electrodes, anode (+ve electrode) and cathode (-ve electrode). Due to the flow of electrons from cathode to anode, current start flowing from anode to cathode along the conductor. [1], [2]

- Cathode: Carbon Nanotube
- Anode: Lithium metal (Li+)
- Electrolyte: bio electrolytes like urine, blood and sweat. (All electrolytes can be used)
- Separator: Cellulose or Paper

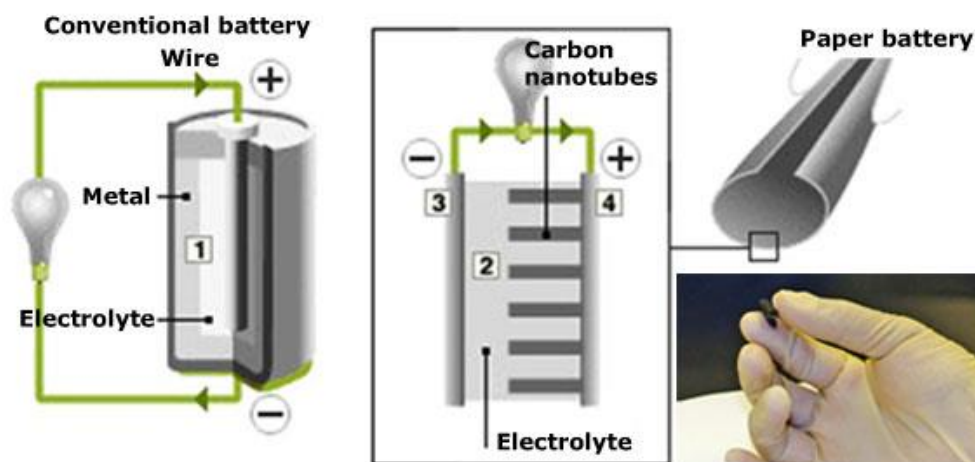


Fig 2. Working Principle of Paper Battery

Similarly in Paper Batteries, the metal (Lithium) is used as the anode and carbon nanotubes as cathode and also the paper or cellulose is used as the separator. Due to the chemical reaction between the electrolyte and carbon, electrons are generated. Similarly due to the chemical reaction between electrolyte and metal, ions are generated. These generated electrons starts flow through the external circuit from cathode to the anode.

ADVANTAGES OF PAPER BATTERY [3] [4]

- Paper battery can be used as both super capacitor and battery.
- Paper batteries are very flexible, ultrathin, nontoxic and biodegradable battery
- Long life.
- Provides a steady power.
- Can be available in different shapes and sizes.
- They offer high energy efficiency.
- Paper Batteries are low cost and can be easily disposed.
- They can be used to produce 1.5V energy and also paper batteries are rechargeable.

LIMITATIONS OF PAPER BATTERY

- The construction of carbon nano tubes used in the paper battery is very expensive. There are different techniques are used like Chemical Vapor Deposition (CVD), Arc discharge, Electrolysis, Laser Ablation etc.
- If we inhaled the paper battery, they start interacting with the Microphages present in the lungs. This is very similar to the same of Asbestos fibers, so it will be very hazardous for the health of humans.

APPLICATIONS OF PAPER BATTERY [8], [9]


Paper Battery can shows favorable for applications where size and portability is the major necessity. Most modern electronic devices like digital watches, smart cards etc. facilitate the necessity of ultra-thin batteries which are nontoxic, flexible and long lasting. The Paper battery can be rolled, twisted, folded and even cut into your desired shape and size without any drop in its efficiency. The **applications of Paper battery** are given below.[5], [6]

- Paper Battery can be now implemented in wearable technology like Google Glass, Wearable Biosensors, and Wearable computer etc. [7]
- Used in entertainment devices.
- Used in tags and smart cards.
- For medical applications like disposable medical diagnostic devices and also can be used in pacemakers due to the paper batteries nontoxic and biodegradable nature.
- Ideal for aircraft, automobiles, remote controllers etc.

CONCLUION

The paper explains about a new technology Paper Battery. It is a flexible, ultra-thin energy storage and production device formed by combining carbon nano tubes with a conventional sheet of cellulose-based paper. It also explains the need for this device and its architecture in detail. It also mentions about the working principle of Paper Batter. The later part of the paper explains advantages, limitations and applications.

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