

Paper Battery

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ABSTRACT

The Batteries form a significant part of many electronic devices. Typical electrochemical batteries or cells convert chemical energy into electrical energy. Batteries based on the charging ability are classified into primary and secondary cells. Secondary cells are widely used because of their rechargeable nature. Presently, battery takes up a huge amount of space and contributes to a large part of the device's weight. There is strong recent interest in ultrathin, flexible, safe energy storage devices to meet the various design and power needs of modern gadgets. New research suggests that carbon nanotubes may eventually provide the best hope of implementing the flexible batteries which can shrink our gadgets even more. The paper batteries could meet the energy demands of the next generation gadgets. A paper battery is a flexible, ultra-thin energy storage and production device formed by combining carbon nanotubes 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. Nontoxic, 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 various types of batteries followed by the operation principle, manufacturing and working of paper batteries are discussed in detail.

How to cite this paper: M. Srikanth | P. Yaswanth Kumar | K. Vijetha "Paper Battery" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-1, December 2019, pp.1119-1121, URL: www.ijtsrd.com/papers/ijtsrd29836.pdf



IJTSRD29836

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KEYWORDS: paper batteries, flexible, carbon nanotubes

INTRODUCTION

An electrical battery is one or more electrochemical cells that convert stored chemical energy into electrical energy. Since the invention of the first battery in 1800 by Alessandro Volta, batteries have become a common power source for many household and industrial applications. Batteries are represented symbolically as Fig. 1a Symbolic view Fig. 1b conventional battery. Electrons flow from the negative terminal towards the positive terminal.

Based on the rechargeable nature batteries are classified as

1. Non rechargeable or primary cells
2. Rechargeable or secondary cells

Based on the size they are classified as

- A. Miniature batteries
- B. Industrial batteries

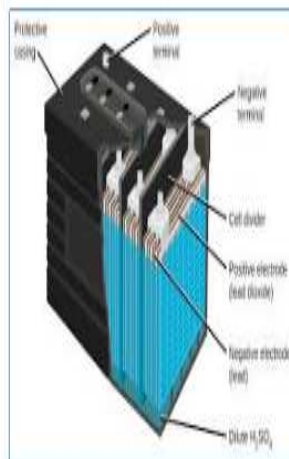
Based on nature of electrolyte

- A. Dry cell
- B. Wet cell

TYPES OF BATTERIES

Batteries are classified into two broad categories. Primary batteries irreversibly (within limits of practicality) transform chemical energy to electrical energy. When the initial supply of reactants is exhausted, energy cannot be readily restored to the battery by electrical means. Secondary batteries can be recharged. That is, they can have their chemical reactions reversed by supplying electrical energy to the cell, restoring their original composition.

Primary batteries: This can produce current immediately on assembly. Disposable batteries are intended to be used once and discarded. These are most commonly used in portable devices that have low current drain, are only used intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available. Disposable primary cells cannot be reliably recharged, since the chemical reactions are not easily reversible and active materials may not return to their original forms. Battery manufacturers recommend against attempting recharging primary cells. Common types of disposable batteries include zinc-carbon batteries alkaline batteries.



SECONDARY BATTERY



2 Pack

PRIMARY BATTERY

Secondary batteries: These batteries must be charged before use. They are usually assembled with active materials in the discharged state. Rechargeable batteries or secondary cells can be recharged by applying electric current, which reverses the chemical reactions that occur during its use. Devices to supply the appropriate current are called chargers or rechargers.

PAPER BATTERY

Energy has always been spotlighted. In the past few years a lot of inventions have been made in this particular field. The tiny nuclear batteries that can provide energy for 10 years, but they use radioactive elements and are quite expensive. Few years back some researchers from Stanford University started experiments concerning the ways in which a copier paper could be used as a battery source. After a long way of struggle they, recently, concluded that the idea was right. The batteries made from a plain copier paper could make for the future energy storage that is truly thin. The anatomy of paper battery is based on the use of Carbon Nanotubes tiny cylinders to collect electric charge. The paper is dipped in lithium containing solution. The nanotubes will act as electrodes allowing storage device to conduct electricity. It's astounding to know that all the components of a conventional battery are integrated in a single paper structure; hence the complete mechanism for a battery is minimized to a size of paper. One of the many reasons behind choosing the paper as a medium for battery is the well-designed structure of millions of interconnected fibers in it. These fibers can hold on carbon nanotubes easily. Also a paper has the capability to bent or curl. You can fold it in different shapes and forms plus it as light as feather. Output voltage is modest but it could be increased if we use a stack of papers. Hence the voltage issues can be easily controlled without difficulty. Usage of paper as a battery will ultimately lead to weight diminution of batteries many times as compared to traditional batteries. It is said that the paper battery also has the capability of releasing the energy quickly. That makes it best utilization for devices that needs burst of energy, mostly electric vehicles. Further, the medical uses are particularly attractive because they do not contain any toxic materials

FABRICATION OF PAPER BATTERY

The materials required for the preparation of paper battery area. Copier paper b. Carbon nano ink c. Oven 14 Dept. of Electronics & Communication, PESCE, Mandya Paper Battery The steps involved in the preparation of the paper battery are as follows

- Step 1 : The copier paper is taken.
- Step 2 : carbon Nano ink which is black in color is taken. Carbon nano ink is a solution of nano rods, surface adhesive agent and ionic salt solutions. Carbon nano ink is spread on one side of the paper.

Step 3 : the paper is kept inside the oven at 150C temperature. This evaporates the water content on the paper. The paper and the nano rods get attached to each other.

Step 4 : place the multi meter on the sides of the paper and we can see voltage drop is generated.

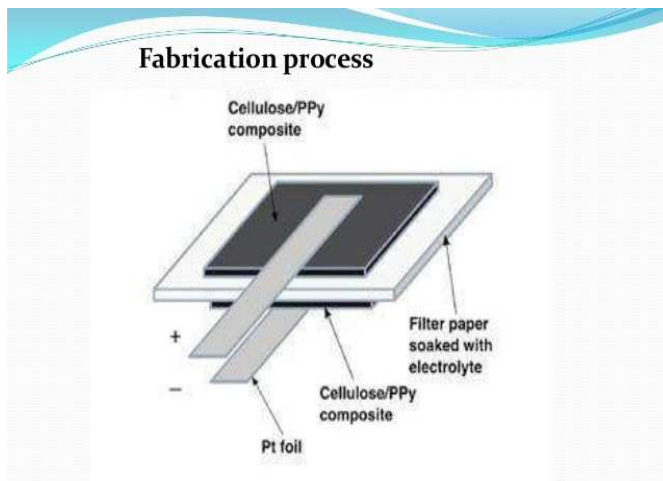
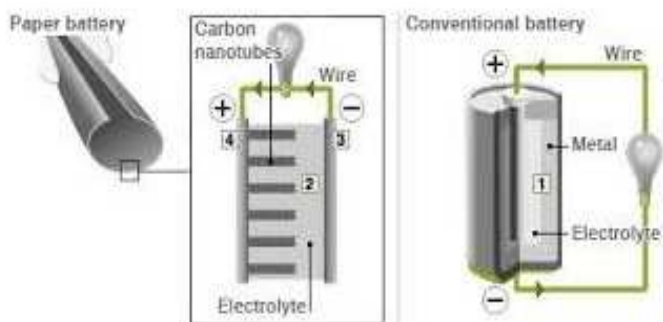


Fig Fabrication process after drying the paper becomes flexible, light weight in nature. The paper is scratched and rolled to protect the nano rods on paper.

WORKING OF PAPER BATTERY

The battery produces electricity in the same way as the conventional lithium-ion batteries that power so many of today's gadgets, but all the components have been incorporated into a lightweight, flexible sheet of paper. The devices are formed by combining cellulose with an infusion of aligned carbon nanotubes. The carbon is what gives the batteries their black color. These tiny filaments act like the electrodes found in a traditional battery, conducting electricity when the paper comes into contact with an ionic liquid solution. Ionic liquids contain no water, which means that there is nothing to freeze or evaporate in extreme environmental conditions. As a result, paper batteries can function between -75 and 150C. The paper is made conducting material by dipping in ink. The paper works as a conductive layer. Two sheets of paper kept facing inward act like parallel plates (high energy electrodes). It can store energy like a super capacitor and it can discharge bursts of energy because of large surface area of nano tubes. Fig.5 working of a paper battery Chlorine ions flow from the positive electrode to the negative one, while electrons travel through the external circuit, providing current. The paper electrode stores charge while recharging in tens of seconds because ions flow through the thin electrode quickly. In contrast, lithium batteries take 20 minutes to recharge.



WORKING OF PAPER BATTERY

ADVANTAGES OF PAPER BATTERIES

- The flexible shape allows the paper battery to be used small or irregularly-shaped electronics: One of the unique features of the paper battery is that it can be bent to any such shape or design that the user might have in mind. The battery can easily squeeze into tight crevasses and can be cut multiple times without ruining the battery's life. For example if a battery is cut in half, each piece will function, however, each piece will only contain 1/2 the amount of original power. Conversely, placing two sheets of paper battery on top of one-another will double the power.
- The paper battery may replace conventional batteries completely: By layering sheets of this paper, the battery's voltage and current can be increased that many times. Since the main components of the paper battery are carbon nanotubes and cellulose, the body structure of the battery is very thin, "paper-thin". Thus to maximize even more power, the sheets of battery paper can be stacked on top of one another to give off tremendous power. This can allow the battery to have a much higher amount of power for the same size of storage as a current battery and also be environmentally friendly at the same time.
- Supply power to an implanted pacemaker in the human body by using the electrolytes in human blood: An improvement in the techniques used in the health field can be aided by the paper battery. Experiments have taken place showing that batteries can be energized by the electrolyte emitted from one's own blood or body sweat. This can conserve the usage of battery acid and rely on an environmental friendly mechanism of fueling battery cells with the help from our bodies.
- The paper battery can be molded to take the shape of large objects, like a car door: As stated earlier, the key characteristics that make the paper battery very appealing are that it can be transformed into any shape or size, it can be cut multiple times without damaging it, and it can be fueled through various ways besides the typical harmful battery acid that is used in the current day battery

APPLICATIONS OF PAPERBATTERY

IN AUTOMOBILES:-

For light weight guided missile.

For powering electronic devices in satellite program.

In hybrid car batteries.

IN MEDICAL SCIENCE:-

Pacemakers for the heart.

In artificial tissues.

In cosmetic, drug delivery system.

IN ELECTRONICS:-

In portable devices like laptop, mobile phone, digital camera etc.

In low drain devices like calculators, wristwatch.

MEDIA AND ADVERTISING:-

The light weight and compactness of paper battery would allow the device to be easily fit into the cereal board design of a cereal box, display videos and play music

CONCLUSION

Energy crisis is one of the main issues bugging the planet now. Because for digitalization each nation wants energy and power. This problem which disturbs the developed countries perturbs the developing countries like INDIA to a greater extent. If the day will come without power then paper batteries can be the path breaking solution to the same. The paper batteries have potential adaptability to power next generation electronics due to their shining.

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