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Paper Battery the Solution for Traditional Battery

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Abstract: *Presently, battery takes up a large space and contributes to an outsized half of the device's weight. There's robust recent interest in ultrathin, flexible, safe energy storage devices to satisfy the assorted style and power desires of contemporary gadgets. New research suggests that carbon nanotubes could eventually offer the simplest hope of implementing the versatile batteries which might shrink our gadgets even additional. The paper battery may meet the energy demands of subsequent generation gadgets. A paper battery may be a versatile, ultra-thin energy storage and production device formed by combining carbon nanotubes with a traditional sheet of cellulose-based paper.*

1. Introduction

In a today's digital life, the portable electronic devices, such as mobile phones, portable camera, notebook computers, PDA etc. are becoming a popular because of their lightweight and small size. Batteries used as a portable power source have also become the focus of public concern and have been an essential element of the various portable electronic devices.

Although actual basic problem with traditional batteries such as carbon-zinc batteries, alkaline batteries and secondary batteries, are allegedly environment benign, they in fact largely contain substantial amount of mercury and other heavy metals and also the price of the manufacturing process increasing daily. The paper batteries may meet the energy demands of this next digital generation gadgets. A paper battery may be a versatile, ultra-thin energy storage and production device formed by combining carbon nanotubes with a standard sheet of cellulose-based paper.

The Paper batteries will replace the conventional batteries and Li-ion batteries. Anatomy of paper battery is based on the use of a Carbon Nano-tubes tiny cylinders to collect electric charge.

A paper battery is Associate in nursing ultra-thin, environmentally friendly and versatile energy galvanic battery made from carbon Nano tubes and paper or polysaccharide. The paper battery is performed as a brilliant electrical condenser and

additionally it is used as a high energy battery. The paper battery is additionally referred to as Nano Composite Paper since it's created from Carbon Nano tubes and paper.

2. The Need

The ordinary Electro-Chemical batteries problems are:

2.1 Limited Life Time. The primary batteries irreversibly (within limits of practically) transform energy to electrical energy. Secondary batteries will be recharged; that's they can have their chemical reactions reversed by supplying electricity to the cell, restoring their original composition. But, reversible batteries square measure still costlier than primary batteries within the markets of developing countries like Asian country.

2.2. Leakage. If leakage happens accidentally the chemicals discharged is also dangerous. For example, disposable batteries typically use zinc "can" as each a chemical and because the instrumentality to carry the other reagents. If this sort of battery is run all the way down, or if it's recharged when running down too far, the reagents will emerge through the cardboard and plastic that forms the rest of the container. The active chemical outflow will then damage the instrumentation the batteries were inserted into.

2.3. Environmental Concerns. The widespread use of batteries has created several environmental concerns, like cyanogenic metal pollution. Metals such as Cadmium, Mercury, Lead, Lithium and zinc have been known as extremely dangerous metals. Also, batteries may be harmful or fatal if handled by young children. Whereas within the digestive tract the battery's electrical discharge can burn the tissues and can be serious enough to lead to death.



Figure. 1. Leakage of Electrochemical Battery

3. Paper Battery

In August 2007 at Rensselaer Polytechnic Institute, a research team conducted by Dr. Robert Linhardt, Dr. Omkaram Nalamasu and Dr. Pulickel Ajayan, developed the Paper battery. In December 2009 at Stanford University, Lolo cui and his analysis team with success unreal the first operating example that gives one. 5V as its terminal voltage.

3.1. What is a Paper Battery?

A Paper Battery is an ultra-thin and environmentally friendly and versatile energy voltaic battery made of Carbon Nano Tubes and paper or polysaccharide. The functioning of paper batteries is comparable to it of traditional chemical battery. In traditional cases, typical batteries could simply break by corrosion and also generally they needed a large housing. However, the paper batteries square measure non-corrosive, non-toxic and lightweight than the conventional batteries.

The Paper batteries could also be fold, cut or otherwise formed for various applications with none loss of integrity or potency. Cutting one in halves its energy production. Stacking them multiplies power output. Early prototypes of the device are able to manufacture a pair of 5V of electricity from a sample of scale of postage.

Paper Battery = Paper (Cellulose) + Carbon Nanotubes.

The devices area unit shaped by combining cellulose with associate infusion of aligned carbon nanotubes that area unit every some one million of a centimeter thick. The carbon is what offers the batteries their black color. These small filaments act just like the conductor's found during a traditional battery, conducting electricity once the paper comes into contact with an Ionic liquid solution. Ionic liquids contain no water, which implies that there's nothing to freeze or evaporate in extreme

environmental conditions. As a result, paper batteries will operate between -75°C and 150°C

The specialized paper batteries may act as power sources for any range of devices implanted in humans and animals, including a RFID tags, cosmetics, drug-delivery systems and pacemakers. An electrical device introduced into associate organism may be implanted totally dry so be gradually exposed to bodily fluids over time to get voltage. Paper batteries are also biodegradable, a need only partially addressed by current re-cycling and other electronics disposal methods increasingly advocated for by the green computing movement.

3.2. Properties of a Paper Battery

The Properties of Paper Batteries are mainly attributed to the properties of its parts such as cellulose and carbon nanotubes.

3.2.1. Properties of Cellulose

- High Tensile strength; Low Shear Strength.
- Biodegradable.
- Biocompatible.
- Excellent Porosity and Absorption Capacity.
- Easily Reusable and Recyclable
- Non-Toxic.

3.2.2 Properties of Carbon Nanotubes

- High tensile Strength (Greater than Steel)
- Low Mass density and High Packing Density.
- Very Light and Very Flexible.
- Low resistance.
- Does not contain Heavy Metals (such as Hg, Pb, Cd, etc.).
- No safety limitations for shipment, packaging storage and disposal.

Carbon is accomplished with several allotropes. Some known variety of carbon allotropes are diamonds, Graphite etc. presently completely different sorts of allotropes of carbon are determined and researched like Carbon Nanotubes. In carbon Nanotubes, every atom is amalgamating with all alternative three carbon atoms so as to create a Nano size cylindrical structure. The Nano size cylindrical structure beside its novel properties makes the nanotube conceivably helpful in wide selection of applications in materials science, physical science, technology and optics. The nanotube unveils outstanding strength beside its distinctive electrical properties additionally the nanotube is a good heat conductor too. Figure. 2. Shows the structure of a Carbon Nanotubes.

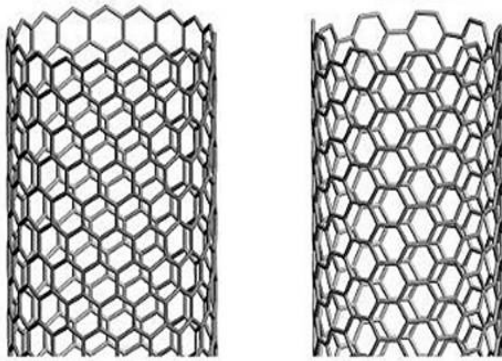


Figure 2. Carbon Nanotubes

4. Construction of a Paper Battery

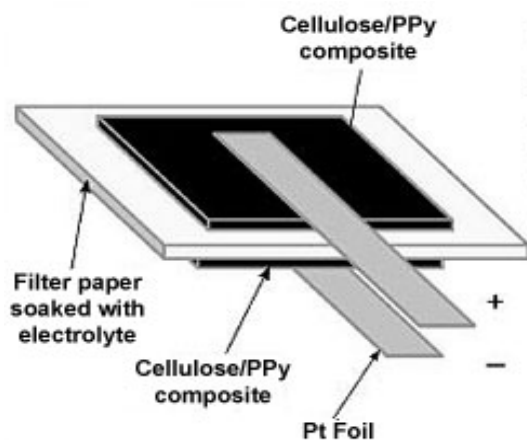


Figure 3. Paper Battery Contain

A paper battery construction involves the following components:

- Cathode: Carbon Nanotube(CNT)
- Anode: Lithium Metal (Li+)
- Electrolyte: All electrolytes (including bio Electrolytes like sweat, blood and urine).
- Separator: Paper (Cellulose)

Construction of a paper battery mainly includes these steps:

Step 1: Black carbon ink is applied on a cellulose-based paper.

Step 2: Black Carbon ink is being spread on a paper spread on the paper.

Step 3: A thin lithium film is laminated over the exposed cellulose surface.

Step 4: The cellulose paper is heated at 80°C for 5 minutes.

Step 5: Next, the film is peeled off from the substrate.

Step 6: The film acts as electrodes of the paper battery. One film is connected to the electrolyte LTO (Li₄Ti₅O₁₂) and another film is pasted to the electrolyte LCO (LiCoO₂).

Step 7: Next, connect a LED on both the ends of the battery and check its functionality.

5. Working of a Paper Battery

A conventional battery or Rechargeable contains variety of separate parts that produce electrons through a reaction between the metal and also the electrolyte of the battery. The Paper battery works once the paper is dipped within the ion-based liquid solution; next a reaction happens between the electrodes and liquid. The electrons move from the cathode to anode to generate electricity. The paper conductor stores energy whereas recharging within ten seconds as a result of the ions flow through the thin conductor quickly. The most effective methodology to extend the output of the battery is to stack totally different paper batteries one over the opposite.

6. Advantages of Paper battery over Existing Batteries

6.1. Biodegradable and Non Toxic: Since its major ingredients are of organic origin, it is a biodegradable and Non Toxic product.

6.2. Biocompatible: They are not easily rejected by our body's immune system if implanted into human body.

6.3. Easily reusable and Recyclable: Being cellulose based product it is easily recyclable and reusable, even with the existing paper recycling techniques.

6.4. Durable: It has a shelf life of three years.

6.5. Rechargeable: It can be recharged up to 300 times using almost all electrolytes, including bio-salts such as sweat, urine and blood.

6.6. Very Light Weight and Flexible.

6.7. Easily moldable into Desired Shapes and Sizes.

7. Limitations of Paper Battery

7.1. Have a Low Shear strength: They can be 'torn' easily.

7.2. The Techniques and the Set-ups used in the production of Carbon Nanotubes are very Expensive and Very less efficient.

7.3. If we inhaled, their interaction with the Microphages present in the lungs is similar to that with asbestos fibers, hence may be seriously hazardous to human health.

7.4. These Batteries generates a E-wastage.

8. Applications of Paper Batteries

With the developing technologies and reduction in the cost of cathode nanotubes, these batteries find applications in the following fields:

8.1. In Electronics: In portable computer batteries, mobile phones, handheld digital cameras; the load of those devices can be considerably reduced by replacing the alkaline batteries, while not compromising, the electrical hazards associated with recharging are going to be greatly reduced.



Figure. 4. Applications of Paper battery

8.2. In a Medical Sciences. This work was supported in part by a grant from the National Science Foundation. Paper batteries are unit utilized in medical field like for creating pacemakers for the heart, artificial tissues, Drug Delivery Systems, Cosmetics and in Bio Sensors.

8.3. In Auto-mobiles and Aircraft. Paper batteries area unit utilized in vehicles and craft like in light weight, radio-controlled missiles, hybrid automobile batteries, long air flights and in satellite programs for powering electronic devices.

9. Conclusion

One of the main issues bugging the planet now could be Energy crisis. Each nation wants energy and everyone wants power. And this problem that disturbs the developed countries perturbs the

developing countries like India to a much bigger extent. Standing at a point within the present where there can't be a day without power, paper batteries will provide an altogether path-breaking resolution to the same. Being biodegradable, Light weight and Non-Toxic, Flexible paper batteries have potential adaptability to power consequent generation of electronics, Medical devices and hybrid vehicles, allowing for radical new styles and medical technologies. However, India still has a long thanks to go if it's to be self-dependent for its energy resolution. Literature reflects that Indian researchers have gotten the scientific astuteness required for such revolutionary work.

10. Acknowledgement

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