

A

Seminar report

on

Paper Battery

Submitted in partial fulfillment of the requirement for the award of degree
of Electronics

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Preface

I have made this report file on the topic **Paper Battery** , I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude towho assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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Introduction

The continuously advancing technology of portable electronic devices requires more flexible batteries to power them. Batteries power a wide range of electronic devices including phones, laptop computers and medical devices such as cardiac pacemakers and defibrillators. With the ever increasing demand for efficiency and design, there is a need for ultrathin, safe and flexible energy storage options. 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 supercapacitor, combining two components that are separate in traditional electronics.

This combination allows the battery to provide long term, steady power production and bursts of energy. Through the use of super capacitors, batteries can be made that will deliver renewable energy from bodily fluids such as blood or sweat. This technology can be greatly utilized by medical devices. It combines two essential materials, cellulose and carbon nanotubes (CNTs), that fit the characteristics of spacer and electrode and provide inherent flexibility as well as porosity to the system. Cellulose, the main constituent of paper and an inexpensive insulating separator structure with excellent biocompatibility, can be made with adjustable porosity. CNTs, a structure with extreme flexibility, have already been widely used as electrodes in electrochemical devices.

By proper integration the output power of paper batteries can be adapted to required level of voltage–current. This cellulose based spacer is compatible with many possible electrolytes. Researchers used ionic liquid, essentially a liquid salt, as the battery’s electrolyte, as well as naturally occurring electrolytes such as human sweat, blood and urine.

Due to the flexible nature of the cellulose and nanotubes, this power source can be easily modified or placed in the body or various medical devices. The need for surgery to replace batteries on internal medical devices would be nonexistent. This is because super capacitor does not show a loss in power dissipation over time like normal chemical batteries do. Patients with implanted medical devices will also benefit from the flexibility because previous devices may cause discomfort for person due to a larger solid power source.

As this technology is adapted it will prove to be extremely useful and could even save not only cost but lives also.

History of Paper Batteries

The creation of this unique nanocomposite paper drew from a diverse pool of disciplines, requiring expertise in materials science, energy storage and chemistry. In August 2007, a research team at Rensselaer Polytechnic Institute (led by Drs. Robert Linhardt, the Ann and John H. Broadbent Senior Constellation Professor of Biocatalysis and Metabolic Engineering at Rensselaer; Pulickel M. Ajayan, professor of materials science and engineering; and Omkaram Nalamasu, professor of chemistry with a joint appointment in materials science and engineering) developed the paper battery.

Senior research specialist Victor Pushparaj, along with postdoctoral research associates Shajumon M. Manikoth, Ashavani Kumar and Saravanababu Murugesan, were co-authors and lead researchers of the project. Other co-authors include research associate Lijie Ci and Rensselaer Nanotechnology Center Laboratory Manager Robert Vajtai.

What is Battery

Battery or voltaic cell is a combination of many electrochemical Galvanic cells of identical type to store chemical energy and to deliver higher voltage or higher current than with single cells.

The battery cells create a voltage difference between the terminals of each cell and hence to its combination in battery. When an external electrical circuit is connected to the battery, then the battery drives electrons through the circuit and electrical work is done. Since the invention of the first Voltaic pile in 1800 by Alessandro Volta, the battery has become a common power source for many household and industrial applications, and is now a multi-billion dollar industry.



Definition of Paper battery

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 supercapacitor, 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.

Paper batteries may be folded, cut or otherwise shaped for different applications without any loss of integrity or efficiency. Cutting one in half halves its energy production. Stacking them multiplies power output. Early prototypes of the device are able to produce 2.5 volts of electricity from a sample the size of a postage stamp

APPLICATIONS

With the developing technologies and reducing cost of CNTs, the paper batteries will find applications in the following fields:

In Electronics:

- in laptop batteries, mobile phones, handheld digital cameras: The weight of these devices can be significantly reduced by replacing the alkaline batteries with light-weight Paper Batteries, without compromising with the power requirement. Moreover, the electrical hazards related to recharging will be greatly reduced.
- in calculators, wrist watch and other low drain devices.
- in wireless communication devices like speakers, mouse, keyboard, Bluetooth headsets etc.
- in Enhanced Printed Circuit Board(PCB) wherein both the sides of the PCB can be used: one for the circuit and the other side (containing the components) would contain a layer of customized Paper Battery. This would eliminate heavy step-down transformers and the need of separate power supply unit for most electronic circuits.

In Medical Sciences:

- in Pacemakers for the heart
- in Artificial tissues (using Carbon nanotubes)
- in Cosmetics, Drug-delivery systems
- in Biosensors, such as Glucose meters, Sugar meters, etc.

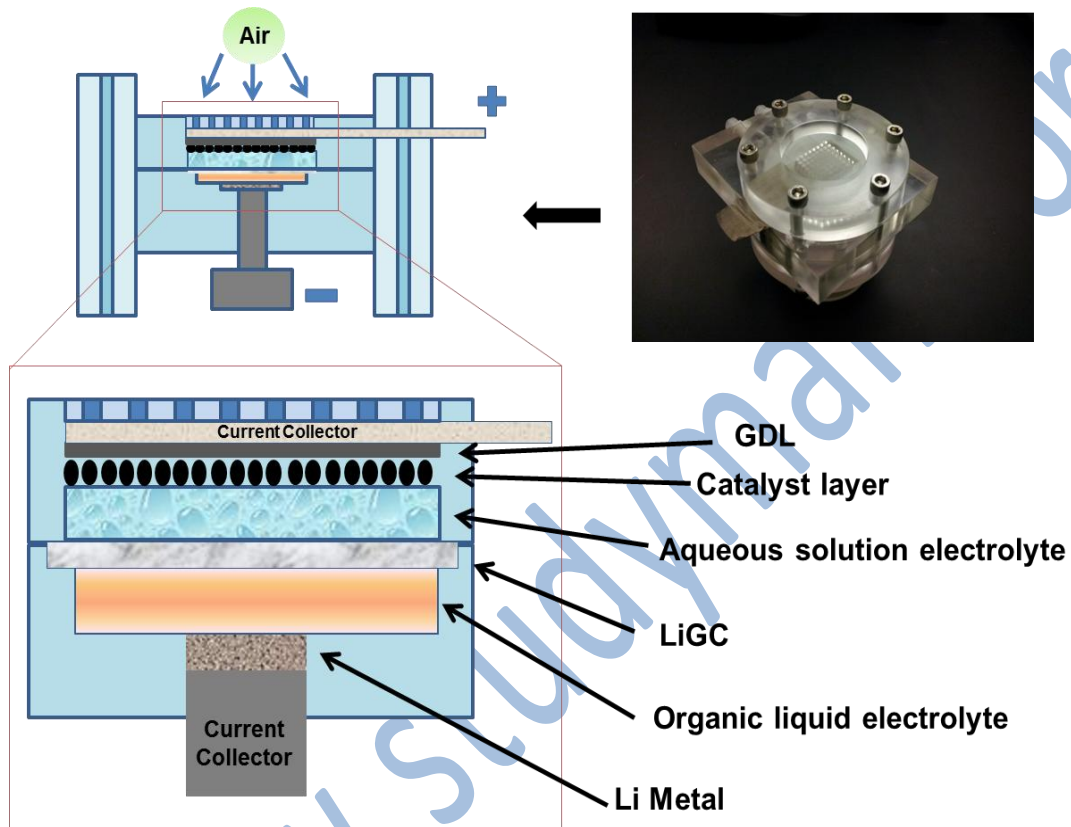
In Automobiles and Aircrafts:

- in Hybrid Car batteries
- in Long Air Flights reducing Refueling
- for Light weight guided missiles
- for powering electronic devices in Satellite programs

Use of paper battery

- While a conventional battery contains a number of separate components, the paper battery integrates all of the battery components in a single structure, making it more energy efficient.
- A paper battery is a battery engineered to use a paper-thin sheet of cellulose infused with aligned carbon nanotubes. nanotubes act as electrodes; allowing the storage devices to conduct electricity.
- Functions as both a lithium-ion battery and a super capacitor, can provide a long, steady power output comparable to a conventional battery, as well as a supercapacitor's quick burst of high energy.
- Integrates all of the battery components in a single structure, making it more energy efficient.
- Paper battery extreme flexibility; the sheets can be rolled, twisted, folded, or cut into numerous shapes with no loss of integrity or efficiency, or stacked, like printer paper (or a Voltaic pile), to boost total output.
- Can be made in a variety of sizes, from postage stamp to broadsheet.
- The paper-like quality of the battery combined with the structure of the nanotubes embedded within gives them their light weight and low cost, making them attractive for portable electronics, aircraft, automobiles, and toys .
- Ability to use electrolytes in blood make them potentially useful for medical devices such as pacemakers & do not contain any toxic materials and can be biodegradable; a major drawback of chemical cells .

Structure of Paper Battery



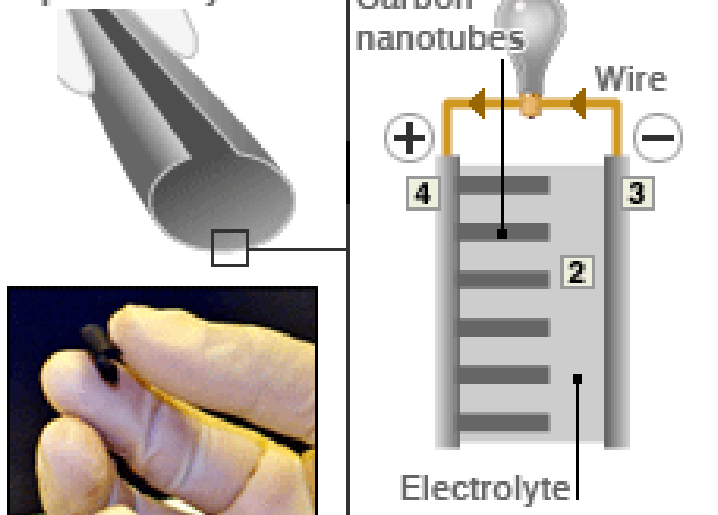
Construction of paper batteries

1. A zinc and manganese dioxide based cathode and anode are fabricated from proprietary links.
2. Standard silkscreen printing presses are used to print the batteries onto paper and other substrates.
3. Power Paper batteries are integrated into production and assembly processes of thin electronic devices.
4. The paper is infused with aligned carbon nano tubes, which gives the device its black color.
5. The tiny carbon filaments or nano tubes substitute for the electrode used in conventional battery.
6. Use an ionic liquid solution as an electrolyte- the two components which conduct electricity.
7. They use the cellulose or paper as a separator- the third essential component of battery.

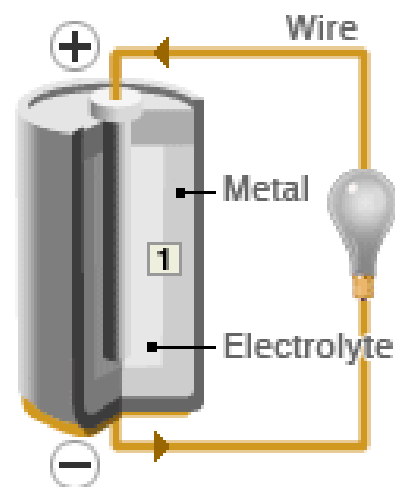
Working of paper batteries

1. The nano tubes acting as electrodes allow the storage device to conduct electricity.
2. Chemical reaction in battery is occurs between electrolyte and carbon nano tubes.
3. Battery produce electrons through a chemical reaction between electrolyte and metal in the traditional battery.
4. Electrons must flow from the negative to the positive terminal for the chemical reaction to continue. Ionic liquid, essentially a liquid salt, is used as the battery electrolyte.
5. The organic radical materials inside the battery are in an “electrolyte-permeated gel state”, which is about halfway between a solid and a liquid. This helps ions to smooth move, reducing resistance, allowing the batteries to charge faster.
6. We can stack one sheet on top of another to boost the power output. It’s a single, integrated device. The components are molecularly attached to each other: the carbon nano tube print is embedded in the paper and the electrolyte is soaked in to the paper.

Paper battery



Conventional battery



Needs and Limitations of paper batteries

Limitations

1. Paper batteries have low strength they can be 'torn' easily.
2. The techniques and the set-ups used in the production of Carbon Nano tubes are very expensive and very less efficient.
3. When inhaled, their interaction with the macrophages present in the lungs is similar to that with asbestos fibers. Hence may be seriously hazardous to human health.

Needs

Limited Life Time:

Primary batteries 'irreversibly' transform chemical energy to electrical energy. Secondary batteries can be recharged but they have very short life time, paper batteries overcome both problems.

Leakage:

In case of leakage the chemicals release may be dangerous but no such toxic chemicals are used in paper batteries.

Environmental Concerns:

The wide spread use of batteries has created many environmental concerns, such as toxic metal pollution e.t.c while paper batteries can be easily decomposed without any harm.

Advantages and Disadvantages

Advantages

- Used as both battery and capacitor.
- It is flexible.
- It is ultra thin energy storage device.
- Long lasting.
- Non toxic.
- Steady power production.
- Shaped for different applications.
- High efficiency.
- Available in different sizes.
- Energy efficient.
- It is light weight.
- It is more economical.
- Can be easily disposed.
- Can be recharged.
- Generates close to 1.5 Volts of energy.

Disadvantages

- Prone to tearing.
- Nanotubes made from carbon are expensive due to use of procedures like electrolysis and laser ablation.
- Should not be inhaled, as they can damage lungs.

Future Scope

It holds great potential to advance capabilities in portable power design for applications ranging from bioinstrumentation to consumer electronics and even large power systems served by conventional batteries.

The paper like qualities of the material make it especially attractive for energy storage in medically implanted devices (for example, a pacemaker, insulin pump or the implantable radio chip).

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Conclusion

A paper battery is a paper like device formed by the combination of carbon nanotubes and a conventional sheet of cellulose-based paper which act as a flexible ultra-thin energy storage and energy production device. In addition to using the aqueous and RTIL (Room Temperature Ionic liquids) electrolytes, the device operates with a suite of electrolytes based on bodily fluids. It suggests the possibility of the device being useful as a dry-body implant or for use under special circumstances.

As a precedent, a urine-activated battery was recently demonstrated for bio-MEMS device applications. Body sweat, composed of water, Na, Cl and K ions, used as electrolyte (a drop of sweat placed on the film gets sucked into the porous cellulose) in the RTIL-free nanocomposite affords good capacitive behavior for the device (specific capacitance of 12 F/g, operating voltage of 2.4V). Blood (human whole blood in K2 EDTA from Innovative Research, Southfield, MI) worked even better as an electrolyte, enhancing the capacitive behavior of the supercapacitor, resulting in a specific capacitance of 18 F/g. As this technology is adapted it will prove to be extremely useful and could even save not only cost but lives also.

Reference

- www.studymafia.org
- www.google.com
- www.wikipedia.com

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