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PAPER BASED LITHIUM-ION BATTERIES

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ABSTRACT—

As devices get smaller and thinner every day, the electronics industry's largest issue right now is battery size. But eventually, the weight and size of the battery become a barrier. Give the best solution to go beyond this "Paper Battery." In actuality, the paper battery is a conducting paper with a significant amount of electricity within. The different issues that widely used batteries encounter and how the paper battery can help with all of them. This paper explains the building of a paper battery in detail. This research also presents a comparative study between SWCNT and MWCNT.

This report also includes potential applications that have the potential to alter our lives. This study discusses the safety concerns associated with Li-ion batteries, the limitations of NiCad and NiMH batteries, and the disadvantages of lead acid batteries. Also discussed is the benefit of paper batteries over these batteries.

Keywords: GEO, LEO, MEO, gateway stations, user terminals, latency, digital divide, satellite internet access, and distant connectivity.

Introduction :

The most popular power source for portable gadgets is lithium-ion batteries (LIBs), which show great potential as power and storage systems in bigger systems such as hybrid electric vehicles and renewable energy plants (Goodenough et al., 2013). While improving performance with newly optimized materials is crucial for a wider diffusion of LIBS, the creation of readily up-scalable and recyclable devices, as well as lowering production costs, are the primary objectives. These cells' mechanical qualities can be improved by adding flexible electrodes, which will make it possible for them to be integrated into a variety of functional systems in a broad spectrum of cutting-edge products including smart cards, displays, and implantable medical equipment. Furthermore, an attempt needs to be made to decrease the quantity of LIBs in order to minimize their cost and environmental impact. quantity of inactive components in the cell, to replace expensive ingredients with less expensive and ecologically friendly alternatives, such as organic solvents and synthetic polymer binders/separators, and to create new environmentally friendly procedures for the production of cell components. Electronic devices that are smaller and thinner are in greater demand. The "paper battery" provides the best answer to meet those requirements. In reality, paper batteries are made of "paper" made of cellulose with carbon nanotubes (CNT) coated on both sides. These papers can be stacked to create a paper battery. Instead of CNT, some batteries use silver nanowires. It is incredibly light, flexible, thin, and has a large capacity to store energy in a little area. Li-ion-based compounds are combined with paper in a recently created paper battery.

Fig.1: Paper Li-ion batteries.

After a longer period of cycling at room temperature, the system constructed in a pouch type cell exhibits remarkably stable cycling properties. We believe that the production of affordable and environmentally friendly Li-ion cells made entirely of paper could be essential for the development of the next generation of auxiliary power generators, which could be used, for example, in solar and hybrid vehicles of the future.

SPECIFICATION OF PAPER BATTERIES

Paper batteries mix CNT with cellulose-based paper. Depending on its design, the paper can function as a super capacitor or a high-energy paper battery. A complex organic material called cellulose is present in pulp and paper. The primary components of paper batteries are CNTs. Iijima, a Japanese scientist, made the discovery of CNTs in 1991. They are currently regarded as superior subjects in both industry and academic settings. Carbon nanotubes (CNTs) are allotropes of carbon composed of graphite, shaped like cylindrical tubes with a diameter of nanometers and a length of several millimeters. Only carbon atoms organized in a sequence of condensed benzene rings coiled up into a tubular form make up carbon nanotubes (CNTs). This new synthetic nanomaterial is a member of the fullerene family, which is the third allotropic form of carbon after diamond and graphite, which are the natural sp2 (planar) and sp3 (cubic) forms of carbon, respectively. Single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs) are the two varieties of carbon nanotubes (CNTs) based on the number of layers in their architectures.

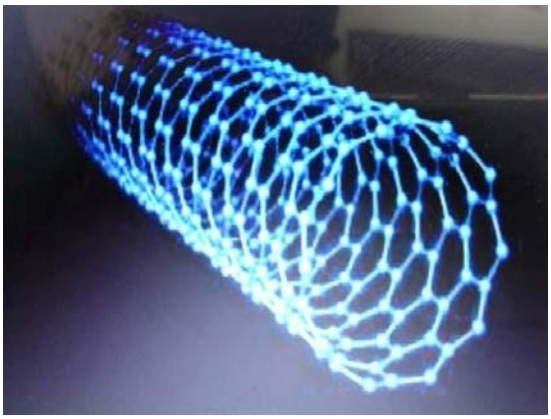

Fig.2.Single Walled

Three methods are used to produce MWCNTs: Arc-Discharge (which involves vaporizing two carbon rods in an arc), Laser Ablation (which uses graphite), and Chemical Vapour Deposition (which uses hydrocarbon sources such as CO, methane, ethylene, and acetylene). Following preparation, CNTs are purified using air oxidation, surfactant-assisted sonication, or acid refluxing to get rid of contaminants such fullerenes, amorphous carbon, and transition metals that were added as catalysts during the synthesis. Nowadays, a large number of chemical companies globally create and sell pristine CNTs.

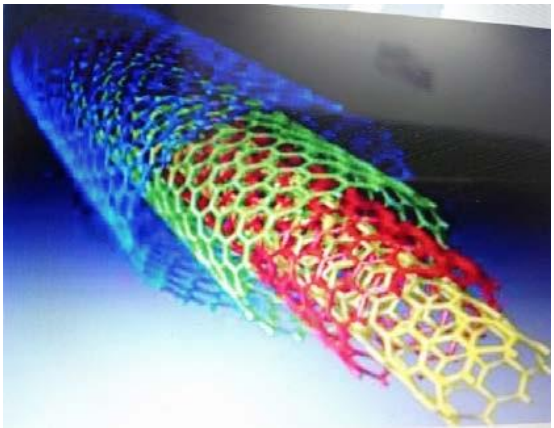

Fig. 3.1:Multi Walled

WORKING PRINCIPAL

The mechanism of operation of paper-based lithium-ion batteries is the same as that of conventional lithium-ion batteries; however, the electrodes are deposited onto cellulose-based paper. A cathode, anode, and electrolyte are among the layers that make up these batteries; they are all integrated into or placed on top of the paper substrate. Typically, the anode is made of materials like graphite or lithium titanate, whereas the cathode is made of compounds based on lithium, like lithium cobalt oxide. Ions can move between the cathode and anode thanks to the separator, which keeps the two electrodes from coming into contact electrically. Lithium ions are moved more easily between the electrodes during charging and discharging cycles because to the electrolyte. Lithium ions go from the cathode via the electrolyte and become embedded in the anode when the battery is charged.substance. Lithium ions, on the other hand, move from the anode to the cathode during discharge, releasing energy that can power electronics. Paper is a flexible, lightweight, and potentially biodegradable substrate. As a result, paper-based lithium-ion batteries hold great promise for usage in wearable electronics, biomedical devices, and portable electronics. For over 20 years, Li-ion batteries have been available for purchase. Based on the

existing battery chemistry, the technology is regarded as reasonably developed. Li-ion batteries are beginning to be utilized more frequently in electric vehicles after being the primary power source for portable electronics like laptops and cell phones. Li-ion batteries will also be taken into consideration for the storage of sustainable energy produced by renewable sources in sustainable energy grids. The growing need for
More advancements in current Li-ion battery technology are needed for energy storage, and the creation of next-generation Li-ion batteries is especially necessary to bring down Li-ion battery costs. Creating a new battery chemistry to take the place of the current Li-ion battery technology is still extremely difficult.

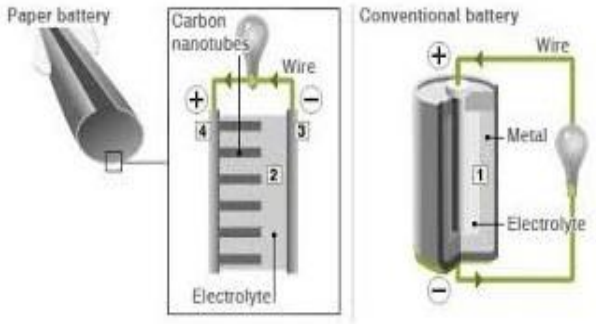

Figure 4.1: working of paper battery

advantages of paper battery

When compared to conventional lithium-ion batteries, paper-based lithium-ion batteries have the following benefits:

1. Flexibility: Because paper substrates are naturally flexible, it is possible to create bendable and flexible batteries. Because of their adaptability, they can be used in flexible screens, wearable electronics, and other flexible technologies.

2. ***Lightweight:*** Compared to conventional battery materials like metal casings, paper is lighter. This weight reduction can add up, particularly in industries like aerospace or portable electronics where weight is an important consideration.

3. ***Environmentally friendly***: Compared to conventional batteries built from non-renewable materials like metals and plastics, paper-based batteries are more environmentally friendly because paper is a renewable and biodegradable material. Furthermore, the manufacture of batteries uses fewer components derived from plastic when paper substrates are used.

4. ***Improved safety***: When it comes to safety, paper-based batteries might be superior to conventional batteries. The potential of paper substrates to stifle thermal runaway processes has been investigated. This can improve the safety of lithium-ion batteries, especially in applications where safety is of utmost importance, like electric automobiles.

5. ***Customizable designs*****:** Paper-based batteries are versatile and simple to modify into many sizes and shapes, making them suitable for integration into a broad range of gadgets and uses. Because of their adaptability, they can be used in items with unusual form factors or certain sizes.

application of paper battery

1. ***Wearable Electronics***: Paper-based batteries are lightweight and flexible, making them ideal for integration into wearable electronics such as smartwatches, fitness trackers, and health monitoring devices.
2. ***Bridging the digital divide:*** Remote areas can get high-speed internet access through airborne networks.
3. ***Flexible Displays***: Flexible displays, including e-paper displays and OLED screens, require power sources that can also flex and bend
4. .***Disaster response:*** Rapidly deployed airborne internet provides critical communication after emergencies.
5. ***Smart Packaging***: Paper-based batteries can be incorporated into smart packaging solutions to power sensors, RFID tags, and other electronic components embedded within packaging materials.
6. ***IoT Devices*****:** The Internet of Things (IoT) relies on small, low-power devices that can be deployed in various environments for monitoring and data collection
7. ***Educational Kits*****:** Paper-based lithium-ion batteries can be used in educational kits and DIY electronics projects to teach students about battery technology, renewable energy, and sustainable materials.
8. ***Portable Electronics***: While traditional lithium-ion batteries are already widely used in portable electronics such as smartphones, tablets, and laptops, paper-based batteries offer a potentially lighter and more environmentally friendly alternative.

Conclusion

To sum up, paper-based lithium-ion batteries are a promising invention with a wide range of benefits and possible uses in different industries. These batteries provide safety, flexibility, affordability, lightweight, environmental friendliness, and customized designs. Wearable electronics, flexible displays, smart packaging, medical equipment, Internet of Things (IoT) gadgets, instructional kits, disaster relief systems, and other products can all incorporate them.Paper-based lithium-ion batteries have a wide range of applications in the future; current research is concentrated on enhancing their scalability, performance, and compatibility with other electronic components. It is anticipated that developments in materials science, manufacturing processes, and battery design will spur additional innovation in this area.

All things considered, paper-based lithium-ion batteries have the potential to completely transform the energy storage industry and pave the way for the creation of lighter, more flexible, and ecologically friendly next-generation electronics. Paper-based batteries have the potential to have a big impact on the future of electronics, healthcare, environmental monitoring, space exploration, and more with sustained study and development.We may conclude from the examination of the paper battery that CNT makes up the majority of its composition. The inefficiency of the CNT manufacturing processes clearly drives up costs, making the paper battery pricey. Batteries have the potential to completely transform the electronics sector if their cost is kept low.

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