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A STUDY OF LI-ION BATTERIES AS AN APPLICATION IN ELECTRIC VEHICLE

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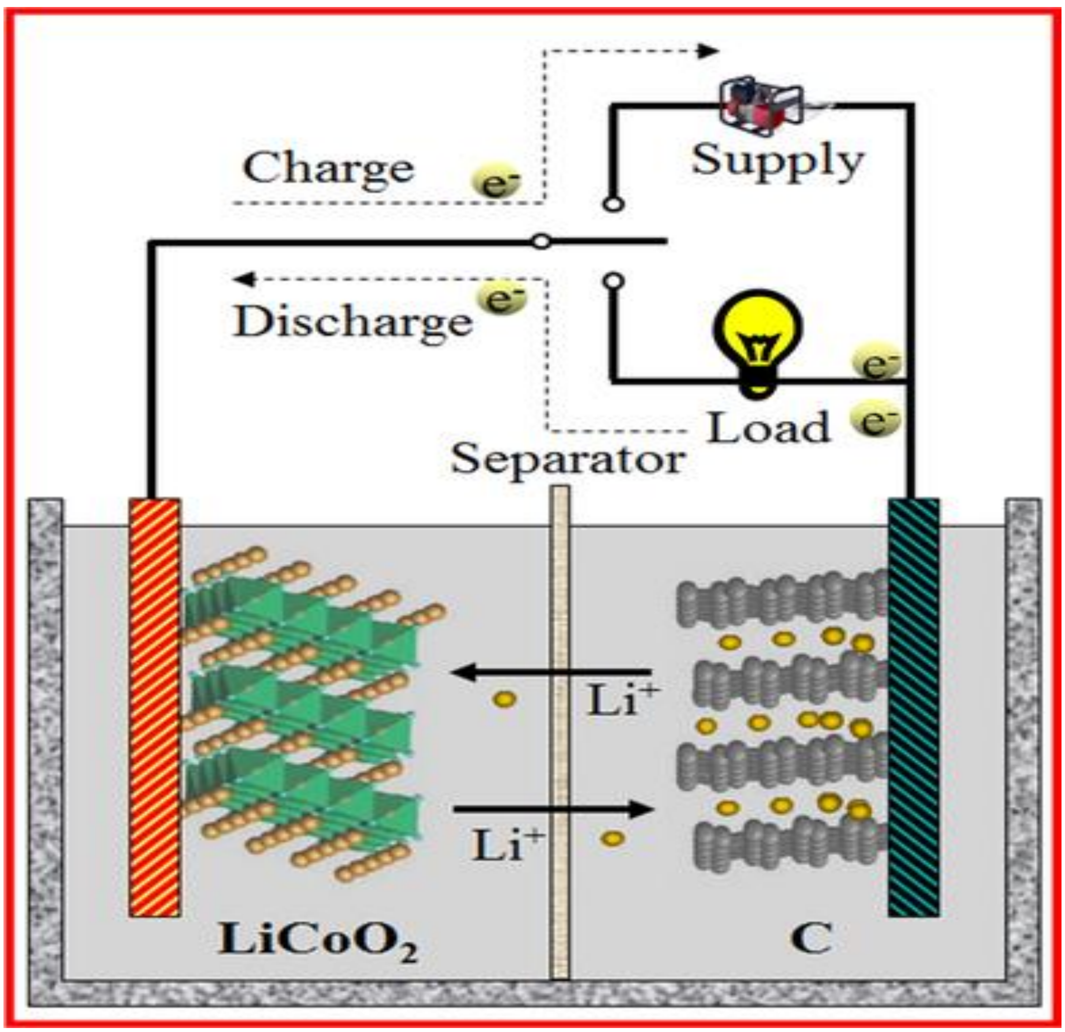
ABSTRACT

Lion Battery (Lithium-Oxygen or Lithium-Air) are the powerhouse for the digital electronic revolution in this modern mobile society that have gained significant attention in recent years due to its high energy density, longer lifespan, and improved safety compared to traditional methods of power generation. Lithium-ion batteries have become the focus of research interest especially for advancement and enhancement of application in the field of electric vehicles (EVs). This review paper provides an in-depth analysis of Lion Battery technology, basic concepts, including its working principles, current advancements, recent progress, challenges, and future directions especially in the field of Electric vehicles (EVs).

Keywords :-Power generation, . Lithium-ion batteries, electric vehicles.

[1] INTRODUCTION

The sources of sustainable energy fluctuate during the day and hence, the use of sustainable energy for electricity production requires the availability of suitable technology for energy storage, namely, batteries. Other modes of energy like petrol and diesel harms the environment and are reducing day by day which can be replaced by batteries with high power storing capacity and with advanced safety. Compared with other commonly rechargeable batteries like Ni-Cd and Lead-acid battery, the lithium-ion battery is featured by high energy and power density along with long service life. With the increasing demand for extended driving range and improved battery efficiency in EVs, Lion Batteries have garnered significant attention from researchers, manufacturers, and policymakers. However, the energy density limitations of lithium-ion batteries pose challenges in achieving long-range capabilities for EVs. Lion Batteries, on the other hand, utilize oxygen from the atmosphere as the cathode material, potentially offering much higher energy densities. This key difference makes Lion Batteries a compelling alternative to conventional lithium-ion batteries in the context of electric vehicles, as they have the potential to significantly enhance EV range, reduce weight, and improve overall efficiency. Lithium-ion batteries must be operated in a safe and reliable operating area, which is affected by the charge rate, temperature and voltage range[4]. Exceeding these ranges will lead to rapid attenuation of battery performance and even result in safety problems. In addition, to ensure the reliable operation of lithium-ion batteries, it is important to evaluate the lithium-ion battery capacity and predict the RUL (Remaining useful life) over the entire service life. If the Li-ion battery is short-circuited or exposed to high temperature, exothermic reactions can be triggered, resulting in a self-enhanced increasing temperature loop known as “thermal runaway” that can lead to battery fires and explosions. Short circuits, mechanical abuse, battery overcharging, and design and manufacturing flaws can all result in a battery fire/explosion



Constituents of a typical lithium-ion battery and the Electrochemical charging and discharging processes with the typical cathode and anode materials.

[2] METHODOLOGY

Lion batteries consists of several key components, including the anode, cathode, and electrolyte. The anode is typically made of lithium metal or a lithium-containing compound, while the cathode is a porous material that utilize oxygen from the atmosphere. The electrolyte serves as a medium for ion transport between the anode and cathode. During charging, lithium ions are extracted from the anode and move through the electrolyte toward the cathode. Meanwhile, oxygen molecules from the air react with the lithium ions at the cathode, forming lithium peroxide (Li_2O_2). This process, known as the oxygen reduction reaction (ORR), stores electrical energy in the battery[9]. During discharging, the reverse reaction takes place. The stored lithium peroxide at the cathode decomposes, releasing lithium ions back to the electrolyte. Simultaneously, the released oxygen molecules return to the atmosphere. This process, known as the oxygen evolution reaction (OER), generates electrical current that can be utilized to power electric vehicles or other devices[9,10].

[3] CURRENT ADVANCEMENT

1. **Increased Energy Density**: Researchers have been making significant progress in improving the energy density of Lion Batteries. By optimizing cathode materials and electrolyte compositions, they have achieved higher energy densities, enabling longer driving ranges for electric vehicles[6].

2. **Enhanced Cycling Stability**: Cycling stability refers to the ability of a battery to maintain its performance over multiple charge and discharge cycles. Recent advancements in Lion Batteries have focused on improving cycling stability by addressing issues such as side reactions and electrode degradation. This has led to longer-lasting batteries with extended lifespans[2].

3. **Oxygen Electrode Catalysts**: One of the critical challenges in Lion Batteries is the oxygen electrode's efficiency and durability. Researchers have been exploring various catalysts to improve oxygen reduction and evolution reactions, enhancing the overall performance and efficiency of Lion Batteries in electric vehicles[9].

4. **Electrolyte Design and Stability**: The stability and compatibility of the electrolyte play a crucial role in Lion Battery performance. Advances have been made in developing stable and efficient electrolytes, including solid-state electrolytes and hybrid electrolyte systems[5]. These advancements contribute to improved safety, reduced side reactions, and enhanced overall battery performance.

[4] CHALLENGES

1. **Limited Cycle Life**: Lion Batteries often suffer from limited cycle life, which refers to the number of charge and discharge cycles a battery can undergo while maintaining its performance. The formation and decomposition of lithium peroxide during cycling can lead to electrode degradation and capacity loss over time, affecting the overall lifespan of the battery[1].

2. **Voltage Gap and Over potential**: Lion Batteries face challenges related to high over potential and voltage gaps between charging and discharging processes. This can result in

inefficiencies and increased energy losses during battery operation, impacting the overall energy efficiency of the battery system.

3. **Materials and Cost**: Developing suitable cathode materials that can efficiently catalyze the oxygen reduction and evolution reactions while maintaining stability remains a challenge. Additionally, the high cost associated with certain materials and fabrication processes for Lion Batteries poses a barrier to their widespread adoption in electric vehicles[3].

4. **Scalability and Manufacturing**: Scaling up the production of Lion Batteries and achieving consistent performance across large-scale manufacturing is a significant challenge. Developing cost-effective and reliable manufacturing processes that can meet the demand of the electric vehicle market is crucial for the commercialization of Lion Battery technology[7].

[5] FUTURE DIRECTIONS

Li-ion batteries will also be employed to buffer the intermittent and fluctuating green energy supply from renewable resources, such as solar and wind, to smooth the difference between energy supply and demand. For example, extra solar energy generated during the day time can be stored in Li-ion batteries that will supply energy at night when sun light is not available[8]. The future of Lion Batteries in electric vehicles involves seamless integration with charging infrastructure. This includes compatibility with fast-charging technologies, bidirectional charging capabilities for vehicle-to-grid applications, and smart charging systems that optimize battery performance and lifespan.

[6] CONCLUDING REMARKS

Li-ion battery technology is at the focus of intensive research. After some years of Li-ion batteries that power most used portable electronic devices, it seems that this technology has reached a high level of maturity and confidence that enables it to be pushed towards more demanding applications. Lion Battery technology holds tremendous potential to revolutionize the electric vehicle industry. With its high theoretical energy density and the ability to utilize oxygen from the atmosphere, Lion Batteries offer the promise of significantly extended driving ranges and improved overall performance of electric vehicles.

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