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Nano Structured Li_2MnO_3 Based Thin Film as a Green Power Source: Review

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ABSTRACT
Lithium ion batteries and solar cells are promising energy conversion and storage
Technologies that could address some environmental problems, as well as prevent the potential depletion of resources and create jobs. LIB is currently generating a tonne of interest due to its extensive portable and transportation applications as well as the rising demand for sustainable energy sources. Electrochemical energy technologies are appealing because they produce clean energy with great efficiency, which has a significant impact on the global economy and ecology. The mainstay of future power source expansion will be energy sources with high energy density, long life cycles, and great efficiency. The current modification methods for thin films are outlined in this overview. The paper also examines the necessity for and future directions of research in thin-film cathode designs for energy storage in cutting-edge portable and personal devices.
Key words: Li2MnO3, cathode material, thin film, green energy

I. INTRODUCTION

The issue of substituting a conventional automobile battery with a renewable energy source is both the most crucial and challenging for electric vehicles. Many different technical systems and functions have made use of thin solid films. The rapid progress of electrical device miniaturization is made possible by advances in thin film technology. Thin film technologies have advanced significantly and developed quickly due to the necessity to make thin materials that are of a high standard of quality, dependability, and reproducibility. In semiconductor devices, transistors, integrated circuits, wireless communications, telecommunications, rectifiers, solar cells, light-emitting diodes, photoconductors, light-crystal displays, lithography, micro electromechanical systems (MEMS), and batteries, thin film materials are employed. An essential component of thin film materials

II. REVIEW OF LITERATURE

According to M. C. Rao, increased electronic conductivities and ion diffusivities in anode and cathode materials are what further permit the improvement in capacity of current lithium batteries. Thin, lightweight, and flexible portable electronic gadgets as well as, more recently, batteries for transportation systems, such as hybrid and electric vehicles, have all benefited from the use of lithium-ion batteries. Over the past 50 years, global energy use and CO_2 emissions have risen dramatically. The development of clean and renewable energy systems, such as solar cells, fuel cells, batteries, and wind turbines, is more crucial than ever as we become more aware of greenhouse gas (GHG) emissions and their detrimental consequences on the environment. Due to their extremely high energy density, lithium-ion batteries have a large amount of energy storage capacity. $LiCoO_2$ has a large capacity and excellent cycling stability, making it a popular cathode material for lithium-ion batteries. Because of their large theoretical capacity and low price, layered $LiNiO_2$, $LiMnO_2$, and their derivatives are potential cathode materials for lithium-ion batteries. [1].

Rechargeable batteries are essential today and are required for the majority of large electronic gadgets that the majority of people use for communication, transportation, and surveillance, according to Bensalah N et al. The characteristics of LIBs need to be improved for future applications that call for high energy and power density with long-term stability. High capacity, low cost, environmental friendliness, and long-term charge/discharge cycling for large and practical applications are the ideal cathode materials for LIBs. Future commercial production of LIBs is anticipated to increase as their energy density and capacity are enhanced. [2].

Tong bo Song et al. discovered that the study and use of solar cells have drawn interest from all over the world due to the rising use of conventional energy and the deteriorating environmental problem. The second generation of solar cell technology, based on semiconductor thin-film materials, has flourished during the past ten years thanks to advancements in thin-film technology. Thin-film solar cell technology can significantly lower material prices because less material is needed. Additionally, the thin film materials may be easily applied to substrates including glass, stainless steel, and plastic, making them especially well suited for incorporation into solar buildings. [3].

Peng Zhang studied. A consistent and dependable energy source is necessary for modern life. Energy prices are anticipated to increase, nevertheless, as a result of pollution and the diminishing availability of fossil fuels. On the other hand, the more sustainable energy sources such as wind and solar power have attracted more and more attention in the last decade.

Batteries offer a way to store energy from a variety of sources. In particular, the lithium-ion battery is currently the most advanced energy storage device for modern electronics due to its high energy density, relatively high power and long life. [4].

TshidiMogashoa et al. studied high energy density Li-ion batteries are in high demand for the realisation of electric and hybrid vehicles in the automotive industry. Due to its high capacity of 459 mA-g-1, Li2MnO3 is considered a promising cathode material for next- generation lithium-ion batteries [5].

SongyootKaewmala et al study Lithium-ion batteries are used as energy storage devices for large energy storage systems, electronic devices, and electric vehicles. This is because they have higher energy density than other commercially available battery technologies such as Pd-acid, Ni-Cd and Ni- MH batteries. The performance of lithium-ion batteries is highly dependent on the electrochemical properties of their electrode materials, especially the cathode materials. The cathode materials contain Li-ions in their structure. So the electrochemical properties of the cathode materials greatly affect the performance of lithium- ion batteries, including power and energy density. [6].

Lian-Bang Wang, et al investigated that rechargeable lithium-ion batteries have been continuously developed since their first use in electronic products in the 1990s. Lithium-rich manganese oxide is a promising candidate for the cathode material of next generation lithium-ion batteries due to its low cost and high specific capacity. Currently, the most widely used cathode materials are ternary NMC and LiFePO4, while Li-rich manganese-based materials have attracted much attention due to their low cost and high specific capacity. However, the sharp price fluctuations of cobalt and nickel in recent years and their negative impact on the environment have led researchers to develop a Li-rich manganese oxide without Ni and Co, using xLi_2MnO_3-(1-x)$LiMnO_2$ as a substitute [7].

Ho Soonmin et al. it has been studied that the deposition of binary, ternary and quaternary metal sulphide thin films has been successfully carried out using the chemical bath deposition method. This deposition technique is simple, inexpensive and suitable for large area deposition at low temperature. The deposition time is one of the factors affecting the structural, optical, morphological and compositional properties of the films. The films prepared with a longer deposition time are thicker and have a low absorption value in the higher wavelength range. The physical, optical and electrical properties of the films were characterized using different tools. The experimental results showed that the obtained materials could be used in solar cells and optoelectronic devices. [8]

SanathAlahakoon et al. as a result of the major challenges facing the world today due to global warming and diminishing conventional energy sources such as fossil fuels, the development of methods to harness all possible forms of renewable energy has become a heavily researched area within the energy and research community major energy consuming sectors such as transportation, manufacturing, electricity consumers, etc., could also benefit from the introduction of energy storage. In transportation, for example, the increasing use of hybrid and plug-in electric vehicles, as well as new transportation concepts such as electric highways, have elevated the importance of energy storage solutions for transportation to the highest level. Energy storage will be an essential and important feature of future power grids. [9]

Yong-Ning Zhouetal foundthat it is important to investigate the underlying relationships between the chemical composition and electrochemical properties of the active material used in lithium batteries. Due to the many advantages of thin film electrodes over powder-based electrodes, including their high purity, perfect stoichiometry, and freedom from the additives and binders used in the latter, the fabrication of thin film electrodes using versatile deposition technologies has undoubtedly proven to be the simplest and most effective way to gain insight into the required intrinsic properties of lithium storage materials. [10]

RakeshSaroha, et al. investigated electrochemical performances of Li-rich layered-layered Li2MnO3- LiMnO2 solid solutions as cathode material for lithium-ion batteries explained the important of Li Ion Batteries. [11]

Jae-Kyo Noh1 et al. in Mechano-chemical Synthesis of Li_2MnO_3 Shell/$LiMO_2$ (M = Ni, Co, Mn) Core-Structured Nano-composites for Lithium-Ion Batteries reports that as the application of lithium-ion batteries expands to higher energy consumption devices, such as electric vehicles (EVs) and electrical energy storage (EES) systems, the development of electrode materials with higher energy density becomes increasingly important. For cathodes, materials with higher operating voltage windows and larger specific capacities are under intense investigation. As part of these developments in advanced cathode materials, most attention in recent years has been paid to the layered transition metal oxide, which can accommodate more than one unit of Li per molecule. [12]

Zhimin Qi, et al studied, thin film batteries are promising for high-power lithium ion batteries as the reduced thickness allows faster lithium diffusion in the electrodes. Modification of thin film electrodes is necessary to meet industrial standards. Among all the techniques for fabricating nanostructured thin film cathodes, electrostatic spray deposition (ESD) is a very versatile and simple technique for fabricating a film with a high surface-to-volume ratio, which could be an easy choice in fabricating nanostructured thin film cathodes. Thin film electrodes have advantages in solid-state battery integration. Therefore, advanced thin Elm electrolytes and thin Elm anodes using either a nanostructure or a Nano composite approach also need further investigation. In addition, research should focus on the interfacial interactions between electrolyte, cathode and anode [13].

III. RESEARCH METHODOLOGY

A technique for depositing thin films is the chemical bath deposition method. The main benefit of CBD is that, in its most basic form, it only needs solution containers and substrate mounting tools. Chemical bath deposition is a reasonably easy procedure that produces stable, adherent, homogenous, and hard films with good reproducibility. The formation of thin films is greatly influenced by growth circumstances, including substrate topography and chemical composition, solution composition, temperature, and deposition time. By altering deposition parameters including temperature, precursor concentration, complexing agent, and solution pH, it is feasible to regulate thickness and chemical composition in this method.
Sol-gel technique:the sol-gel method is a technique for solidifying a substance containing a solvent under mild circumstances.

IV. EXPECTED OUTCOMES ANDSCOPE

This work aims to prevent and reduce environmental contamination while also putting human and animal safety first. The majority of research scientists and students working in the subject of energy storage systems will benefit from this study's findings. Decrease in reliance on foreign fuels. Reduces dangerous emissions. Fostering economic growth, opening up jobs in manufacturing and installation, and more ultimately, the future increase of power sources will favour energy sources with high energy density, lengthy life cycles, and high efficiency.
Several deposition methods, such as chemical bath deposition, can be used to create metal oxide thin films. This method of deposition is affordable for low-temperature deposition over a vast region. Several instruments can be used to characterize the thin film's physical, optical, and electrical properties. It can be applied to electrical vehicle technologies, portable electronics, and energy storage devices. The substance utilized in wireless sensors and pacemakers, among other applications.

V. CONCLUSIONS

- The problems of today are to make AL batteries more permeable and stable by addressing the corrosion issue, according to the literature review.
- Cathode: Li-rich and Ni-rich oxides are drawing increasing attention because Co-free Li-rich materials have enhanced kinetics and cycling performance, but further study is still needed to increase rate capability and cycle performance.
- Anode: Graphite is a key component of Li-ion technology, but its energy and power are limited. Additionally, it is a crucial raw material among natural graphite's, necessitating research into new compositions with other metal sulphides that might be recyclable from other products and promote a circular economy.
- Salt, solvent, and additives are all components of electrolytes, which have a significant impact on the power, cost, and energy density of batteries.

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