IJARCCE
ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 10, Issue 10, October 2021
DOI: 10.17148/IJARCCE.2021.101026

Nanotechnology in Development of Batteries for Electric Vehicles

Vinith.P[1] , Chaitrashree.S[2] , Somashekar.S.R[3]
Student GAT, Karnataka, India[1,2,3]

Abstract: This paper discusses different methods to enhance the efficiency and life of an electric vehicle. This document addresses many strategies for increasing an electric vehicle's efficiency and lifespan. To address the need for electric vehicle applications, many battery research and development are undertaken in both academia and industry. Lithium-ion batteries play a significant part in hybrid electric vehicles and are quite useful. Nanotechnology plays a critical role in extending the life of batteries. As a result, the usage of nanostructured materials in battery design is becoming more common. In this Review, we provide an overview of nanostructured materials that have been marketed or are on their way to commercialization for hybrid electric vehicle applications and those in development that have the potential to meet the needs of long-range electric vehicles.

Keywords: Electric Vehicles, Multi-functional EV Batteries, Nanochain Structure, Pb-Acid battery, Li-ion battery.

INTRODUCTION

The battery is an important component in electric vehicles because it determines the vehicle's performance. Batteries and supercapacitors are components of electrochemical systems. During the charging process, a battery stores electrical energy as chemical energy in its anode and cathode, and when needed, releases the energy as electrical output during the discharge process. A good battery should have high specific energy, a high power density, a long cycle life, good abuse tolerance, and a reasonable cost. As the world's population grows, so does the number of automobiles on the road. The battery is an important component in electric vehicles because it determines the vehicle's performance. Batteries and supercapacitors are components of electrochemical systems. During the charging process, a battery stores electrical energy as chemical energy in its anode and cathode, and when needed, releases the energy as electrical output during the discharge process.
A good battery should have high specific energy, a high power density, a long cycle life, good abuse tolerance, and a reasonable cost. As the world's population grows, so does the number of automobiles on the road. Other chemical-bond-based batteries, such as the Li–O_2, Li–S, and Li–Se systems, have also been the subject of recent research due to their potential for significantly better energy density. Many advancements in battery technology would not have been possible without creating new materials with desirable qualities based on the study and manipulation of physicochemical processes on a 1 to 100 nm scale. Our world has seen significant changes as a result of technological advancements. The biggest detrimental effects are climate change and increased pollution. Furthermore, traditional car engines powered by gasoline and diesel fuels contribute to increased pollution, raising the risk of climate change. As a result, conventional automobiles are being phased out in favor of electric vehicles (EV).
However, electric vehicles have several challenges due to their greater price, dependent on the battery and battery cycle life.

LITERATURE REVIEW

1. Current State of Electric Vehicle Technology

Lithium-ion battery technology has risen to the forefront of the automobile sector over the last two decades. By lowering or eliminating fossil fuels in internal combustion engines, automakers may reinvent consumer and business mobility (ICE). However, battery technology for electric vehicles (EVs) is constantly pushing the limits of lithium-ion batteries capacity to offer enough power, longevity, and safety. Plug-in electric vehicles (PEV's, including plug-in hybrid electric and all-electric) will play a crucial part in the country's transportation future due to their enormous potential for boosting the country's energy security, economic vibrancy, and quality of life.
The block diagram of charging system configuration for electric vehicles is as shown in Figure (1).

ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 10, October 2021

DOI: 10.17148/IJARCCE.2021.101026

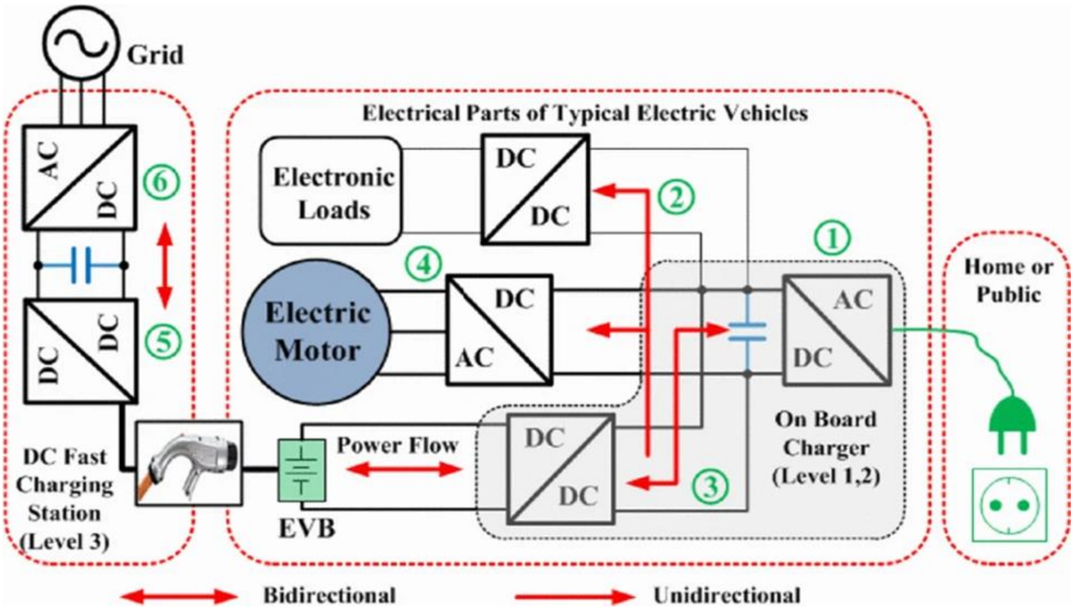

Fig 1: Charging system configuration of electric vehicles

In reality, switching to a mix of plug-in electric vehicles, low-carbon fuels, and electricity could cut greenhouse gas emissions by more than 80% and eliminate the use of petroleum almost altogether. See Electric Vehicle Basics for a broad overview of plug-in electric automobiles. However, the battery is the biggest disadvantage of electric vehicles. For electric cars to obtain a bigger market share, manufacturers will need to lower the cost of their battery packs while increasing the capacity and longevity of batteries, hence the vehicle's range and performance. Many businesses are counting on nanotechnology to usher in this revolution. Nano-enabled components and systems can also boost the performance of the rest of the vehicle. Weight reduction, energy efficiency, increased control, and communications are just a few of the important measures that polymer nanocomposites, nanostructured metals, and nano-enhanced sensors and power electronics may help with.

2. Nanotechnology in Batteries

With ever-increasing energy densities and shorter charge periods, battery technology is always evolving. The next major wave of battery breakthroughs will almost certainly take advantage of our growing understanding of nanotechnology.

The physical boundaries of the materials used in batteries are being pushed as we employ high-performance batteries in hybrid and electric cars and demand technological gadgets. Nanotechnology improvements could give existing materials a fresh lease of life and unearth novel materials that haven't been explored before. In batteries, nanotechnology plays an important role in achieving certain performance goals. For example, graphite powder has traditionally been utilized on the negative electrode of lithium-ion batteries as an intercalation material.

By replacing the micrometer-sized powder with carbon nanomaterials such as carbon nanotubes, the rate of lithium removal or insertion and battery capacity can be enhanced. Carbon nanotubes can bind substantially higher quantities of lithium due to their large surface area. Negative electrode materials composed of titanium dioxide (TiO_2), vanadium oxide (V_2O_5), or tin oxide (ZnO) nanowires are also promising.
Vertically aligned carbon nanotube (VACNT) design for electric vehicles is as shown in Figure (2).

ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 10, Issue 10, October 2021
DOI: 10.17148/IJARCCE.2021.101026

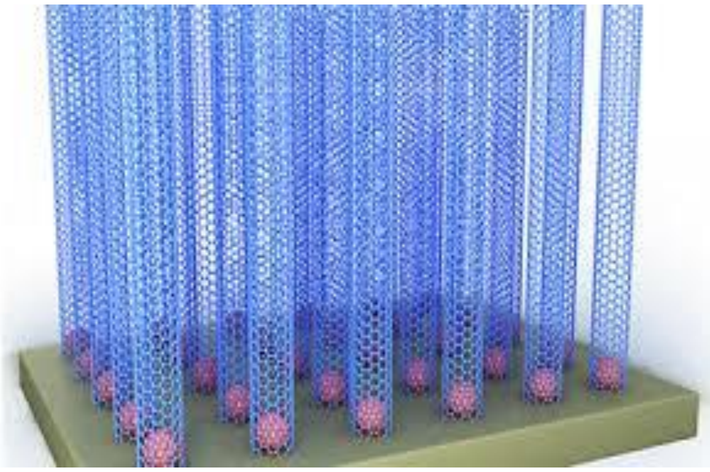

Fig 2 : Vertically aligned carbon nanotube (VACNT) design

Many of these materials are still in the early stages of commercial development; one of the obstacles in bringing significant technological improvements to a massive business like the automotive industry is that any new technology must adapt to the massive manufacturing scales required. Commercially available oxide materials are attractive electrode materials, but most are either too expensive or too dangerous.

Such compounds include $Li(NiCoAl)O_2$, $Li(NiMnCo)O_2$, $LiMn_2O_4$, $Li(AlMn)_2O_4$, and $LiCo_2O_4$. These materials' intercalation capability is greatly improved by nanostructuring. For various reasons, using nanostructured materials to improve the current density of electrodes is beneficial: it reduces the diffusion path for lithium ions, increasing their mobility, and it also tends to increase electrical conductivity, allowing the electrochemical reaction to take place more quickly. Nanotubes, nanowires, and other nanostructured materials are used in several applications. Both positive and negative electrodes have been investigated using nanopillars, nanoparticles, and mesopores as suitable materials. Researchers are seeking to find optimum compositions by altering the features of the electrodes, such as shape and surface area, to squeeze as much performance as possible out of batteries that are as economical, light, and small as possible.

3. Nano-Enhanced Batteries for Electric Vehicles

The EPA's Design for the Environment Program in the Office of Pollution Prevention and Toxics, in collaboration with the National Risk Management Research Laboratory in the Office of Research and Development, researched a screening-level life cycle assessment (LCA) of current lithium-ion (Li-ion) battery technologies for electric vehicles.

As well as a next-generation battery component (anode) based on single-walled carbon nanotube (SWCNT) technology. Primary data from recyclers and battery manufacturers and data on the nano-enhanced anode under study were used to do a quantitative environmental LCA. This type of research is necessary to ensure that the automotive battery business evolves environmental friendly and efficiently. The findings will help battery suppliers and manufacturers evaluate whether methods and materials impact or constitute a risk to health or the environment throughout the product lifespan, reducing current and future impacts and risks.

In addition, the study demonstrates how the life-cycle consequences of a developing technology based on nanomaterials, such as the SWCNT anode, may be assessed before the technology matures, setting a standard for future life-cycle studies of this technology. Another team at the Ulsan National Institute of Science and Technology's Interdisciplinary School of Green Energy reduced the time it takes to charge an electric automobile from hours to minutes.
The below Figure(3) represents the multi-functional EV batteries.

ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 10, October 2021

DOI: 10.17148/IJARCCE.2021.101026

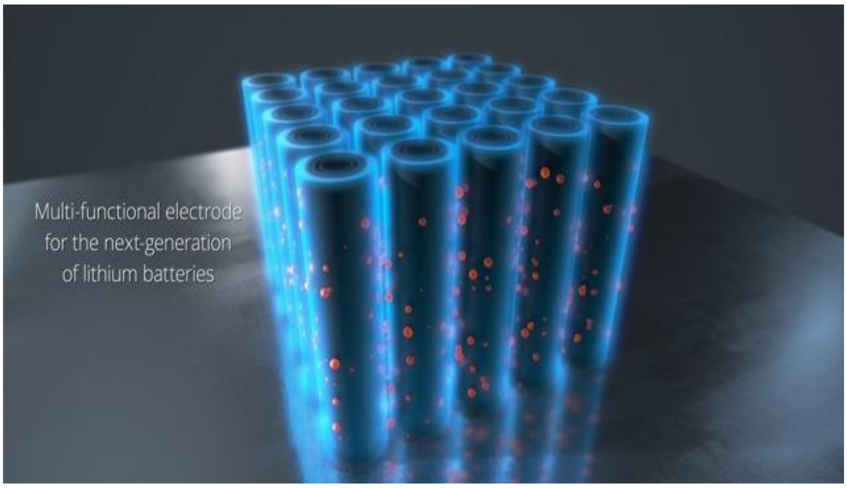

Fig 3 : Multi-functional EV batteries

In comparison to currently available lithium-ion batteries, this novel technology aims to reduce recharging time by at least 30 times and increase speed by 120 times. The cathode material in their unique battery technique is lithium manganese oxide bathed in a graphite-containing solution. Sucrose-coated nanoparticle clusters produce highly dense carbonized secondary particles. Internal sucrose graphitization helps create conductive particles inside the network when heated to 600°C, allowing all particles in the electrode to participate in the reaction simultaneously, speeding up charging and discharging. According to Professor Cho, the study group's leader, this technology was used to charge a battery appropriate for an electric vehicle in under one minute.

4. Nano Chain Structure

The battery's life is determined by the amount of lithium ions that can be stored in the negative electrode material. If the battery runs out of these ions, it won't be able to create enough electricity to power the vehicle and would eventually fail. Higher lithium ion storage capacity materials are either too heavy or the improper form to replace graphite, the existing electrode material in batteries. Purdue University scientists and engineers have proposed a technique to rearrange these materials into a novel electrode design that would allow them to extend the life of a battery, improve its stability, and reduce its charging time.

Then antimony, a metalloid known to improve lithium ion charge capacity in batteries, was used to construct a net-like structure dubbed a "nanochain." For at least 100 charging-discharging cycles, the nanochain keeps lithium ion capacity steady. There's basically no difference between cycles 1 and 100, so there's no reason to believe cycle 102 won't be the same. The electrode design also has the ability to scale up to larger batteries.

Nano chain structures used in electric vehicles are as shown in Figure(4).

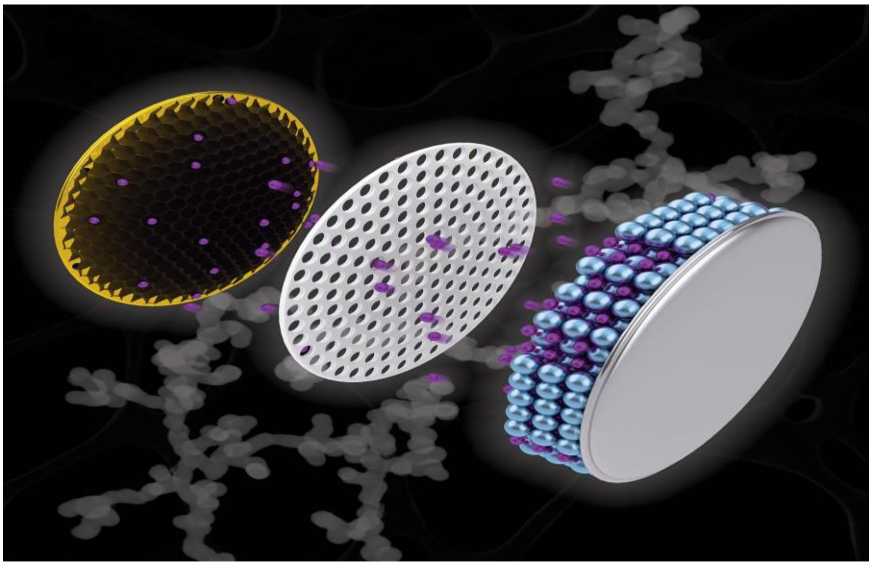

Fig 4 : Nanochain Structure

ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 10, October 2021

DOI: 10.17148/IJARCCE.2021.101026

CONCLUSION

The improvement in efficiency and stability is the subject of this work. Nanotechnology and nanomaterials have brought tremendous fresh insights and progress in Li metal protection. The booming development of nanotechnology and nanomaterials endows physical, chemical, and electrochemical revolution in the lithium battery system, providing emerging opportunities for largely enhancing the efficiency and cycle life of Li metal anode. In order to improve the efficiency of a battery, parallel connections of both Pb-Acid and Li-Ion batteries, Nano chain structures and multi functional EV batteries are used. Furthermore, nanomaterials are used to boost the overall efficiency in electric vehicles.

REFERENCES

[1]. Koki Ogura, Mohan LalKolhe, "Battery technologies for electric Vehicles," Elsevier, 2017.

[2]. Vaibhav S. Deshpande, Mohit .N.Talele, "Nanotechnology enabled hybrid power system suitable for batteries in a hybrid electric vehicle," IEEE International Conference on Advances in Electrical, Electronics, Information, Communication and Bioinformatics, 2017.

[3]. Ahmed Al-karakchi, GhanimPutrus, "A method of electric vehicle charging to improve battery life," September 2015.

[4]. Yow-Chyi Liu, "Battery management systems for improving battery efficiency in electric vehicles," World Electric Vehicle Journal Vol. 4, 2010

[5]. Howell D (2012) Battery status and cost reduction prospects. In: EV everywhere grand challenge battery workshop

[6]. Srinivasan V (2008) Batteries for vehicular applications. In: Hafemeister D, Levine M, Schwartz P (eds) Physics of sustainable energy: using energy efficiently and producing it renewably, AIP conference proceedings 1044. Berkeley, USA, March 1–2, pp 283–296

[7]. Laboratory test procedure for new car assessment program frontal impact testing. Federal Highway Administration, U.S. Department of Transportation.

[8]. Dunn, B., Kamath, H. & Tarascon, J. M. Electrical energy storage for the grid: a battery of choices. Science 334, 928–935 (2011).

[9]. Etacheri, V., Marom, R., Elazari, R., Salitra, G. & Aurbach, D. Challenges in the development of advanced Li-ion batteries: a review. Energy. Environ. Sci. 4, 3243–3262 (2011).

[10]. Goodenough, J. B. & Park, K.-S. The Li-ion rechargeable battery: a perspective. J. Am. Chem. Soc. 135, 1167–1176 (2013)

[11]. Mihai-OvidiuNicolaica, "Vehicle dynamics effect on energy efficiency in hybrid electric vehicles," IEEE, 2015.

[12]. Thu H Nguyen, ArwaFraiwan, Seokheun Choi, "Paper-based batteries: a review," Elsevier, 2014.

[13]. Lokesh Kumar Bramhane, Jawar Singh, Improved performance of bipolar charge plasma transistors by reducing the horizontal electric field, Superlattices and Microstructures, Volume 104, Pages 215-221, (2017).

[14]. Lokesh Kumar Bramhane, Jawar Singh, "Two-zone SiGe base heterojunction bipolar charge plasma transistor for next generation analog and RF applications," Superlattices and Microstructures, Volume 101, Pages 200-208, January 2017.

[15]. Sudhir B. Lande, Sushil Z. Kawale, "Energy efficient routing protocol for wireless sensor networks," International Conference on Computational Intelligence and Communication Networks, IEEE, 2016

