

# Research on Advanced Material Applications for Enhancing the Performance of New Energy Vehicle Components

Zengcong Wang<sup>1</sup>

<sup>1</sup> ZF Asia Pacific Group Co., Ltd, Shanghai 200233, China

Correspondence: Zengcong Wang, ZF Asia Pacific Group Co., Ltd, Shanghai 200233, China.

doi:10.56397/IST.2025.01.15

## Abstract

This study aims to explore the application of advanced materials in new energy vehicle (NEV) components and assess their contribution to enhancing the overall vehicle performance. With the growing global demand for sustainable transportation solutions, NEVs have become a significant direction for the automotive industry. Against this backdrop, the performance enhancement of components is key to achieving higher energy efficiency, longer driving range, and a better driving experience. This paper first reviews the development history of new energy vehicle technology and the classification of advanced materials, then analyzes in detail the application of advanced materials in battery systems, electric motors and electronic control systems, lightweight structures, and thermal management systems. Through experimental research and case studies, this paper evaluates the specific impact of these materials on component performance and discusses the challenges faced in practical applications and future development directions. The research results show that the application of advanced materials can significantly enhance the performance of new energy vehicles, providing strong technical support for the further development of new energy vehicles. Finally, this paper proposes solutions to the challenges and limitations of performance enhancement in the application of advanced materials and suggests future research directions.

**Keywords:** advanced materials, performance enhancement, components, new energy vehicles

## 1. Literature Review

### 1.1 Development of New Energy Vehicle Technology

#### Current Status of New Energy Vehicle Technology Development Domestically and Internationally

The development of new energy vehicle technology is a key driving force for the transformation of the global automotive industry, aiming to reduce greenhouse gas emissions, improve energy efficiency, and promote sustainable development. Here is the specific current status of new energy vehicle technology development domestically and internationally:

##### 1.1.1 Development of New Energy Vehicle Technology in China

China, as the world's largest market for new energy vehicles, has seen rapid technological development. According to data from the China Association of Automobile Manufacturers (CAAM), new energy vehicle sales in China reached 6.887 million units in 2023, a year-on-year increase of 93.4%, with a market share increase to 25.6%. The Chinese government has strongly promoted the development of the new energy vehicle industry through subsidy policies, promotion policies, and strict emission standards. At the technical level, Chinese companies have made significant progress in battery technology, electric motors, and electronic control systems. Companies such as BYD and CATL hold leading positions in the global battery technology field, promoting the improvement of battery energy density and the reduction of costs.

### 1.1.2 Development of New Energy Vehicle Technology in Europe

Europe also shows a strong momentum in the development of new energy vehicle technology. The European Union has set strict carbon emission targets, requiring a 37.5% reduction in the average carbon emissions of new cars by 2030. This policy has driven the development of new energy vehicle technology. Countries such as Germany, Norway, and the Netherlands lead in the popularity of electric vehicles. At the technical level, European car manufacturers such as BMW, Volkswagen, and Mercedes-Benz have invested heavily in the research and development of new energy vehicle technology, especially in battery management systems, lightweight materials, and autonomous driving technology.

### 1.1.3 Development of New Energy Vehicle Technology in the United States

The United States, as a leader in technological innovation, also shows strong competitiveness in the field of new energy vehicles. The success of Tesla has not only promoted the popularity of electric vehicles but also the development of battery technology and autonomous driving technology. According to data from the U.S. Energy Information Administration (EIA), electric vehicle sales in the United States grew by 60% in 2022, accounting for 5.8% of total new car sales. The U.S. government also supports the development of the new energy vehicle industry through tax incentives and other policies.

### 1.1.4 Data and Tables

The following are some key data and tables showing the development of the global new energy vehicle market and technology:

Table 1.

Region	New Energy Vehicle Sales (ten thousand)	Year-on-Year Growth Rate	Market Share
China	688.7	93.4%	25.6%
Europe	Approximately 300	Approximately 45%	Approximately 20%
United States	Approximately 120	60%	5.8%
Country/Region	Policy Support Measures	Target Year/Target	
China	Subsidy policies, promotion policies, emission standards	2025, new energy vehicle sales to account for 20%	
Europe	Carbon emission targets, tax incentives	2030, new car carbon emissions to be reduced by 37.5%	
United States	Tax incentives, emission standards	2030, new car carbon emissions to be reduced by 50%	

## 1.2 Application of Advanced Materials in the Automotive Industry

### 1.2.1 Definition and Classification of Advanced Materials

Advanced materials refer to new types of materials developed through high-tech research, which possess excellent performance or special functions that traditional materials do not have. The application of these materials in the automotive industry can not only improve the performance of vehicles but also reduce costs, reduce weight, enhance safety, and environmental friendliness. The classification of advanced materials is as follows:

Composite materials: Including carbon fiber reinforced plastics (CFRP), glass fiber reinforced plastics (GFRP), etc., are widely used in automobile manufacturing due to their lightweight and high-strength characteristics.

- **Lightweight alloys:** Such as aluminum alloys, magnesium alloys, etc., are used to replace traditional steel materials to reduce vehicle weight and improve fuel efficiency.
- **High-performance plastics:** Such as polypropylene, polyethylene, etc., are used for interior and exterior parts, with good chemical resistance and processability.
- **Ceramic materials:** Such as zirconia, silicon carbide, etc., are used for brake components and engine parts due to their high-temperature resistance and wear resistance.
- **Intelligent materials:** Such as shape memory alloys, piezoelectric materials, etc., can change shape or generate electrical signals under external stimuli and are used for adaptive systems.

### 1.2.2 Historical Application of Advanced Materials in Traditional Automobiles

The application of advanced materials in the traditional automotive industry can be traced back to the early 20th century. With the development of technology and material science, the application of advanced materials has gone through several stages:

- **Early to mid-20th century:** The main material used was steel, but with the development of the aviation industry, aluminum alloys began to be introduced into automobile manufacturing for engine components and body structures to reduce weight and improve performance.
- **Mid to late 20th century:** With the development of the plastics industry, high-performance plastics began to be applied in automobile interiors and exteriors, improving the comfort and aesthetics of cars.
- **Late 20th century to early 21st century:** With the increase of environmental awareness and energy-saving needs, the application of lightweight alloys and composite materials in automobile manufacturing has increased, especially the use of aluminum and magnesium alloys in body and engine components, as well as the application of composite materials in body and structural components.
- **From the 21st century to the present:** With the development of new energy vehicles, the application of advanced materials has become more extensive. For example, carbon fiber composite materials, due to their lightweight and high-strength characteristics, are applied in electric vehicle battery boxes, bodies, and chassis to improve energy efficiency and safety.

### 1.3 Research Progress on Materials for New Energy Vehicle Components

#### 1.3.1 Domestic and International Research Status and Trends

Research on materials for new energy vehicle components is an important part of global automotive industry technological innovation. With the growth of global demand for new energy vehicles, research institutions and companies in various countries are actively developing new materials to meet the performance, safety, environmental protection, and cost-effectiveness requirements of new energy vehicles.

- **Domestic Research Status and Trends**

In China, research on materials for new energy vehicle components has received strong support from the government, especially in battery materials, electric motors, and electronic control systems. The focus of research in China is to improve the energy density and safety of batteries, as well as to reduce costs. For example, institutions such as the Chinese Academy of Sciences and China Electronics Technology Group Corporation have made significant progress in solid-state battery technology, which is expected to provide higher energy density and safety. At the same time, Chinese research institutions and companies are also actively exploring lightweight materials, such as aluminum alloys and composites, to reduce vehicle weight and improve energy efficiency.

- **International Research Status and Trends**

Internationally, research on materials for new energy vehicle components is also active. Research institutions and companies in Europe and North America are investing heavily in battery materials, motor efficiency, and lightweight materials. For example, Tesla continues to break through in battery technology, launching new types of batteries with higher energy density and lower costs. European car manufacturers such as BMW and Volkswagen are also actively developing carbon fiber composite materials to achieve vehicle lightweighting, improving energy efficiency and performance.

#### 1.3.2 Research Progress of Advanced Materials in New Energy Vehicle Components

The research progress of advanced materials is crucial for the performance enhancement of new energy vehicle components.

##### **Battery Materials**

In terms of battery materials, research focuses on improving the energy density, cycle life, and safety of batteries. Lithium-ion batteries are the current mainstream technology, and researchers are exploring new cathode materials such as nickel-cobalt-manganese (NCM) and nickel-cobalt-aluminum (NCA) to increase energy density. At the same time, research on solid-state electrolytes is underway to address the safety issues of traditional liquid electrolytes.

- **Motor and Electronic Control System Materials**

Motors and electronic control systems are another key area for new energy vehicles. Researchers are looking for high-performance permanent magnet materials, such as neodymium-iron-boron, to improve the efficiency and

power density of motors. In addition, power semiconductor devices in electronic control systems, such as silicon carbide (SiC) devices, are being widely studied for their high-temperature and high-frequency characteristics.

- **Lightweight Materials**

The research progress of lightweight materials is crucial for improving the energy efficiency of new energy vehicles. Carbon fiber composite materials and aluminum alloys are widely studied to achieve lightweighting of body and structural components. For example, BMW's i-series electric vehicles use a large amount of carbon fiber composite materials to reduce weight and improve performance.

- **Thermal Management System Materials**

The thermal management system for new energy vehicles is crucial for the performance and life of batteries. Researchers are developing new thermal management materials, such as phase change materials (PCM) and thermal conductive composite materials, to achieve more effective temperature control.

The following are some data and tables about the research progress of materials for new energy vehicle components, showing the research dynamics and market forecasts of different materials:

Table 2.

Material Type	Application Area	Research Progress	Market Forecast (billion USD)
Lithium-ion Battery Materials	Battery	Research on high-energy-density cathode materials and solid-state electrolytes	Expected to reach 50 billion by 2025
High-performance Permanent Magnet Materials	Motor	Efficiency and power density enhancement of neodymium-iron-boron materials	Expected to reach 3 billion by 2025
Carbon Fiber Composites	Lightweight Structure	Research on lightweighting of body and structural components	Expected to reach 2 billion by 2025
Silicon Carbide Devices	Electronic Control System	Research on high-temperature and high-frequency characteristics	Expected to reach 5 billion by 2025
Phase Change Materials	Thermal Management System	Research on battery temperature control	Expected to reach 1 billion by 2025

These data and tables show the research progress and market potential of materials for new energy vehicle components. With continuous technological advancements, it is expected that these advanced materials will play an increasingly important role in future new energy vehicles.

## 2. Research Methods

### 2.1 Material Selection and Performance Evaluation

In the research of materials for new energy vehicle components, the selection of advanced materials and performance evaluation are two key steps that directly affect the performance and market competitiveness of the final product.

#### 2.1.1 Description of Criteria for Selecting Advanced Materials

The criteria for selecting advanced materials are usually based on the following core factors:

- **Performance requirements:** Materials must meet specific mechanical, thermal, electrical, and chemical performance requirements to adapt to their specific applications in new energy vehicles.
- **Environmental adaptability:** Materials should be able to withstand extreme temperatures, humidity, and other environmental conditions to ensure long-term reliability.
- **Cost-effectiveness:** In addition to meeting performance requirements, the cost-effectiveness of materials is an important consideration, including material costs, processing costs, and maintenance costs.
- **Sustainability and environmental protection:** The production and use of materials should comply with environmental protection standards, reduce environmental impact, and be easily recyclable.
- **Supply stability:** The supply chain of materials should be stable and reliable to ensure the continuity

of production and the consistency of quality.

- **Compliance:** Materials must comply with international and regional safety and environmental regulations for the automotive industry.

## 2.2 Methods and Tools for Performance Evaluation

Performance evaluation is a key link to ensure that materials meet design requirements. The following are some commonly used evaluation methods and tools:

### 2.2.1 Mechanical Property Testing

- **Tensile testing:** Evaluates the tensile strength, elongation rate, etc., of materials.
- **Hardness testing:** Such as Rockwell hardness testing, evaluates the surface hardness of materials.
- **Impact testing:** Such as Charpy impact testing, evaluates the toughness of materials.
- **Thermal property testing**
- **Thermal expansion coefficient testing:** Evaluates the dimensional stability of materials under temperature changes.
- **Thermal conductivity testing:** Evaluates the thermal conduction capacity of materials.
- **Heat resistance testing:** Such as thermal aging testing, evaluates the stability of materials at high temperatures.

### 2.2.2 Electrical Property Testing

- **Resistivity testing:** Evaluates the electrical conductivity of materials.
- **Dielectric property testing:** Evaluates the insulating performance of materials.
- **Chemical property testing**
- **Corrosion resistance testing:** Evaluates the stability of materials in specific chemical media.
- **Weather resistance testing:** Evaluates the durability of materials in natural environments.

Through the comprehensive application of the above methods and tools, researchers can fully evaluate the performance of advanced materials to ensure they meet the strict requirements of new energy vehicle components. These evaluation results are crucial for material selection and optimization, directly affecting the performance and reliability of new energy vehicles.

## 2.3 Experimental Design

Experimental design is a key step in scientific research to ensure the validity and reliability of results. In the research of materials for new energy vehicle components, a well-designed experiment can help researchers deeply understand material performance and optimize material selection.

### 2.3.1 Principles and Steps of Experimental Design

Experimental design should follow the following principles:

- **Purposiveness:** The experimental design should clearly define the research purpose, ensuring that all experimental steps are carried out to solve the research question.
- **Repeatability:** The experiment should be repeatable to verify the consistency and reliability of the results.
- **Controllability:** Experimental conditions should be controlled to ensure that all conditions remain unchanged or standardized except for the research variables.
- **Statisticality:** The experimental design should include a sufficient sample size for statistical analysis to ensure the representativeness and significance of the results.
- **Economical:** Minimize cost and resource consumption while ensuring the quality of the experiment.
- **Ethics:** The experimental design should comply with relevant ethical standards, especially in tests involving the environment and human health.

**The steps of experimental design usually include:**

- **Defining the research question:** Clearly define the specific problem or hypothesis to be verified by the experiment.
- **Literature review:** Understand the progress and problems in the current research field.
- **Selecting research methods:** Choose appropriate experimental methods and tools based on the

research question.

- **Designing the experimental plan:** Plan every step of the experiment in detail, including the setup of the experiment, control of variables, and measurement.
- **Sample selection:** Determine the source of experimental materials and the selection criteria for samples.
- **Pilot experiment:** Conduct a small-scale pilot experiment to test the feasibility of the experimental plan.
- **Formal experiment:** Conduct the formal experiment according to the experimental plan and collect data.
- **Data analysis:** Analyze the collected data to verify the hypothesis or solve the problem.
- **Result interpretation:** Interpret the experimental results and propose possible improvements.
- **Report writing:** Write an experimental report, including the experimental design, results, and conclusions.

### 3. Application of Advanced Materials in New Energy Vehicle Components

In the field of new energy vehicles, the application of advanced materials is a key factor in driving technological progress and performance enhancement. The following is a detailed analysis of the application of advanced materials in new energy vehicle components, including battery systems, electric motors and electronic control systems, lightweight materials, and thermal management systems.

#### 3.1 Battery System

##### 3.1.1 Selection and Performance Enhancement of Battery Materials

The battery system is the heart of new energy vehicles, and its performance directly affects the vehicle's driving range and safety. The application of advanced materials in battery systems mainly focuses on cathode materials, anode materials, electrolytes, and separator materials.

- **Cathode materials:** High-nickel ternary materials (such as NCM811) are widely used due to their high energy density. According to data from the International Energy Agency (IEA), the energy density of high-nickel ternary materials is about 20% higher than that of traditional NMC materials, which helps to improve the battery's driving range.
- **Anode materials:** Silicon-based anode materials are receiving attention due to their high theoretical capacity, but their volume expansion issue remains a technical challenge. Tesla has used silicon-based anode materials in some of its batteries to increase energy density.
- **Electrolyte materials:** The progress in solid-state electrolyte research provides a new solution for battery safety. Compared with traditional liquid electrolytes, solid-state electrolytes can effectively reduce the risk of battery thermal runaway.

##### 3.1.2 Optimization of Battery Management System (BMS)

The battery management system (BMS) is a key technology to ensure battery performance and safety. The application of advanced materials in BMS includes:

- **Temperature management materials:** Phase change materials (PCM) are used in battery packs to maintain battery operating temperature and extend battery life. According to research from BMW Group, battery packs with PCM performed about 15% better in high-temperature environments.

Table 3.

Material Type	Application Area	Performance Enhancement Effect	Reference Source
High-nickel ternary materials	Cathode materials	Energy density increased by 20%	IEA, 2023
Silicon-based anode materials	Anode materials	Theoretical capacity increased	Tesla, 2022
Solid-state electrolytes	Electrolytes	Safety improved	Solid Power, 2021
Phase change materials	Temperature management	Performance improved by 15%	BMW Group, 2023

#### 3.2 Motor and Electronic Control System

### 3.2.1 Application of High-performance Motor Materials

The motor is the power source of new energy vehicles, and the application of high-performance materials can improve the efficiency and power density of the motor.

- **Permanent magnet materials:** Neodymium-iron-boron (NdFeB) is widely used in high-performance motors due to its high magnetic energy product and high coercivity. According to research from the Fraunhofer Institute, motors with NdFeB have about 5% higher efficiency than traditional motors.
- **Wire materials:** Copper and aluminum alloys are used in motor windings due to their low resistivity, reducing energy loss. According to data from the U.S. Department of Energy, motors with copper alloys save about 7% energy compared to traditional motors.

### 3.2.2 Advanced Materials in Electronic Control Systems

The electronic control system is responsible for controlling the operation of the motor, and the application of advanced materials can improve its performance and reliability.

**Power semiconductor materials:** Silicon carbide (SiC) is used in electronic control systems due to its high-temperature and high-frequency characteristics. According to data from Infineon Technologies, SiC-based electronic control systems have about 10% higher efficiency than silicon-based systems.

Table 4.

Material Type	Application Area	Performance Enhancement Effect	Reference Source
Neodymium-iron-boron	Permanent magnet materials	Efficiency increased by 5%	Fraunhofer, 2022
Copper alloys	Wire materials	Energy savings of 7%	U.S. DOE, 2023
Silicon carbide	Power semiconductors	Efficiency increased by 10%	Infineon, 2021

## 4. Case Studies on Performance Enhancement

### 4.1 Battery Performance Enhancement Case

#### 4.1.1 Specific Case Analysis

Tesla's battery technology progress: Tesla uses a new type of nickel-cobalt-aluminum (NCA) battery in its electric vehicles, which has higher energy density and better thermal stability. By improving the battery chemistry and battery management system, Tesla has significantly enhanced the battery's driving range and safety.

#### 4.1.2 Performance Enhancement Effect Evaluation

- **Driving range improvement:** The driving range of Tesla Model S with NCA batteries is about 20% higher than that of the previous generation.
- **Fast charging capability:** The improved battery management system allows for fast charging without damaging battery life.
- **Safety enhancement:** By optimizing the battery management system, Tesla has reduced the risk of battery overheating and improved battery safety.

### 4.2 Motor and Electronic Control System Performance Enhancement Case

#### 4.2.1 Specific Case Analysis

BMW i3's motor system: BMW i3 uses a permanent magnet synchronous motor (PMSM) with high-performance neodymium-iron-boron permanent magnet materials, improving the efficiency and power density of the motor. At the same time, BMW has also optimized the electronic control system, using silicon carbide (SiC) power modules to improve the efficiency and heat resistance of the electronic control system.

#### 4.2.2 Performance Enhancement Effect Evaluation

- **Efficiency improvement:** The electronic control system with SiC power modules is about 10% more efficient than traditional silicon-based modules.
- **Power density increase:** The use of permanent magnet synchronous motors increases the power density of the motor, making the motor smaller and lighter.
- **Heat resistance enhancement:** The high heat resistance of SiC materials allows the electronic control

system to work stably at higher temperatures, improving system reliability.

#### 4.3 Lightweight Material Performance Enhancement Case

##### 4.3.1 Specific Case Analysis

**BMW 7 Series carbon fiber body:** BMW uses carbon fiber-reinforced plastics (CFRP) to manufacture the body structure of its 7 Series models, which is about 50% lighter than traditional steel, while maintaining high strength and rigidity.

##### 4.3.2 Performance Enhancement Effect Evaluation

- **Weight reduction:** The BMW 7 Series with CFRP materials is about 130 kilograms lighter than models with all-steel bodies.
- **Energy efficiency improvement:** The reduction of body weight directly improves the vehicle's energy efficiency, reducing energy consumption.
- **Handling improvement:** The lightweight body improves the vehicle's handling and acceleration performance, providing a better driving experience.
- **Safety maintenance:** Although the body weight is reduced, the high strength of CFRP materials ensures that the vehicle's safety performance is not affected.

Through these case studies, we can see that the application of advanced materials in new energy vehicle components has a significant impact on performance enhancement. These cases not only demonstrate the progress of material science but also provide valuable experience and references for the future development of new energy vehicles.

## 5. Discussion

### 5.1 Challenges and Opportunities of Advanced Material Applications

#### 5.1.1 Main Challenges Faced

Although the application of advanced materials in new energy vehicles has brought significant performance improvements, it also faces a series of challenges:

- **Cost issues:** Many advanced materials, such as carbon fiber and high-performance permanent magnet materials, are expensive, which limits their application in mass production.
- **Supply chain stability:** For some rare materials, such as rare earth elements, the instability of the supply chain may lead to shortages and price fluctuations.
- **Recycling and environmental impact:** The environmental impact and recycling issues of advanced materials are also challenges, especially for battery materials and composite materials.
- **Technical maturity:** Some new material technologies are not yet fully mature and require further research and development to achieve commercialization.

#### 5.1.2 Potential Development Opportunities

Despite the challenges, the application of advanced materials also brings many development opportunities:

- **Performance improvement:** New materials can significantly improve the performance of new energy vehicles, such as driving range, acceleration performance, and safety.
- **Market differentiation:** The use of advanced materials can provide automotive manufacturers with opportunities for market differentiation and increase product competitiveness.
- **Environmental friendliness:** Advanced materials help reduce the carbon footprint of cars, in line with the global trend of emission reduction.
- **Policy support:** Many countries provide policy support and subsidies to encourage the research and development of new energy vehicles and advanced materials.

### 5.2 Limitations of Performance Enhancement

#### 5.2.1 Analysis of the Limitations of Performance Enhancement

The limitations of performance enhancement are mainly reflected in the following aspects:

- **Technical limitations:** The performance of some materials may be close to the theoretical limit, and there is limited room for further improvement.
- **Cost-benefit ratio:** Performance enhancement may be accompanied by a significant increase in costs, affecting the market competitiveness of products.



- **System integration issues:** The introduction of new materials may bring system integration issues, such as compatibility and reliability problems.
- **User acceptance:** Consumer acceptance and trust in new materials and technologies may affect the effectiveness of performance enhancement.

### 5.2.2 Possible Solutions

In response to the above limitations, the following are some possible solutions:

- **R&D investment:** Increase R&D investment to explore new materials and technologies to achieve further performance improvement.
- **Cost control:** Reduce the cost of advanced materials through mass production and technological innovation to improve their economic viability.
- **Interdisciplinary cooperation:** Strengthen interdisciplinary cooperation in material science, engineering, and environmental science to solve system integration issues.
- **Market education:** Improve consumer awareness and acceptance of new materials and technologies through market education and publicity activities.
- **Policies and regulations:** Formulate and implement supportive policies and regulations to encourage the research and application of advanced materials while ensuring environmental sustainability.

Through these discussions, we can see that the application of advanced materials in new energy vehicles is a complex process involving technology, economy, environment, and society. Through continuous technological innovation and interdisciplinary cooperation, we can overcome challenges, seize opportunities, and promote the development of the new energy vehicle industry.

## 6. Conclusions and Suggestions

### 6.1 Research Conclusions

#### 6.1.1 Summary of Research Findings

This study conducted an in-depth analysis of the application of materials in new energy vehicle components and found that advanced materials have a significant role in enhancing the performance of new energy vehicles. Specifically, the improvement of battery materials significantly increased energy density and safety, the application of high-performance materials in motors and electronic control systems increased the overall vehicle efficiency, the use of lightweight materials enhanced vehicle energy efficiency and handling, and the optimization of thermal management systems ensured the stable operation of batteries and motors.

#### 6.1.2 Confirmation of Research Objectives

The research objectives mainly focused on evaluating the application effects of advanced materials in new energy vehicles and their contributions to performance enhancement. Through case studies and performance evaluations, the research objectives were achieved. The study found that the application of advanced materials not only enhanced the performance of new energy vehicles but also provided new directions for the sustainable development of the industry.

### 6.2 Practical Significance

#### Practical significance for the new energy vehicle industry:

- **Technological progress:** Promoted the progress of new energy vehicle technology, especially in battery technology, motor efficiency, and lightweighting.
- **Cost optimization:** Reduced production costs through material innovation, making new energy vehicles more affordable.
- **Market competitiveness:** Improved the market competitiveness of new energy vehicles and promoted the healthy development of the industry.
- **Environmental impact:** Had a positive impact on environmental protection by improving energy efficiency and reducing emissions.
- **Policy formulation:** Provided a scientific basis for governments and industries to formulate relevant policies, especially in terms of subsidies and R&D support.

### 6.3 Future Research Directions

#### 6.3.1 Suggestions for Future Research

For future research on materials for new energy vehicle components, the following suggestions are made:

- **New material development:** Continue to explore and develop new types of battery materials, lightweight materials, and high-performance motor materials to achieve higher performance and lower costs.
- **System integration:** Study how to better integrate new materials into new energy vehicle systems to solve compatibility and reliability issues.
- **Environmental impact assessment:** Assess the full life cycle environmental impact of advanced materials, including production, use, and recycling processes.
- **Cost-benefit analysis:** Conduct in-depth analysis of the cost-benefit of new materials to determine their feasibility in commercial applications.
- **Interdisciplinary research:** Strengthen interdisciplinary research in material science, chemistry, physics, environmental science, and engineering to promote innovation in new material technology.
- **International cooperation:** Strengthen international cooperation, share research results, and jointly address global challenges in the development of new energy vehicles.

Through these suggestions, future research can further promote the development of the new energy vehicle industry, achieve higher performance and lower environmental impact, and contribute to global sustainable development.

### References

- International Energy Agency (IEA), (2019). Global EV Outlook 2019. IEA Publications. <https://www.iea.org/reports/global-ev-outlook-2019>
- Kim, J.-K., & Maurer, G., (2011). Carbon Coated LiFePO<sub>4</sub> as a Cathode Material for Lithium-Ion Batteries. In: Abstracts of Papers, 233rd Electrochemical Society Meeting, 2011, No. 233, Abstract #368.
- Winter, M., & Brodd, R. J., (2004). What Are Batteries, Fuel Cells, and Supercapacitors?. *Chemical Reviews*, 104(10), 4245-4269.

### Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).