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The Application of New Energy Materials in New-energy Vehicle

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Abstract: Climate change is becoming one of the biggest environmental challenges in the 21st century. New-energy vehicle produce less greenhouse gases as compared to the traditional vehicles with internal combustion engines. New energy vehicles have great potential to successfully address the issue of climate change. Additionally, new energy materials can also be used in automotive lightweight technology. This paper discussed the currently lightweight materials including high-strength low-alloy steel (HSLA), carbon fiber composite material, and modified plastics. According to the discussion in this paper, high-strength low-alloy steel can be used in automotive safety parts, chassis, and body. Carbon fiber composite materials can be used in car bodies, chassis, roofs, doors, head covers, hoods, rear wings, center consoles, trim strips, drive shafts, leaf springs, frames, brake pads, interior and exterior accessories. Modified plastics can be mainly used in exterior decorative parts, interior decorative parts, functional parts, and structural parts. However, three are still many drawbacks of application of new energy materials in new-energy vehicle. The current new energy materials used in automotive lightweight technology are usually costly and time-consuming. Moreover, the characteristics of the new energy materials are still not clear. It could have a negative impact on the environment. Before this technology can be widely used in new-energy vehicles, more research is needed regarding the new energy materials.

Keywords: New energy material, New-energy vehicle, Climate change, High-strength low-alloy steel (HSLA), Carbon fiber composite material, Modified plastic, Greenhouse gases.

1. Introduction

Climate change is one of the biggest challenges of our times[1]. It is believed that one of the major reasons of climate change is human activity such as fossil fuel combustion. When these fossil fuels are combusted, greenhouse gases are released into the Earth's atmosphere. As a result, the heat from the sun was trapped and global temperatures to rise. Based on climate models, the Intergovernmental Panel on Climate Change (IPCC) predicts that the global temperatures will rise by about 1.4-5.8 degrees Celsius (2.5-10.4 degrees Fahrenheit) by 2100 [2]. According to this forecast, global temperatures will undergo dramatic changes not seen in the past 10,000 years, with potentially significant impacts on the global environment. To reduce global warming, many countries have agreed to reduce their greenhouse gas (GHG) emissions into the atmosphere to 1990 levels.

Generally speaking, transportation sector produces one of the largest proportion of GHG emissions. It also has a negative impact on public health and the environment. Vehicle electrification has great potential to reduce air pollutions and tackle climate change [3]. Compared with the internal combustion engine vehicles, new-energy vehicles hardly generate greenhouse gases during driving. If it can completely replace internal combustion engine, new energy vehicles could effectively solve the climate change problem. According to data released by the China Association of Automobile Manufacturers, the production and sales of new-energy vehicles reached 397,000 and 383,000 respectively in October 2021, an increase of 1.3 times year-on-year. From January to October, the production and sales of new-energy vehicles reached 2.566 million and 2.542 million respectively, a year-on-year increase of 1.8 times [4]. At the same time, the scale of the auto parts market continues to increase. The scale of China's auto parts market has grown from 3.46 trillion yuan in 2016 to 4.57 trillion yuan in 2020, with an average annual compound growth rate of 7.2%; the market size is expected to reach 4.9 trillion yuan in 2021.

In recent years, new energy materials have wide applications in a variety of technological fields such as thin-film solar cells, light-emitting device, and photodetector. Many new energy materials have been introduced to the new-energy vehicle industry and has produced some promising outcomes. Clean energy technologies of new-energy vehicles usually require a wide range of minerals1 and metals. The type and volume of mineral needs are very different based on the clean energy technologies (Table 1) [5]. In the current new-energy vehicle industry, reduction in weight is one of the development directions of the automotive industry in the future. The reduction in weight directly means an increase in cruising range. It is found that for the pure electric vehicles, the vehicle weight can be reduced by 10 kg, and the driving range can be increased by 2.5 km. As a result, the GHG emissions could be significantly reduced in the same diving range. In the lightweight industry chain of new-energy vehicles, the main raw materials for lightweight include high-strength steel, aluminum alloy, magnesium alloy, carbon fiber composite materials and modified plastics. These materials could constitute chassis, engine, seat, luggage rack, gear lever, interior, exterior and steering wheel, etc.

Few studies have been conducted in this field due to the rapid growth of new energy material technology. The objectives of this paper are to: 1) present the classification of new energy materials and the application in new-energy vehicle; 2) discuss the future vision of new energy materials applied in new-energy vehicle.

Table 1. Critical mineral needs for clean energy technologies

	Copper	Nickel	Chromium	Aluminium
Solar photovoltaic	High	Low	Low	High
Bioenergy	High	Low	Low	Moderate
Nuclear	Moderate	Moderate	Moderate	Low
Electricity networks	High	Low	Low	High
New-energy vehicle and battery storage	High	High	Low	High
Hydrogen	Low	High	Low	Moderate

2. New Energy Materials and the Application in New-energy Vehicle

2.1. Classification of New Energy Materials

At present, new energy materials has been widely implemented in automotive lightweight technology. With the development of this technology in the last decade, research has begun to utilize new energy materials' properties. Automotive lightweight technology is mainly divided into three aspects: structural optimization design, lightweight material application and advanced manufacturing technology. Among them, the use of lightweight alternative materials is generally recognized in the industry. The currently used lightweight materials mainly include high-strength low-alloy steel (HSLA), carbon fiber composite material, and modified plastics. Table 2 shows the mass reduction for different new energy materials.

Table 2. Mass reduction for different new energy materials

Lightweight materials	Mass reduction
Magnesium	30-70%
Carbon fiber composites	50-70%
Aluminum	30-60%
Titanium	40-55%
Advanced high strength steel	15-25%

High-strength low-alloy steel (HSLA) refers to steel with cold rolling of 340 MPa and hot rolling of 490 MPa or more [6]. High strength steel has a better weight reduction effect. Compared with the traditional 340 MPa material, the theoretical weight reduction potential of the 600 MPa grade steel is about 20%, and the weight reduction potential of the 800 MPa material will increase to more than 30%. At present, high-strength steel is mainly used in automotive safety parts, chassis, and body.

Carbon fiber composite materials can be used in car bodies, chassis, roofs, doors, head covers, hoods, rear wings, center consoles, trim strips, drive shafts, leaf springs, frames, brake pads, interior and exterior accessories etc. In 2019, the domestic demand of carbon fiber composite materials in China was 38000 tons (Figure 1) [7]. In the future, with the increase of China's scientific research capabilities and the steady development of the carbon fiber composite material industry, the domestic demand will continuously increase.

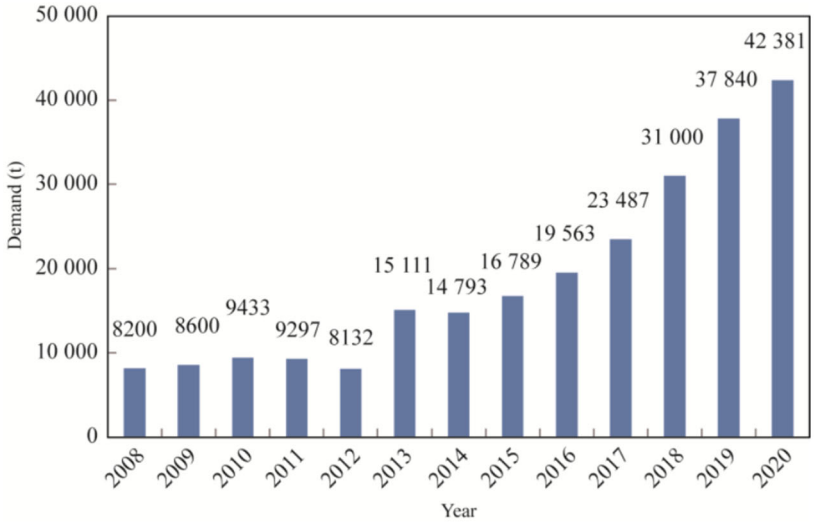

Figure 1. China's domestic demand of carbon fiber composite materials in in past decades

Modified plastics are the plastic products that are processed and modified by filling, blending, strengthening and other methods based on general-purpose plastics and engineering plastics to improve the properties of flame retardancy, strength, impact resistance, toughness, etc. At present, modified plastics are mainly used in exterior decorative parts, interior decorative parts, functional parts, and structural parts. In 2019, the output of modified plastics of industrial enterprises above designated size in China reached 19.55 million tons. In 2021, China's domestic demand for modifies

plastics of industrial enterprises above designated size is 21.1 million tons and the sales scale exceed three trillion RMB.

2.2. Future Vision of New Energy Materials applied in New-Energy Vehicle

In December 2017, the Ministry of Industry and Information Technology issued the "Three-Year Action Plan for Promoting the Development of the New-Generation Artificial Intelligence Industry (2018-2020)", which pointed out to establish an architecture that supports vehicle intelligent computing platform, vehicle intelligent chips, and automatic driving operations. Research and development of key technologies and products such as systems and vehicle intelligent algorithms, and build a vehicle intelligent platform that integrates software, hardware, and algorithms. Electric energy, electronic control systems, and lightweight vehicle bodies play an important role in sensor interconnection, automated driving, and safety assurance of new-energy vehicle which will be the development trend of future transportation.

The development of the new energy material industry will become the infrastructure supporting this trend. For example, the new-energy vehicle bodies can be built by plexiglas glass, which could be a god alternative for automotive glass. It has many advantages such as high transparency and high strength compared to the currently widely used metal and glass materials. The current new energy materials used in new-energy vehicle can be implanted with sensors. The manufacturing of special functional parts can be completed through 3D printing. The application of these new materials in the automotive industry will also be the development trend of future transportation. Last but not least, the existence of 5G signals will serve for truly intelligent urban transportation, and new-energy vehicle will become a new entrance to the Internet in the era of everything connected.

3. Conclusion

New energy material is being developed at an exponential rate, and it will revolutionize the new-energy vehicle industry. Compared with the internal combustion engine vehicles, new-energy vehicles hardly generate greenhouse gases during driving. If it can completely replace internal combustion engine, new energy vehicles could effectively solve the climate change problem. In addition, new energy materials have a great potential to implement in automotive lightweight technology due to their properties. According to the discussion in this paper, high-strength low-alloy steel can be used in automotive safety parts, chassis, and body. Carbon fiber composite materials can be used in car bodies, chassis, roofs, doors, head covers, hoods, rear wings, center consoles, trim strips, drive shafts, leaf springs, frames, brake pads, interior and exterior accessories. Modified plastics can be mainly used in exterior decorative parts, interior decorative parts, functional parts, and structural parts. However, three are still many drawbacks of application of new energy materials in new-energy vehicle. The current new energy materials used in automotive lightweight technology are usually costly and time-consuming. Moreover, the characteristics of the new energy materials are still not clear. It could have a negative impact on the environment. Before this technology can be widely used in new-energy vehicles, more research is needed regarding the new energy materials.

It can be seen that China's new-energy vehicle industry is splendid. But as far as the future is concerned, if new-energy vehicle is a solution for reduction of air pollutions and climate change, then automotive lightweight technology is the core technology. The new cutting-edge materials continuously incubated by research and development institute will become the basis and source of inspiration for the vigorous development of energy innovation and intelligent technology. It can provide infinite possibilities for the future of the new-energy vehicle industry.

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