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Research on Application of New Carbon-based Nanomaterials in New Energy Automobile Industry

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Abstract: In order to alleviate the serious impact of over-exploitation of fossil energy such as coal, oil and natural gas, people began to turn their attention to other renewable clean energy sources. Energy storage technology can be roughly divided into two routes: physical energy storage and electrochemical energy storage. Supercapacitor is the most commercial technical device in physical energy storage, which is a good supplement to other electrochemical energy storage technologies. Batteries based on traditional chemical reactions, such as lithium ion, lead acid, Ni-MH, Ni-MH and Ferrous lithium phosphate, have been widely used in many fields. These batteries have large capacity and no memory effect, but their charging and discharging currents are small, their life is short, and their charging circuits are complex. For many occasions with high requirements for reliability, working life and specific power, this kind of battery is slightly insufficient. Therefore, it is imperative to study high-performance energy storage devices. This paper introduces the principle and characteristics of supercapacitors, and analyzes the supercapacitors based on new carbon-based nanomaterials and their applications in the new energy automobile industry.

Keywords: Supercapacitor, New energy, Carbon-based nanomaterials.

1. Introduction

Due to the increasingly serious environmental pollution and energy shortage, the new energy vehicle technology is highly valued in the world. Supercapacitors have unique advantages such as high power density, short charging and discharging time, long cycle life, high reliability and safety, and can work together with other power sources, which is an effective way to realize energy recycling, reduce environmental pollution and increase the driving range of new energy vehicles [1]. Facing the bottleneck problems of efficient storage, conversion and utilization of traditional renewable energy, the establishment and application of new electrochemical energy storage system has undoubtedly become an effective solution [2]. Supercapacitor, as a new type of energy storage device, has obvious advantages such as high power density and fast charge and discharge, which has aroused considerable interest in academia and industry. As one of the national strategic emerging industries, the new energy industry is the direction of green transformation of automobile enterprises, and its own development needs policy support [3]. The current energy storage technologies are mainly physical energy storage and electrochemical energy storage, and supercapacitor is a new type of technical device in physical energy storage, which has a good commercial prospect. At the same time, it is a good supplement to other electrochemical energy storage technologies [4]. As a new type of energy storage device, supercapacitor has been rapidly developed and applied, especially in the field of new energy vehicles, and it has exerted its unique advantages.

The appearance of supercapacitor timely fills the application gap of secondary battery, and has been effectively applied in public transportation, heavy industry and daily electronic products [5]. There are opportunities as well as challenges. The main shortcomings of supercapacitors are low energy density and poor stability under high current density. Supercapacitor is a new type of energy storage device between electrolytic capacitor and secondary battery. It has higher energy density than conventional capacitor and higher power density than traditional secondary battery, and has been applied in electric vehicles, new energy power generation and military industry [6]. Traditional chemical batteries have been used in many fields of life. However, the battery itself has low discharge current and short life, so it is not suitable for a wide range of use. For some demanding fields, this kind of battery is even more inadequate, so it seems that using high-performance energy storage battery is the only way [7]. This paper introduces the principle and characteristics of supercapacitors, and analyzes the supercapacitors based on new carbon-based nanomaterials and their applications in the new energy automobile industry.

2. Supercapacitor Based on New Carbon Nano Materials

2.1. Principle of super capacitor

Supercapacitors, also known as electrochemical capacitors, are widely regarded as electrochemical energy storage devices with development potential between ordinary capacitors and batteries. Electrode of supercapacitor is usually obtained by mixing active material, conductive agent and binder in proportion, drying and tabletting. From the perspective of basic research, many milestones have been made in the research of microstructure and energy storage characteristics of electrode materials. However, if the results of basic research are to be applied to practical applications, it is necessary to analyze and evaluate the whole device [8]. Through the contact between the electrode and the electrolyte, the electrode has a chemical reaction in the electrolyte to form a regular movement of charge, resulting in a double-layer charge at the solid-liquid interface, which has strong stability. Because the whole process is a physical process, it is a new energy storage technology in physical energy storage, and it has a long cycle life, and its charging and discharging efficiency is high. Compared with the traditional energy

storage technology, its charging and discharging process is faster, so it is used in new energy vehicles.

Supercapacitors are widely used as auxiliary power for starting, braking and climbing of new energy vehicles. Frequent start-up, climbing and braking of automobiles cause great changes in the power demand curve, especially in urban road conditions. This requires frequent switching between peak power and working power. The application and development of supercapacitors, to some extent, avoid the disadvantages of traditional energy storage components, and at the same time, make up the gap between traditional capacitors and batteries to some extent.

2.2. Characteristics of supercapacitor

Because of the application principle of supercapacitors, compared with ordinary capacitors of the same volume, supercapacitors have super-high capacitance, which meets the needs of realizing large power consumption in daily life. For pure electric vehicles, fuel cells and series hybrid electric vehicles, this means that either the vehicle's power is insufficient, or the voltage bus often bears a large peak current, which will undoubtedly greatly damage the life of batteries or other APUs. Compared with traditional capacitors, supercapacitors have smaller equivalent resistance and can quickly store and release charges, so their power density is naturally much higher than that of traditional capacitors [9]. The maximum power can reach ten times that of ordinary capacitors. If a supercapacitor with larger specific power is used, when the instantaneous power demand is large, the supercapacitor provides peak power and absorbs peak power during braking feedback, then the pressure on batteries, fuel cells or other APUs can be reduced, thus greatly increasing the power output of the system during starting and accelerating, and efficiently recovering the high-power braking energy. Because of its own performance, it has certain pressure resistance at the charge and discharge level, and the stability of its own system can greatly shorten the charge and discharge time. It does not produce any chemical reaction, and its own stability, whether it is service life or storage life, is much higher than that of ordinary capacitors.

Supercapacitors have short charging and discharging time and high efficiency, and can complete a charging and discharging cycle in a short time, which is far lower than that of rechargeable batteries. They are especially suitable for short-distance vehicles, and their fast charging and discharging characteristics make them more suitable for providing main power for buses. Because the energy density of supercapacitor itself is low, as a pure electric driving force, it can't achieve long-range battery life, so it can only be applied to the auxiliary power of hybrid electric vehicles, and work together with other energy drives, which also limits the development of supercapacitors in the new energy vehicle industry.

3. Application of Supercapacitor in New Energy Vehicle Industry

3.1. As an auxiliary energy storage battery

For carbon-based materials, by directly adsorbing or mixing other kinds of active materials, preparing electrode materials with both electric double layer capacitance and Faraday's capacitance can not only improve the utilization rate of carbon-based materials, but also improve the specific capacitance of electrode materials. In the promotion of new energy vehicles, the driving force and battery are the decisive factors. Battery determines the applicability of new energy vehicles to a great extent. From the aspect of performance, supercapacitor, as one of the main power storage of new energy vehicles, has unique advantages in both power storage and power release. For supercapacitors, after determining the energy storage system composed of electrode materials and electrolyte, it is of great application value to adopt a suitable structure to package it, so as to prolong the cycle life of supercapacitors and realize its industrialized mass production. Figure 1 shows the energy storage battery of a new energy vehicle.

Figure 1. Energy storage battery of new energy vehicle

As a new type of energy storage element, supercapacitor fills the gap between storage battery and conventional capacitor, and meets the requirements of some loads for high-power discharge, such as solar photovoltaic power generation, hybrid vehicles, electric weapons and other occasions. The manufacturing process of stacked structure is simple, and it is widely applicable to electrode materials. However, the area utilization rate of electrode materials in the same volume is not as high as that of common packaging materials, which are usually packaged by pot or non-induced steel [10]. As most capacitors need to be filled with a certain electrolyte to provide conductive ions, how to make the packaging materials have good adaptability with the electrolyte, and isolate the external environment while withstanding certain corrosion, so as to improve the service life of the capacitors, is an important direction for the packaging research of supercapacitors. According to the cyclic test of series capacitor modules in Section, due to the influence of manufacturing process and environmental factors, there will be some differences in electrical parameters of individual capacitors, such as capacity, internal resistance and insulation performance, etc., which will lead to inconsistent voltages among individual series capacitors when they are used in series on a large scale.

3.2. Absorption and transformation of regenerative braking

At present, most of the low-voltage supercapacitors are wound, and the capacitor capacity is increased by reducing the thickness of electrode materials and diaphragm. During the working period of the energy storage system, the cyclic charging and discharging will cause the aging of supercapacitor electrodes and the deterioration of electrolyte, thus making the difference of electrical parameters among the monomers gradually serious. Therefore, when charging and

discharging the supercapacitor energy storage system, if certain voltage equalization measures are not taken among the series monomers, the efficiency of the energy storage system will be affected, and in severe cases, the energy storage system will collapse due to the failure of a single capacitor. Because different electrode materials are used for the anode and cathode of the asymmetric supercapacitor, the advantages of different materials can be fully utilized, thus improving the energy density and power density of the element (see Figure 2).

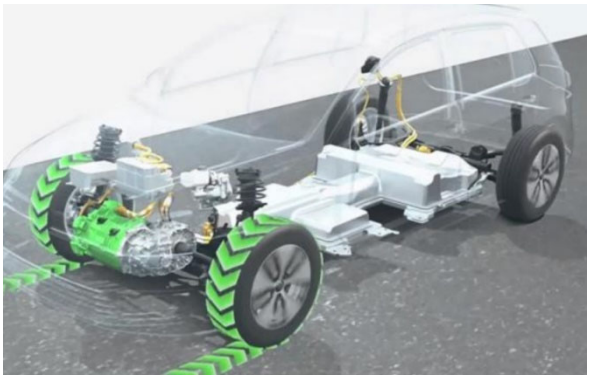

Figure 2. Schematic diagram of kinetic energy recovery of new energy vehicles

Compared with the mainstream electric vehicles on the market, the new energy vehicles using supercapacitors, because of their high power density, allow high-current charging, which greatly shortens the charging time. Moreover, its instantaneous output power is far higher than that of the mainstream electric vehicles in the market, and it can instantly provide a larger discharge current, which is incomparable with that of traditional capacitors. Therefore, as a new type of energy storage equipment, supercapacitor has an ideal utilization rate in electric vehicles. If traditional capacitors and supercapacitors can be combined to give full play to their advantages, the application rate of energy vehicles will be greatly improved, and its development prospect is immeasurable.

4. Conclusions

As a new type of energy storage device, supercapacitor has been rapidly developed and applied, especially in the field of new energy vehicles, and it has exerted its unique advantages. Compared with batteries, the energy density of supercapacitors is low. Finding new electrode active materials and improving the energy density of supercapacitors become the fundamental task of supercapacitors, and it is also the difficulty. This paper introduces the principle and characteristics of supercapacitors, and analyzes the supercapacitors based on new carbon-based nanomaterials and their applications in the new energy automobile industry. For carbon-based materials, by directly adsorbing or mixing other kinds of active materials, preparing electrode materials with both electric double layer capacitance and Faraday's capacitance can not only improve the utilization rate of carbon-based materials, but also improve the specific capacitance of electrode materials. With the continuous development of materials and manufacturing technology, supercapacitors will definitely replace traditional batteries, thus promoting the development of electric vehicle industry and even other industries, and making an important contribution to solving the energy crisis.

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