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Research on the application of nanomaterials in new energy batteries and future development prospects

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Abstract. Nowadays, new energy batteries and nanomaterials are one of the main areas of future development worldwide. This paper introduces nanomaterials and new energy batteries and talks about the application of nanomaterials in new energy batteries and their future directions. Nanomaterials can bring human technology to a new level and bring many new functions to objects. It can be objected that are lighter, stronger, and higher. Because of the smaller surface area, the product made by nanomaterials is more stable. And they have higher sensitivity, as well. However, they have disadvantages too, such as pollution, and poor nanotechnology humans controlled. But in any case, nanomaterial plays a vital role in the technological development of mankind. A new energy battery is also one of the future development goals of mankind, it is an energy-saving battery that can reduce the pollution of the environment. But poor charging speed and poor continuity are its weaknesses. However, it does not stop it from gradually replacing the original traditional battery and becoming the mainstream battery in the future. Nanomaterials play a key role in improving new energy batteries improving the stability of batteries, accelerating battery charging, and so on. It can help people to understand nanomaterials and new energy batteries and their applications. It can also help to understand their future research directions and the market development of nanomaterials and new energy batteries.

Keywords: nanomaterials, new energy batteries, advanced technology, future Introduction.

1. Introduction

Since ancient times, mankind has been using materials to make things develop. When a new material is discovered, it means that there will be great progress for mankind. The better the materials mankind has, the better our quality of life will be. In the past, when technology was not mature, humans used nature as a material. However, this caused great damage to the earth. Gradually, the earth's resources were about to be exhausted and nature was severely damaged by us. Fortunately, mankind has discovered a brand-new material - nanomaterials. Nanomaterials are of great help to mankind, such as computer technology, space technology, fibber optic communication, and so on. Nanomaterials have helped mankind to take a big step forward. Most importantly, nanomaterials have solved the problem of destruction, so that human beings no longer destroy nature.

Besides nanomaterials, new energy batteries are also a successful product under modern technology. Traditional batteries (such as lead-acid and lithium batteries) are old, slow, and unsafe. Their age ends after 500-600 recharges, which is very limited. However, as a comparison, new energy batteries can hold more than 100,000 recharges. In addition, conventional batteries in cars are only used for starting

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and energy storage. In contrast, new energy batteries can provide their power. The traditional battery is a lithium battery, but the new energy battery is an energy storage battery. Therefore, new energy batteries are more environmentally friendly than traditional batteries. In addition, when nanomaterials are used in the new energy battery, it can make the new energy battery more rigid and have higher efficiency. More importantly, nanomaterials can make new energy batteries safer. It makes the new energy battery can be repeatedly shut down and started without receiving any influence. Nanomaterials and new energy batteries are both the focus of human development in the future, but when they are combined together, they can make a brighter spark.

This paper introduces the basic information about nanomaterials and new energy batteries and describes the application of nanomaterials in new energy batteries. In addition, it describes the future uses of nanomaterials and new energy batteries and their future market development.

2. Nanomaterials and new energy batteries

2.1. Nanomaterials

2.1.1. Nanomaterials and technologies. Nanophase materials, obviously, contain nanotechnology. First, a nanometer is a unit of distance, and one nanometer is equal to minus nine cubic meters of ten. Nanotechnology is the scientific and technical problem of studying the laws of motion between nanophases of size 0.1 to 100 and their possible practical applications [1]. Nanotechnology is new in the world and is the main direction of future technological development. Objects made by nanotechnology are different from other materials, such as iron, cotton, silk, etc. Nanotechnology takes people to a new level of technology, a mysterious field related to atoms and molecules [1]. Objects made by nanotechnology have a new system that is structurally ordered and non-equilibrium in state properties [1]. Nanophase materials can bring new functions to the object, such as sound, light, and heat. With the help of nano-phase materials, we can make new materials that are important for human development. Objects made with nano-phase materials are lighter, higher, and stronger. Lighter means that the objects are smaller but have the same capabilities; higher means that the objects have higher capabilities such as light and electrons; stronger means that the nano-phase products do not break easily and have better toughness [1]. Nanophase materials can be divided into several parts. From a chemical point of view, the group of nanophase materials includes nanometals, nanoceramics, nano-glasses, etc. In addition, nanophase materials can be separated by applications, such as nanoelectronics, nano-biotics, etc. Due to the small surface area, objects made of nanophase materials have higher robustness than ordinary materials, and they have higher sensitivity.

2.1.2. Advantages and disadvantages. Nanotechnology has many advantages and has a great contribution to the development of human beings. First, nanotechnologies can treat diseases such as the Ebola virus and even some cancers [2]. Secondly, they can be used in industrial products and consumer products. Most importantly, nanotechnology is widely used in automobiles and sensors, two important areas that are being researched by humans. Surprisingly, nanotechnology can even be added to our foods to make them taste better, which is amazing, right? However, advantages inevitably come with disadvantages. The overdevelopment of nanotechnology may cause pollution to the environment. Moreover, our understanding of nanotechnology is limited, so over-dissemination may cause people to misunderstand nanotechnology.

2.2. New energy batteries

2.2.1. New energy batteries. Another popular technology today is the new energy battery, which is a less polluting type of battery. Nowadays, the most common new energy batteries are lithium battery packs, specifically lithium iron phosphate and ternary lithium batteries [3]. For example, Tesla uses ternary lithium batteries, and cars made by the country are using lithium iron phosphate batteries. In

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addition to these two types of batteries, there are also lead-acid batteries, nickel-hydrogen batteries, lithium manganate batteries, etc., which are included in the new energy batteries.

2.2.2. Advantages and disadvantages. The reason why mankind wants to develop new energy batteries is that they can bring many benefits. The biggest advantage of new energy batteries is environmental protection. As we know, coal and natural gas produce a lot of pollution and are non-renewable resources. Therefore, new energy batteries can effectively solve this problem. In addition to environmental protection, new energy batteries can save money, have higher efficiency, and have no limitations in driving. However, like nanophase materials, new energy batteries also have disadvantages. For example, the biggest drawback is the difficulty of charging. Tesla's chargers are limited, and the charging process is really slow. In addition, they have higher capitalization costs and poor after-sales service. In addition, another big disadvantage of new energy batteries is the short distance. The short distance and low charging efficiency create a lot of difficulties for users of new energy batteries [4].

3. Application of nanomaterials in new energy batteries

With the great development of nanotechnology, nanophase materials have been widely used in many fields. For example, a company called Store Dot has used nanotechnology to create a new energy battery that can be charged much faster than conventional lithium batteries [5]. The main problem with conventional lithium batteries is the electrical resistance. However, the battery made by this company solves this problem perfectly, with almost no electrical resistance. The principle of this technology is that "Nanodot" molecules convert peptides into energy-storage nanotubes that can store and release large amounts of electricity at once [5]. With these “Nanodots”, they can be easily recharged, and 7000 "Nanodots" can fully charge a car [5]. Second, nanotechnology solves the problem of exploding batteries. This type of battery can be turned off and on in repeated heating and cooling without the quantity being affected. It can do this because nickel particles with nanoscale bumps are covered with a layer of graphene and embed these particles in an elastic polyethylene film [5]. Specifically, when the cell is heated above 70 degrees Celsius, the polyethylene film expands rapidly, which allows the nickel particles to separate. Conversely, when the temperature drops below 70 degrees Celsius, the polyethylene film shrinks, and the nickel particles remain attached again. Thus, with the amount of nano-phase material, it effectively solves the collision problem of the battery.

Before man discovered the use of nanotechnology, lithium was the main material for batteries. However, lithium is unstable in batteries, and they tend to lose efficiency in a few rounds. But when the particles were scaled down to the nanoscale, everything was solved. One reason is that when particles have nanoscale dimensions, they are more easily adapted to mechanical strain. Another reason is the increased power due to the reduced diffusion length of the lithium ions [6]. An example is that a metal storage electrode nanostructure referring to a silicon electrode prepared with a nano cylindrical surface morphology [6]. These nanostructures can expand the space to improve the charge transfer and provide a great improvement to the cyclic reaction. Another benefit taken is the morphology of tin oxide in the form of nanofibers prepared using a specific temperature plate technique [7]. It was shown that these nanoparticles are stable in terms of cyclic reactions and have high efficiency. In addition, nanoscale particles are useful for controlling the poor electronic conductivity and low diffusivity of lithium ions in the reaction phase [7]. Another situation is that the dispersion of nanoparticle size can produce LiFePO4 electrodes with enhanced electrochemical properties [7]. Through our study, we know that nano powder is the key to the growth of lithium iron phosphate particles and makes the connection between electronics, as well. It leads to an increase in the IR and mutual conductivity of the particles. In addition, these metal complex lithium iron phosphates can cycle efficiently and provide good capacity at room temperature [8].

3.1. CQDs and GQDs

A new type of nanomaterial is known as carbon quantum dots nanomaterials. They are created from shiny, tiny dispersed spherical carbon particles. It consists of carbon, hydrogen, and oxygen particles,

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usually amorphous sp^2 hybridized carbon cluster structures. Quantum dots of carbon materials include graphene quantum dots and carbon quantum dots with a distinct lattice [9]. Carbon quantum dots and graphene quantum dots nanomaterials have become popular in recent years.

Carbon quantum dot nanomaterials can provide an electron transport layer for batteries, which can select electricity and transfer electrons to a conductive glass [10]. In addition, it can effectively block the holes' nanomaterials perfectly solve the hysteresis and stability problems of the electron transport layer for power transfer and extraction. One example is that fast electron extraction can be induced by introducing oxygen plasma treatment of graphene quantum dots on the blocking layer. With the help of the graphene quantum dots material, the photovoltaic conversion efficiency is increased by 10 % to reach an optimal tetrachloroethylene of 19.11 % [11]. For a real example, in 2018, a group of people made a chalcogenide solar cell with fluorine-dropped tin oxide and cesium lead bromide. Then, they increased its efficiency to 4.1 % and improved its stability by using graphene quantum dots for interfacial modification [12]. In addition, the migration of ions leads to lower transmission efficiency of chalcogenide solar cells and surface defects in chalcogenide films due to insufficient coordination of metal cations with halide anions [12]. Therefore, the cell will use carbon quantum dots to increase the size of the carcinogen grains to reduce the non-radiative complexation of carriers. Here is a real example, in 2019, a group used phenyl-C_{61}-butyric acid methyl ester films doped with sphere-like carbon quantum dots as an electron transport layer for inverted chalcogenide solar cells [12]. As a result, they found that sphere-like carbon quantum dots can improve conductivity, electron mobility, and charge extraction efficiency, as well as their stability.

4. Future development

Materials have always been an important factor in determining human development. Without the materials, humans could not even survive. Also, human civilization will not advance either if people do not find new materials. Luckily, with the rapid development of human technology, new materials are soon discovered. In the future, nanomaterials and new energy batteries will become mainstream because they are stronger, faster, and better. They will gradually eliminate old, traditional materials and push human technology into a new era. Imagine how cool it would be if an electronic car could drive you hundreds of miles with only 3 minutes of charging [11]. In addition to cars, nanomaterials and new energy batteries can be used in many other areas. For example, they could be used in aluminium robots. The latest Al robots use a modular lithium-ion battery system, which has a larger capacity and is easily expandable.

In the past, when nanomaterials and new energy batteries were first discovered, they were so expensive that many households could not afford them. So, new energy batteries had no markets and were not so popular at that time. Then, as technology evolved, the price of new energy batteries dropped dramatically. The average price of a lithium battery is less than $500, compared to one-third of the price in the past. In addition, the most popular battery of the future is called a graphene polymer material battery. The power density of an ordinary lithium battery is around 180-200 Ah/g, while the power density of a graphene polymeric material battery is over 600 Ah/g, which is more than three times of an ordinary lithium battery. Graphene polymeric material battery has many advantages, for example, if you put a graphene polymeric material battery in Tesla, its driving range can reach 1500km, which is three times the previous one. In addition, it can be charged much faster than lithium battery and its service life is two times longer than lithium battery. In addition, the most important point is that it costs 77 % less than lithium batteries, which means that the cost of energy vehicles will also be lower [13]. As it mentioned above that new energy batteries have weaknesses in charging speed and continuity, but the Graphene battery recovers it perfectly. Therefore, the new energy batteries will be the main direction of human technology's development, and the graphene polymeric material batteries will be the key development target.

Nanomaterials are also a major area of human research in the future. As shown in Fig. 1, the market size of nanomaterials is gradually increasing every year. From less than 80 billion in 2016 to more than 150 billion in 2022. People can see that nanomaterials technology is getting better and more popular. I

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predict that the market size will continue to grow in the future. As shown in Fig. 2, the forecast for nanomaterials in ten years. The total value of nanomaterials soars within these ten years. As mentioned above, the world will go into the nano age soon in the future. The graph shows that nanomaterials can significantly improve the level of human technology. Therefore, nanomaterials will be vigorously developed in all countries in the future.

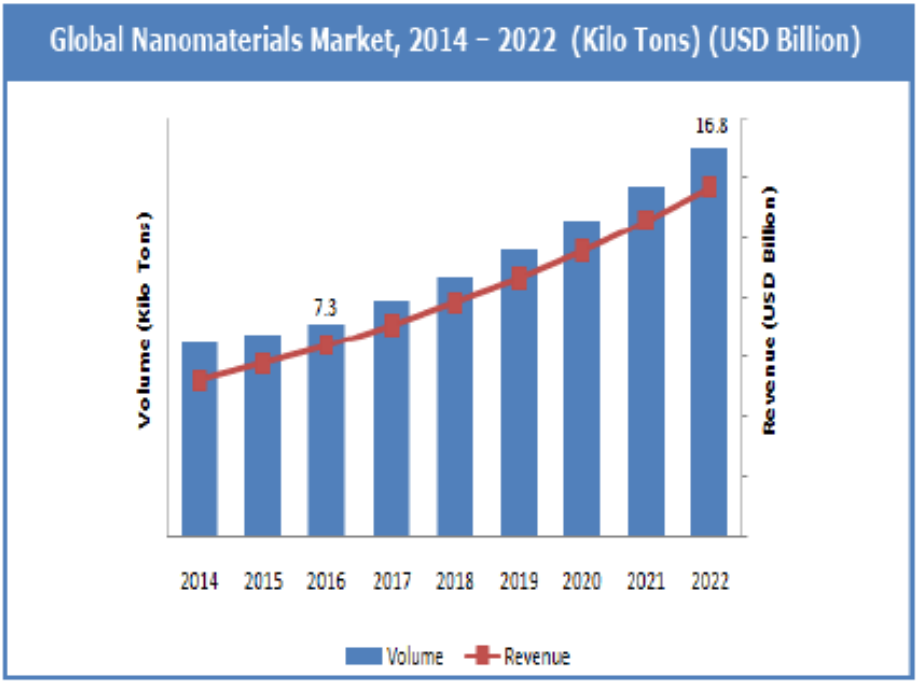

Figure 1. Global Nanomaterials market data, from 2014-2022 [14].

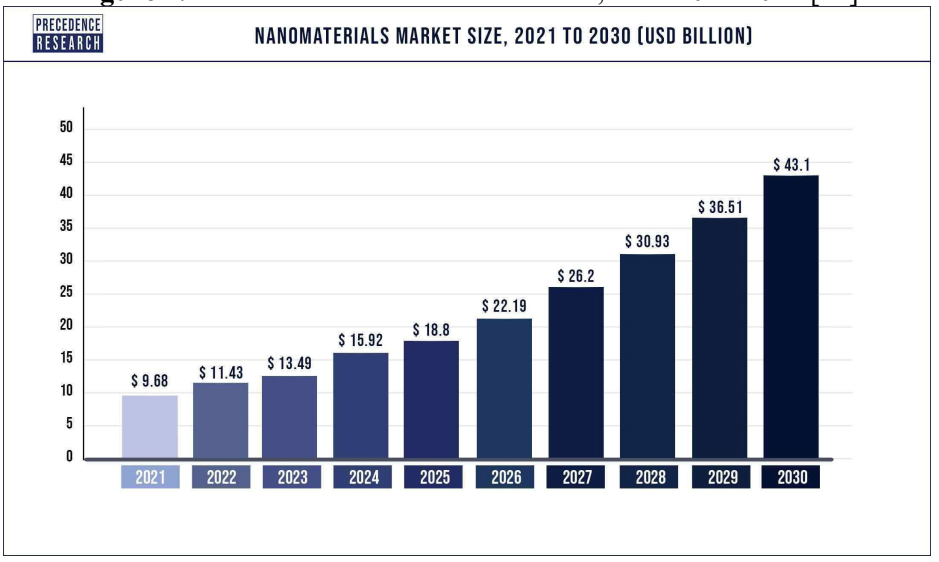

Figure 2. Nanomaterials market size prediction, from 2021 to 2030 [15].

5. Conclusion

In conclusion, nanomaterials and new energy batteries have been and will be the main development direction of mankind in the next two decades. Both nanomaterials and new energy batteries are the latest technologies in the world. Nanomaterials have brought mankind into a whole new field of technology and are widely used. New energy batteries have better numbers and are the most popular batteries used

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in vehicles that also include nanotechnology. Nanotechnology can be an effective solution to many areas of battery problems, allowing for improved performance. In the future, people will continue to study them and even more, discoveries will be made about them. In addition, the cost of nanomaterials and new energy batteries will come down and approach civilian use. In addition, there are still many things that people do not know about nanomaterials and new energy batteries, so humans need to discover them in the future. This article shows the meaning of nanomaterials and new energy batteries to those who are confused about what they mean. In addition, it tells people about the use of nanomaterials in new energy batteries and makes predictions about their future.

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