

The Application and Prospect of Nanotechnology

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Abstract

With the constant development of science and technology, the application of nanotechnology has gradually been expanded to a variety of fields. In fundamental research of emerging industries, the application of nanotechnology has become an important efficient, multi-functional and eco-friendly practice, which had played a positive role in promoting industrial development. The purpose of this study is to address the application and prospect of nanotechnology. In this study, literature review and case analysis are used to probe in the application and prospect of nanotechnology. The basic theory and application fields of nanotechnology, as well as its application in experiments are analyzed through literature review. By studying the application and prospect of nanotechnology, we can identify its development potential and wide application prospect in various fields. In the future, nanotechnology is expected to bring more benefits and development opportunities to mankind. On the other hand, we should also pay attention to the potential risks of nanotechnology to mankind and the environment, take effective measures to lower its negative impact and facilitate the healthy development of nanotechnology.

Keywords

Application of Nanotechnology; Nanomaterials; Nanomedicine; Prospect of Nanotechnology.

1. Introduction

As one of the most promising technologies for development and research, nanotechnology not only has considerable theoretical research value, but also has broad application prospects both at present and in the future. Since the late 1980s, the research and development of nanotechnology has been taken seriously by all countries in the world, and even some countries have enabled the application of this technology. Nanotechnology has been applied in quite a few traditional industries, such as healthcare, food technology and building materials. Especially in the field of building materials, the application of nanotechnology not only enhances the quality of construction works, but also strengthens the functionality and applicability of buildings. The application of nanotechnology is also of vital significance for the construction industry in China, especially tapping foreign markets through its advantages in high and new technology.

To deeply study the application and prospect of nanotechnology, the author combines comprehensive analysis with experimental study to explore its application and development trend in building materials, health care and food technology, etc., in the hope of providing scientific basis and reference for technological innovation and industrial upgrading in related fields. At the same time, our study will also focus on the safety and environmental impact of nanotechnology to ensure the sustainability and social benefits of its applications.

2. Basic theory of Nanotechnology

2.1 Definition and History of Nanotechnology

The definition and history of nanotechnology has become the foundation of nanotechnological research, and a prerequisite for the understanding of its application and prospect. Nanotechnology is a technology that can achieve control, and change the structure of substances. The particle size is generally nanoscale, that is, 1-100 nm, hence the name “nanotechnology”. Nanotechnology originated in 1950s, which was coined by Richard Feynman at that time, but it didn’t really develop until 30 years later. With the invention of scanning tunneling microscopy and the preparation of monatomic layer, an important theoretical foundation is laid for the development of nanotechnology.

2.2 Physical Properties at the Nanoscale

Physical properties at the nanoscale are one of the cores of the development of nanotechnology. Nanomaterials often have a variety of physical properties that are quite different from macroscopic materials. Therein, the surface area characteristic of nanomaterials is the most conspicuous aspect. The surface area of nanoparticles is much larger than that of macroscopic particles of the same volume, which leads to a unique set of physical properties. For example, the optical, electrical and other properties of nanoparticles are closely related to their special surface area. In actual application, it is common to use the high surface area of nanoparticles to improve the rate of catalytic reaction, enhance sensitivity to light and increase magnetism.

In general, physical properties at the nanoscale have a profound effect on the preparation, characterization and application of nanotechnology. It is beneficial to the further development of nanotechnology to investigate the use of nanomaterials and design specific applications, based on an inquiry into physical properties.

2.3 Preparation and Characterization of Nanotechnology

The preparation and characterization of nanotechnology is an important foundation of the application of nanotechnology. Therein, the preparation of nanoparticles is a crucial part of nanotechnology. So far, the preparation of nanoparticles mainly includes three methods, physical method, chemical method and biological method.

3. Application Fields of Nanotechnology

3.1 Application of Nanomaterials

Nanomaterials refer to materials with nanoscale characteristics, which exhibit unique physical, chemical and biological characteristics. With the constant development of nanotechnology, nanomaterials have become more and more widely used. Today, the applications of nanomaterials mainly focus on the following aspects.

Firstly, nanomaterials are applied to the manufacture of electronic devices. Due to the tiny size of nanomaterials, their electronic properties are ever-changing, such as the electron spin quantization of their carriers, quantum confinement effect (QCE), etc. These properties allow nanomaterials to be widely used in the manufacture of electronic devices. What’s more, nanomaterials are also widely applied in the environmental protection industry. Nanomaterials have extensive applications in the aspects of wastewater treatment, air purification, garbage disposal and water quality testing. Lastly, nanomaterials are also used in the field of medicine. In short, the application of nanomaterials in numerous fields will be continuously explored and promoted in the near future. With the constantly development and breakthrough of nanotechnology, the performance of nanomaterials will be further enhanced, thereby creating a better future for mankind.

3.2 Nanoelectronics

Nanoelectronics refer to the application of nanotechnology in the field of electronics. With the constant progress of science and technology, people are increasingly demanding for electronic components, and the development of nanoelectronics provides a new train of thought for the

manufacture of electronic components. The main directions of nanoelectronics include nanocircuits, nanosensors and, quantum dot devices, etc.

In the field of nanocircuits, considerable progress has been made in nanowire technology and nanotube technology. Nanowire technology can produce metal wires and semiconductor wires with a diameter of only dozens of nanometers, while nanotube technology can produce tubular structures with a diameter ranging from one to dozens of nanometers. These nanowires and nanotubes can be adopted to manufacture higher-performing integrated circuits and super-fast data transmission devices.

In general, nanoelectronics is very widely applied in the field of electronic devices, including integrated circuits, sensors and quantum dot devices, etc. These devices play a vital role in the development of electronic technology and render a more advanced technical support for the development of human beings.

3.3 Nanomedicine

Nanomedicine is a field that has proliferated fast in recent years, which improves medical work by using nanotechnology. Nanotechnology has brought some new tools and approaches to medicine, so it can enhance the level of medicine in many ways, especially in terms of diagnosis and treatment.

In the first place, nanotechnology is very widely used in the field of disease detection. Being tiny and sensitive, nanosensors can detect a specific set of biomolecules, such as DNA, proteins and hormones. Secondly, nanoparticles have a wide range of applications in nanomedicine. Nanoparticles are ideal carriers for drug delivery systems, and the amount of drug loaded and their release rate can be adjusted by changing their size, shape and chemical properties on the surface. Finally, in nanomedicine, another important application field of nanotechnology is therapy. For different diseases, researchers have prepared all kinds of nanomedicine products, such as nano-drugs, nanomedical devices and nanometer diagnosis and treatment systems.

3.4 Nano Energy

Nanotechnology is increasingly widely used in the field of energy. The main purpose is to improve energy efficiency and reduce energy waste, so as to better satisfy the energy needs of contemporary society, and also ease the burden on the environment and alleviate the shortage of energy. The application of nanotechnology can significantly improve all kinds of energy sources, such as solar cells, fuel cells, lithium-ion batteries and hydrogen energy. In addition to this, nanotechnology can also be adopted to prepare energy storage materials, such as improving the properties of lithium-ion batteries and preparing high-performing hydrogen storage materials, etc. using nanomaterials. In conclusion, the application of nanotechnology is of vital importance for the improvement of energy efficiency, the reduction of energy waste, and the protection of the environment. With the development of nanotechnology, it is believed that more promising application fields will spring up, which will contribute more to the sustainable development of energy.

4. Application of Nanotechnology in Experiments

4.1 Preparation Experiment of Nanomaterials

In the field of nanomaterials, preparation experiment is one of the steps of the utmost importance. There are diversified ways to prepare nanomaterials, such as sol-gel method, rapid gelation method, hot melting method, vapor condensation method, etc. Among them, sol-gel method is a relatively commonly used method, which prepares gels in the form of sols and converts gels into nanomaterials through heat treatment and other methods. The rapid gelation method is a preparation method of nanopowder samples that uses organic matters to swell in a supercritical state, forms a polymer network structure, and then quenches fast using high pressure.

4.2 Characterization Experiment of Nanomaterials

In the field of nanotechnology, the preparation and characterization of nanomaterials are crucial research interests. This chapter will focus on the characterization experiment of nanomaterials.

To characterize nanomaterials, we need to adopt a variety of chemical, physical, electrical and optical methods, etc. Among them, the most commonly used methods are transmission electron microscopy (TEM) and scanning electron microscopy (SEM).

4.3 Nanoelectronics Experiment

As a new subject, nanoelectronics mainly study the behaviors of electrons at the nanoscale and their application in nanostructures. Nanoelectronics experiment is one of the powerful ways to investigate nanoelectronics, including electrical property test, device preparation and performance test, etc.

5. Prospect and Challenges of Nanotechnology

5.1 Market Prospect of Nanotechnology

With the constant update of technologies and unceasing improvement of nanotechnology, nanotechnology market has shown a promising prospect. The manufacture and application of nanomaterials have played an important part in shaping a more efficient and eco-friendly future.

To begin with, through the application of nanotechnology, many traditional industries have been refined in efficiency and quality. In the energy industry, for example, nano-products can be adopted to produce more efficient, durable and safe batteries. In the field of medicine, nanotechnology has realized precision treatment and diagnosis and greatly improved the level of medical treatment.

Secondly, nanotechnology can also bring about more opportunities for the development of emerging industries. With the characteristics of self-repair and self-assembly, nanotechnology can bring new innovations to the sustainable development of manufacturing, electronics, information technology, biology and healthcare, etc. We can foresee that with the constant advancement of science and technology, nanotechnology will usher in future innovations and wonders for us in more fields.

5.2 Safety and Ethical Issues Confronting Nanotechnology

As nanotechnology develops rapidly, people begin to pay more and more attention to its safety and ethical issues. To begin with, the application of nanotechnology may result in the release of toxic substances and pollute the environment. Secondly, when nanotechnology is applied in the medical field, it can pose an unknown health risk to humans. Thirdly, the spread of nanotechnology may cause social inequality. As the current research and production of nanotechnology still requires a heavy investment, probably only a handful of people can enjoy its benefits. Fourthly, the application and development of nanotechnology can also give rise to ethical and moral issues.

To address these safety and ethical issues, firstly, the government has set safety standards for the research and application of nanotechnology, and monitored manufacturers. Secondly, attention should be paid to environmental protection and utilization of resources in the preparation and use of nanomaterials, and more eco-friendly production process and reduction measures should be adopted. Thirdly, the research on nanotechnology in the field of molecular medicine should be intensified to further understand its potential role and risks in biology. Finally, public awareness and understanding should be raised through education and publicity, and insecurity and ethical issues posed by nanotechnology applications should be avoided.

5.3 Future Direction of Nanotechnology

Nanotechnology is a hot field that has been spotlighted in recent years, which has a promising future. Based on the existing research, we can see that the future development of nanotechnology can be mainly divided into the following directions:

First of all, the field of biomedicine. With the development of nanomaterials, nanomedicine has become a key area in the research of medical equipment. Nanotechnology has notable advantages in controlled release drugs, as well as the preparation of biomaterials, etc. Secondly, the field of energy.

Nanotechnology can improve the specific surface area and physical properties of materials. It has a wide range of energy applications. Nanomaterials have unique electronic, catalytic and adsorption properties, and can be adopted to prepare solar cells, fuel cells, nanoscale catalysts and energy storage materials, etc. Thirdly, the field of new materials. Nanotechnology can be used to produce new nanomaterials, such as metal nanomaterials, ceramic nanomaterials and polymer nanomaterials, etc. These materials have high strength, high stability, high temperature resistance, special optical and electrical properties, and they determine the usage of nanomaterials in the field of new materials.

Generally speaking, the future of nanotechnology is promising, but safety and ethical issues need to be taken care of. We can adopt more active measures to research and develop nanotechnology, so that it can play a broader role and better serve the mankind.

6. Conclusion

6.1 Advantages and Disadvantages of the Application of Nanotechnology

Nanotechnology is a hot technology in the field of science and technology since the 21st century, which has super-strong material science and engineering capabilities. Compared with traditional technology, nanotechnology has a lot of advantages. To begin with, nanotechnology can perfect the properties and characteristics of materials satisfactorily. Secondly, nanotechnology can significantly improve the efficiency and accuracy of existing technologies. Nanotechnology can be used to create precise nanoscale tools and instruments. These tools are far more precise than traditional tools, which allow them to determine the properties and structures of various substances accurately and manufacture even better nanodevices on the basis of them.

However, nanotechnology also has some defects. The production process of nanotechnology has a lot of environmental risks, for example, nanoparticles may spread to the environment through air or water, and pose unpredictable hazards to human body and the environment. Secondly, safety issues, ethical issues and legal issues of nanotechnology in the process of application are also worthy of attention. Taken together, nanotechnology has great potential and prospect, but to avoid the adverse environmental and ethical problems caused by nanotechnology, it is necessary to evaluate its advantages and disadvantages in all-round way, develop scientific and technological policies and norms that maximize its benefits and minimize its obligations, with a view to solve the contradiction between established goals and needs fundamentally and give better play to nanotechnology in practice.

6.2 Future Direction and Research Focus of Nanotechnology

With the rapid development of nanotechnology, the future directions are intelligent, digital and functional. Intelligent means that nanomaterials can receive and process information through system and the Internet, so as to achieve programmability and controllability. Digital means that nanotechnology has been widely applied in the process of digitalization, such as nanoelectronics, nanosensors and nanorobots, etc.

In nanotechnology studies, the focuses of future research are multifaceted. First of all, the research of nanodevices, including nano-metamaterials, nanoaerogels and nano-films, etc. Secondly, the research of nanodevices, including nanotransistors, nanomanipulators and nanosensors. In addition, the problems of nanobiomaterials and nanoenvironment, etc. need to be explored further. These studies will conduce to the application and development of nanotechnology.

To sum up, in the application and prospect of nanotechnology, we need to evaluate the advantages and disadvantages of its application in an all-round way, explore the future direction and research focus, establish a scientific and reasonable evaluation and regulation mechanism on a case-by-case basis, and step-up standardization and international cooperation to facilitate the sustainable development of nanotechnology.

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