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The Analysis of the Development and Application Prospects of Nanomaterials

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Abstract: Nanotechnology is one of the most revolutionary sciences and technologies in the 21st century, involving materials science, physics, chemistry, biology and other fields. Nanomaterials, as the core of nanotechnology, exhibit their unique physical and chemical properties that make them highly promising for a wide range of applications in various fields. In 1981, Japanese scientist Mieko Kawamura successfully prepared nanoscale ceramic particles for the first time, laying the foundation for the research of nanomaterials. Since then, the research of nanomaterials has gradually attracted the interest of scientists. This paper will discuss the development of nanomaterials, current research hotspots and future application prospects. The main research method we use in this article is a literature review, which mainly studies the development and application of nanomaterials in today's era, as well as some problems and challenges we are facing at present. The high production cost of nanomaterials limits their large-scale application. The safety of nanomaterials is still in doubt, and their impact on the environment and human health still needs to be further evaluated.

Keywords: Nanomaterials, nanobiotechnology, electronics, environmental protection technology.

1. Introduction

The concept of nanotechnology dates back to 1959, when physicist Richard · Feynman hinted in a speech that there was plenty of room at the bottom, predicting that future technologies could operate at the atomic and molecular levels. However, it wasn't until the invention of the scanning tunneling microscope (STM) in 1981 that humans really had the ability to observe and manipulate matter at the nanoscale. Nanomaterials are defined as materials that possess at least one dimension within the range of 1-100 nm, or they can function as basic units comprised of approximately 10 to 1,000 atoms densely packed together. Nanoscale structural materials, nanomaterials, and the size of their structural units are between 1 nm and 100 nm. Since its size is already close to the coherence length of the electron, its properties are greatly changed because of the self-organization brought about by the strong coherence. Moreover, the scale of the material is similar to the wavelength of light, and it exhibits unique characteristics due to its large surface area, so its properties such as melting point, magnetism, optics, thermal conductivity, electrical conductivity, and so on, are often different from those of the material in its overall state. Tianao Chen et al. discussed this in their work on micro-nano materials through interface shearing, highlighting its significant influence on several domains including biology, medicine, and chemistry, and its profound impact on human life [1]. The preparation and exploration of these materials are of great significance. Microdroplets play an important role in various scientific fields, including single-cell analysis, drug release control and catalyst. Traditional methods such as emulsification, high-speed stirring and layered assembly have made great contributions to the production of microdroplets.

Regarding that article, this paper mainly adopted the research method of literature review, mainly studying the application of nanomaterials in various fields and some problems that have been identified. The purpose of this article is to provide a summary of recent developments in nanomaterials and to identify future challenges that need to be addressed.

2. Application of nanomaterials

2.1. Application of medicine

Nanomedicine refers to the application of nanotechnology with the purpose of accurately diagnosing, treating, and preventing diseases at the molecular level. Nanomedicine carriers have the potential to enhance the precision and absorption of medications while hence minimizing adverse reactions. Advanced nanodiagnostic technologies have the potential to facilitate the timely identification and precise management of diseases. Advancements in nanomedicine show great potential for enhancing human health. According to the Advances and Prospects of Gold Nanorods by Da-Peng Yang Dr. and Da-Xiang Cui, the progress of nanotechnology has led to the growing exploitation of several new nanomaterials with distinct characteristics including magnetic, electrical, and photonic activities [2]. Gold nanorods, characterized by their rod-shaped structure, exhibit significant promise in the realms of biology and biomedicine, particularly in the domains of photothermal therapy, biosensing, imaging, and gene delivery for cancer treatment. Numerous research groups have demonstrated significant interest in gold nanorods and have endeavored to further their potential clinical uses. Nevertheless, the quantum size effect of nanomaterials has also generated worries over their possible toxicological liabilities. Hence, it is more imperative to investigate and advance the analysis of the biological impacts of gold nanorods in the next future. Furthermore, the significant contribution of nanomaterials in the field of medicine is also profoundly evident in the investigations conducted by other scientists. In his book "Nanomedicine and Nanovaccinology Tools in Targeted Drug Delivery," Bogala Mallikharjuna asserts that infectious diseases are the primary cause of mortality globally, exerting a substantial influence on public health and the socio-economic progress of the human population [3].The swift emergence of medication resistance in pathogens to existing treatments, together with the substantial adverse consequences that arise from their extended use, present a grave risk to public health and safety. Hence, it is imperative to create novel biomedical therapies. Despite being relatively young, nanomedicine and nanovaccine drug delivery technologies are swiftly revolutionizing biomedical research. They serve as a crucial platform for regulating the administration of drug therapies to the intended location. In the context of treating chronic human diseases, these technologies provide numerous advantages by enabling accurate drug administration to defined targets.

2.2. Application of electronics

Nanomaterials have promising applications in electronics. For example, carbon nanotubes and graphene are considered ideal materials for next-generation electronic devices due to their excellent electrical conductance and mechanical strength. The development of nanoelectronics will drive revolutionary advances in computer, communication, and sensing technologies. Peng Yingcai and Zhao, in their discussion of 21st-century nanoelectronics, emphasize the impact of historical development on emerging disciplines and technology. They argue that these developments are rooted

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in fertile scientific soil, such as the emergence of quantum mechanics leading to the formation of the solid belt theory and the birth of solid-state electronic devices, which has resulted in rapid development in microelectronics technology, serving as a clear example [4]. The emergence of nanoelectronics at the beginning of this century is deeply rooted in both social and technological developments. It is generally believed that there are two paths for the origin and development of nanoelectronics. The first pathway involves top-down development, which focuses on the size and dimensions of solid-state electronic devices made from inorganic materials. The second pathway involves bottom-up development, which is based on the self-assembly scale of chemical organic polymolecules and biomolecules. And other scientists have also proposed a more optimistic outlook for the application of nanomaterials in electronics. Wen Dianzhong, Li, and Xiaofeng Zhao stated in their research and outlook on nanoelectronics that solid nano materials are experiencing rapid development within the field of nanotechnology. They believe that this century will witness significant advancements in science and technology, with broad prospects for the application of nano materials. Despite this progress, silicon remains the most important, largest, fastest developing, and widely used semiconductor material [5].Currently, more than half of the world's semiconductor devices are composed of silicon. Subsequently, amorphous silicon and microcrystalline silicon thin films were developed, leading to the advancement of solar cells and thin film transistors, exhibiting special functions in light, force sensitivity, and color sensitivity. The recent emergence of nanosilicon films has garnered attention due to their unique performance characteristics. Nano silicon thin film is made of semiconductor planar technology under specific process conditions. Its process program is fully compatible with silicon devices and integrated circuits, which is a great advantage.

3. Prospects and challenges of nanomaterials

3.1. Development prospects of nanomaterials

Furthermore, nanomaterials have demonstrated significant promise in the fields of environmental management and energy advancement. Nanocatalysts have the potential to enhance the catalytic efficiency of chemical processes involved in the breakdown of contaminants and the effective conversion of energy. Furthermore, nanomaterials have the potential to enhance the efficiency of energy devices, including solar cells and lithium-ion batteries. Jayaprabakar and other academics have expressed their perspectives on the application of nanomaterials in the renewable generation of hydrogen. Their study centers on the technical challenges of choosing suitable nanomaterials, comprehending their characteristics, investigating various manufacturing techniques, and scrutinizing their commercial usage [6]. The creation of hydrogen has seen a substantial surge in interest, mostly driven by the increasing recognition of the exhaustion of fossil fuel reserves. The widespread availability and unique characteristics of hydrogen make it highly suitable for numerous energy applications. Its storage and productivity have consistently been the main focus of development. Analysing the suitability of hydrogen as an energy carrier is crucial for comprehending the possibilities of green hydrogen production. Naturally, there exist some limitations and multitude of challenges that must be addressed in the implementation of nanomaterials. In their study titled "Toxicity and Risk Assessment of Nanomaterials," Chaudhery et al. propose that the widespread use of nanomaterials (NMs) can significantly enhance their dissemination to the environment, including air, groundwater, and soil [7]. Nanomaterials (NMs) have the potential to be released into the environment during their whole lifespan and, being hazardous, so heightening their associated hazards. When released into the environment, the unique characteristics of nanomaterials (NMs) might lead to unacceptable consequences in the ecosystem. In addition, apart from possessing direct hazardous characteristics, nanomaterials (NMs) can potentially interact with substances in an unwanted manner or bind nutrients due to their unique form, surface, or electronic charge. Both the

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duration and manner of their persistence are still being investigated. Furthermore, once nanomaterials (NMs) are introduced into the environment, they have the potential to stockpile in environmental organisms. A crucial aspect in assessing the danger of exposure to nanomaterials (nm) is their stability and expected alterations upon entering the environment. These studies necessitate our ongoing enhancement and resolution of these issues in future investigative endeavors.

3.2. Discussion

At this stage, the research on nanomaterials is carried out very rapidly. It has a wide range of applications in many fields, and the development prospects are very broad. In the future, more fields will use the relevant technologies of nanomaterials, and some existing products will also be upgraded and improved. Of course, it is undeniable that numerous challenges still need to be encountered, and a multitude of problems need to be addressed, such as production costs and technological upgrades. It is believed that through persistent research, these problems will be ultimately resolved. The development and application of nanomaterials is the result of interdisciplinary integration, which not only promotes the progress of science and technology, but also provides new ideas and methods to solve the numerous challenges faced by human beings. Although the research and application of nanomaterials still face many challenges, such as safety and environmental impact, with the continuous progress of science and technology and the improvement of policies, nanomaterials will play an increasingly important role in future scientific and technological development and social progress.

4. Conclusion

This paper provides an overview of the development of nanomaterials and their current applications, while also exploring some associated problems and challenges. Nanotechnology is a technology that studies and manipulates substances on the nanoscale, which has a far-reaching impact on the development of human society. Nanotechnology has promoted the innovation of scientific research, revealed new physical, chemical and biological phenomena, and has also paved the way for the development of basic science. It not only promotes economic growth and industrial development, but also provides a powerful tool for environmental protection and sustainable development. In short, as an interdisciplinary cutting-edge technology, nanotechnology plays an irreplaceable role in promoting social progress, improving quality of life and promoting environmental protection. There are still several limitations in this research. For example, there is a lack of specific project surveys, and the literature conducted is not comprehensive enough. Further research on nanomaterials and other related fields will be conducted in the future. As an interdisciplinary cutting-edge technology, nanotechnology has broad development prospects. It has great potential in medicine, energy, material science and other fields, but it is necessary to solve the problems of safety, industrialization and standardization in order to realize its real value.

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