ORIGINAL ARTICLE

# Nano Composite Materials for Optoelectronic Devices Application

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***Abstract:*** Study on the design, preparation, application and performance of nano-scale materials has been attracting attentions of researchers in related fields. Nanocomposite structures in all dimensions can play an effective role in optoelectronic materials and devices. It can become the basic component of a variety of optoelectronic devices, such as organic solar cell (OSC), organic light-emitting diode (OLED), optoelectronic sensor, quantum dot light-emitting diode (QLED), etc., and give these optoelectronic devices unique electrical, optical and mechanical properties, providing a new way to prepare novel optoelectronic functional devices with high performance. With the design of novel structures and the development of materials, the application field scope of nanocomposites continues to broaden and the costs continue to be reduced. These all promote the development of related electronics manufacturing, aerospace and biomedical fields.

***Keywords:*** Optoelectronics; Nanomaterials; Organic Semiconductor; Quantum Dots

## 1. Introduction

Under the background of huge application and development of nano-materials, a variety of micro-nano material preparation and processing methods have emerged and have been continuously developed, including nano-imprinting, atomic manipulation, photolithography, focused ion beam etching and other technologies.[1-4] However, the high cost and limited production of these technologies have severely limited their widespread use. Therefore, the development of low-cost, large-scale nanomaterial preparation methods can promote the large-scale application of nano-optoelectronic devices. In addition, the application field of nanomaterials in optoelectronic devices is also expanding. In addition to excellent photoluminescence properties, quantum dot materials can also be fabricated as QLED device, which is widely used in the field of display and lighting;[5] One-dimensional nanomaterials, such as organic semiconductor nanowires and carbon nanotubes, show excellent performance in optoelectronic devices;[6,7] noble metal nanoparticles can effectively improve device performance when applied in organic optoelectronic devices;[8] two-dimensional nanomaterials, such as graphene and transition metal disulfides, also play a great role in the field of optoelectronic devices.[9,10] However, there are still many problems in the research and application of nano-optoelectronic devices. For example, there is still a lot of room for improvement in photoelectric conversion efficiency, luminous efficiency, sensing sensitivity, and device stability. Development of novel nanomaterials in various dimensions and improvement of the device performance are particularly important.

## 2. Preparation of quantum dots and development of QLED device

As an inorganic semiconductor material, quantum dots have the advantages of high color purity, narrowluminescence spectrum, and good light stability. They have attracted widespread attention in the fields of full-


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-color display and solid-state lighting. Electroluminescent device based on quantum dot technology, namely QLED, has the characteristics of low cost, high color saturation, high stability, solution processing- and flexible devices-compatibility. At present, they have begun to move from research laboratories to commercial applications in the display field, which will directly change the human lifestyle in the future. QLED technology still needs further research since the theoretical basis of its carrier injection and transport, carrier recombination, and luminescence needs to be improved. This is important for the development of QLED with low operating voltage, high luminous efficiency, and long operating lifetime.

# 3. Application of metal nanoparticles in organic optoelectronic devices

Noble metal nanoparticles, such as gold, silver, copper, etc., have a local surface plasmon resonance effect. When they are introduced near the luminescence group and have a suitable distance, the luminous intensity can be significantly improved. This phenomenon is usually referred to as "metal-enhanced fluorescence". When noble metal nanostructures are introduced into organic optoelectronic devices through appropriate modification method, the performance of the devices can be significantly improved by reasonable adjustment of related parameters. Because large-scale preparation of metal nanoparticles can reduce their costs to a large extent, this research can promote the research and development of low-cost and high-performance organic optoelectronic devices, and promote their large-scale commercial applications.

# 4. Preparation of one-dimensional semiconductor nanomaterials and study of their optoelectronic properties

One-dimensional semiconductor nanomaterials have many unique optoelectronic properties, so they have broad application prospects in the field of nano-optoelectronic devices. When homogeneous one-dimensional nanomaterials based on the growth of a single material are used in photoconductivity application, effective exciton separation is generally not easy to occur under light conditions, resulting in poor photoconductivity performance. One-dimensional organic semiconductor nanomaterials with heterojunction structure were prepared based on electron donor/acceptor materials with specific structures, which can overcome the difficulty in charge separation of homogeneous materials. However, the stability of heterojunction structure-based device will be affected by the introduction of different materials. Therefore, the design and preparation of one-dimensional semiconductor nanomaterials with high stability and high photoconductivity has aroused great attention in related research fields. By investigating the factors that affect one-dimensional semiconductor nanostructures, understanding the methods of controlling their composition stability, and studying the relevant optoelectronic property mechanisms are of great significance for achieving breakthroughs in their research and application.

# 5. Preparation of two-dimensional nanomaterials and study on their optoelectronic properties

Two-dimensional nanomaterials such as graphene, transition metal disulfide, and organic semiconductor thin films have also received significant attention in the field of optoelectronic devices. At present, related researchers have made many breakthroughs in the preparation and application of two-dimensional nanomaterials. However, simple, efficient, and large-scale preparation methods of two-dimensional nanomaterials still need to be further developed; the performance of optoelectronic devices based on two-dimensional nanomaterials, such as electrical switching ratio, electron mobility, luminous property, and photoelectric response property also need to be further improved. Therefore, the research on the preparation of two-dimensional nanomaterials and the research on its optoelectronic properties can pave the way to improving device performance and expanding device application fields.

# 6. Conclusion

In conclusion, developing novel nano composite materials is crucial for obtaining high performance of various optoelectronic devices. Suitable modification and incorporation of such novel functional nanomaterials can provide new strategy for improved device performance.

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