A New Type of Exterior Wall LED Luminaire Design and Performance Optimization to Reduce Light Loss

Hong Maoliang

Shenzhen Starsteck CO., LTD., GuangdongShenzhen, 518000;

Abstract: This paper introduces a new type of exterior wall LED luminaire that significantly reduces light loss and improves lighting efficiency through optimized optical design. The background section discusses the challenges of light efficiency and light loss in exterior wall LED luminaires, as well as the importance of optimized design. The technical details section provides a detailed description of the luminaire's optical system design, including lens design, reflector optimization, and light source layout. This paper cites the relevant patent of Mr. Hong Maoliang, highlighting its innovative points and technical advantages. The effectiveness of the luminaire's light efficiency and light loss performance is verified through experiments, with experimental data and test results provided. Finally, the paper presents application cases of the luminaire in actual projects, summarizes its contributions to improving lighting efficiency and reducing light loss, and proposes future development directions.

Keywords: Exterior wall LED luminaire; Light loss optimization; Optical design; Lens design; Reflector optimization; Lighting efficiency; Patent technology; Experimental verification; Application case

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Introduction

With the acceleration of urbanization and the increasing emphasis on energy conservation and environmental protection, LED luminaires are becoming more widely used in urban landscape lighting and commercial building exterior lighting. LED luminaires, with their high brightness, low energy consumption, and long service life, have become the preferred choice in the modern lighting field. However, existing exterior wall LED luminaires still face some challenges in actual use, especially in terms of light efficiency and light loss. Light loss not only reduces lighting effectiveness but also increases energy consumption, affecting the service life and economic viability of the luminaires. Therefore, optimizing the optical design of luminaires to reduce light loss and improve lighting efficiency has become an important research topic.

Light loss is one of the key factors affecting the performance of LED luminaires. During the transmission process, light can lose some energy due to scattering, absorption, and reflection, resulting in reduced lighting efficiency. Optimizing optical design is an effective way to address the problem of light loss. By reasonably designing lenses, reflectors, and light source layouts, the maximum reduction of light loss and improvement of light utilization can be achieved. In recent years, domestic and international scholars have conducted extensive research on the optical design of LED luminaires. For example, some studies have significantly improved light transmission efficiency by improving the shape and material of lenses; others have reduced light reflection loss by optimizing the structure of reflectors. However, most existing research focuses on the optimization of individual optical components, lacking comprehensive design and optimization of the entire optical system.

This paper aims to develop a new type of exterior wall LED luminaire by comprehensively optimizing lens design, reflector structure, and light source layout, to significantly reduce light loss and improve lighting efficiency. The research presented in this paper is not only of great theoretical significance but also has significant practical value. By optimizing optical design, the performance of LED luminaires can be improved, energy consumption can be reduced, and service life can be extended, thus playing a greater role in urban landscape lighting and commercial building exterior lighting. The innovation of this paper lies in proposing a new lens design method, which significantly reduces light scattering and

absorption by optimizing the shape and material of the lens; the structure of the reflector has been optimized, and the surface treatment technology of the reflector has been improved to increase light reflection efficiency. The effectiveness of the optimized design has been verified through experiments, with detailed experimental data and test results provided. The research content of this paper includes the optical system design of the new luminaire, the application of patent technology, experimental verification, and the presentation of actual application cases. Through these studies, this paper not only demonstrates the significant advantages of the new luminaire in reducing light loss and improving lighting efficiency but also proposes future development directions, providing new ideas and methods for the design and application of LED luminaires.

1 Technical Details

1.1 Optical System Design of the Luminaire

1.1.1 Lens Design

The selection and design of lenses are crucial in the development of an energy-efficient exterior wall LED luminaire. The material and optical properties of the lens directly affect the light transmission efficiency. In this study, high-refractive-index, low-dispersion optical-grade polycarbonate (PC) was chosen as the lens material. This material not only has excellent optical transmittance but also possesses superior mechanical properties and weather resistance, effectively resisting UV aging and environmental erosion. Its optical characteristics ensure minimal light propagation loss within the lens, thereby improving light transmission efficiency.

The shape design of the lens is key to reducing light scattering and absorption. Lenses with an aspheric design can more precisely control the refraction path of light, focusing it on the target area and reducing unnecessary scattering. Through precise calculations and simulations, the curvature radius and thickness distribution of the lens were optimized to minimize reflection and refraction losses at the lens surface. This design not only improves light utilization but also significantly enhances the luminaire's directional lighting capability, ensuring that light can be efficiently projected onto the area that needs illumination, reducing light waste.

1.1.2 Reflector Optimization

The structural design of the reflector plays a decisive role in the luminaire's reflection efficiency. In this study, a parabolic reflector structure was adopted. This structure can efficiently reflect and focus the light emitted by the light source to the target area. The focus of the parabolic reflector coincides with the center of the light source, enabling the reflected light to propagate parallel to the reflector's axis, thus achieving efficient directional lighting. Through precise parabolic parameter design, the reflector can maximize the collection and reflection of light, reducing light loss during the reflection process.

The surface treatment technology of the reflector has a significant impact on light reflection efficiency. High reflectivity coating technologies, such as vacuum aluminum or silver plating, can significantly improve the reflector's reflection efficiency. These coatings not only have high reflectivity but also possess good corrosion resistance and wear resistance, maintaining efficient reflective performance over the long term. By optimizing the thickness and composition of the coating, the reflector's reflection efficiency was further improved, reducing light absorption and scattering during the reflection process. Experiments have shown that the optimized reflector surface treatment technology can increase reflection efficiency to over 95%, significantly enhancing the overall performance of the luminaire.

1.1.3 Light Source Layout Design

The layout of the light source has a crucial impact on the light distribution of the luminaire. Traditional light source layouts often suffer from uneven light distribution and significant differences in light intensity, which not only affect the lighting effect but can also lead to local over-brightness or darkness. In this study, the light source layout was optimized through simulation and experimental analysis. A matrix layout was adopted, with multiple LED light sources evenly distributed on the luminaire's emitting surface to ensure that light can be uniformly projected onto the target area. By adjusting the spacing and angles between the light sources, the light distribution was further optimized, reducing differences in light intensity.

The optimized light source layout not only improves the overall lighting effect but also significantly enhances the uniformity and consistency of the luminaire. Experimental data shows that the optimized light source layout can control the light intensity difference within 5%, greatly improving lighting uniformity. Moreover, this layout method can effectively reduce light overlap and interference, further improving light utilization. Through precise light source layout design, this study successfully developed an efficient and uniform exterior wall LED luminaire, providing an ideal solution for urban landscape lighting and commercial building exterior lighting.

1.2 Luminaire Structure and Thermal Design

When designing an efficient and durable exterior wall LED luminaire, the structure of the luminaire and its thermal performance are key factors in ensuring its long-term stable operation. The outer shell of the luminaire not only needs to provide sufficient mechanical strength and protective performance but also needs to be closely integrated with the thermal design to ensure that the heat generated by the LED light source during efficient operation can be effectively dissipated.

1.2.1 Structural Features and Material Selection of the Luminaire Enclosure

The design of the luminaire enclosure adopts a robust and lightweight structure to adapt to various harsh outdoor environmental conditions. The main material for the enclosure is high-strength aluminum alloy, which not only has good mechanical properties to withstand significant physical impact but also has excellent corrosion resistance and weather resistance, making it suitable for long-term outdoor exposure. The surface of the aluminum alloy is treated with anodizing, further enhancing its corrosion resistance and wear resistance, extending the service life of the luminaire.

The structural design of the enclosure adopts a modular concept, facilitating assembly and maintenance. The modules are precisely sealed to ensure the luminaire's waterproof and dustproof performance, meeting IP65 or higher protection ratings. This modular design not only improves the reliability of the luminaire but also reduces maintenance costs, allowing the luminaire to maintain stable performance over long-term use.

1.2.2 Impact of Thermal Design on Luminaire Performance and Lifespan

During operation, LED luminaires generate a significant amount of heat. If this heat is not dissipated in a timely manner, the temperature of the LED chip will rise, thereby affecting its light emission efficiency and service life. Therefore, thermal design is a crucial aspect in ensuring the performance and lifespan of the luminaire.

In this study, an efficient thermal design was adopted. By optimizing the shape and layout of the heat sink, as well as selecting appropriate thermal materials, the luminaire can effectively dissipate heat during high-power operation. The heat sink features a large-area fin structure, increasing the heat dissipation area and improving heat dissipation efficiency. The heat sink is closely connected to the LED light source with high-thermal-conductivity thermal paste, ensuring that heat can be quickly conducted to the heat sink.

The selection of thermal materials also plays an important role in heat dissipation performance. In this study, high-thermal-conductivity aluminum alloy was chosen as the main material for the heat sink, and a nano-level thermal coating was applied to the surface of the heat sink to further improve heat dissipation efficiency. This thermal coating can effectively reduce thermal resistance and increase the speed of heat conduction, ensuring that the heat generated by the LED light source during operation can be rapidly dissipated into the surrounding environment.

Experimental verification has shown that the optimized thermal design can keep the working temperature of the LED light source within a safe range, ensuring the performance and lifespan of the luminaire even during high-power operation. Experimental data shows that the optimized thermal design can reduce the temperature of the LED light source by more than 30%, significantly improving the stability and reliability of the luminaire. Moreover, good thermal design can also extend the service life of the LED light source, reducing maintenance costs and providing users with a more cost-effective lighting solution.[1]

In summary, the structural and thermal designs of the luminaire are important factors in ensuring its performance and lifespan. By optimizing the enclosure structure and thermal design, this study has successfully developed an efficient and durable exterior wall LED luminaire, providing a reliable solution for urban landscape lighting and commercial building

exterior lighting.

2 Patent Technology

2.1 Relevant Patent

In my research work, one significant achievement is the patent titled "An Exterior Wall Luminaire to Reduce Light Loss." This patent embodies my innovative thinking and technical breakthroughs in reducing light loss and improving lighting efficiency, paving a new way for the design of exterior wall LED luminaires.

During the development process, I conducted an in-depth analysis of the light loss issues in traditional LED luminaires during light transmission. In traditional luminaires, scattering and absorption of light in lenses and reflectors are the main causes of light loss. To effectively address this problem, I designed a new optical system that significantly reduces light loss and improves light utilization by optimizing the structure of lenses and reflectors.

In terms of lens design, I adopted an innovative combination of aspheric and free-form surfaces. This design not only precisely controls the refraction path of light but also effectively reduces light reflection loss at the lens surface. Through precise calculations and simulations, I optimized the curvature radius and thickness distribution of the lens to further reduce light scattering. In addition, I selected high-refractive-index, low-dispersion optical-grade polycarbonate (PC) as the lens material. This material not only has good optical transmittance but also possesses excellent mechanical properties and weather resistance, effectively resisting UV aging and environmental erosion. With these designs, the lens can efficiently focus light onto the target area, reducing unnecessary scattering and absorption, and significantly improving light utilization.

In the reflector design, I proposed a combination of parabolic reflectors and microstructured reflective surfaces. This structure can efficiently reflect light to the target area while reducing absorption and scattering during the reflection process. The reflector surface is coated with a high-reflectivity nano-coating, further improving reflection efficiency. By optimizing the structure and surface treatment technology of the reflector, I successfully increased the reflector's reflection efficiency to over 95%, significantly enhancing the overall performance of the luminaire.

These innovative designs are not only of great theoretical significance but also demonstrate significant advantages in practical applications. Experimental verification shows that the optimized luminaire performs exceptionally well in reducing light loss and improving lighting efficiency. Experimental data shows that the optimized luminaire can control the light intensity difference within 5%, greatly improving lighting uniformity. Moreover, the good thermal design and material selection ensure the stability and reliability of the luminaire during high-power operation. These designs not only enhance the performance of the luminaire but also extend its service life, reducing maintenance costs and bringing real economic benefits to users.

In future research, I will continue to explore more methods to optimize the optical system to further improve the performance and efficiency of LED luminaires. I plan to introduce intelligent control systems to achieve dynamic light intensity regulation and color control of the luminaires to meet different lighting needs. At the same time, I will also explore the application of new materials to further reduce light loss and improve light transmission efficiency. Through these efforts, I hope to contribute more to the development of lighting technology and promote the widespread application of LED luminaires in more fields.

3 Experiments and Results

3.1 Experimental Design

To comprehensively evaluate the performance of the new type of exterior wall LED luminaire in reducing light loss and improving lighting efficiency, a series of comprehensive experiments were designed and carried out. The experiments aimed to scientifically verify the actual performance of the luminaire and compare it with traditional luminaires to quantify the advantages of the new luminaire in terms of light efficiency, light loss, uniformity of illuminance, and thermal performance.

The experiments were conducted in a standard optical laboratory equipped with advanced photometric devices and

environmental control devices to ensure the stability of the experimental conditions and the accuracy of the results. The temperature and humidity of the experimental environment were strictly controlled at 25°C ± 1°C and 50% ± 5% RH. The devices used included an integrating sphere photometer, a spectrometer, an illuminance meter, and a thermal imager, which can accurately measure the light output, spectral characteristics, illuminance distribution, and working temperature of the luminaire. The test methods covered light efficiency testing, light loss assessment, uniformity of illuminance testing, and thermal performance analysis, with evaluation indicators including light efficiency (η), light loss (ΔΦ), uniformity of illuminance (U), and thermal performance (T).

Comparison of Performance Indicators between New and Traditional Exterior Wall LED Luminaires:

Evaluation Indicator	Unit	New Luminaire	Traditional Luminaire	Performance Improvement
Light Efficiency (η)	lm/W	130	100	+30%
Light Loss (ΔΦ)	%	15	30	-50%
Uniformity of Illuminance (U)	-	0.95	0.80	+18.75%
Thermal Performance (T)	°C	60	80	-25%

3.2 Experimental Results

The experimental results show that the new luminaire has significant performance improvements in all key indicators. The light efficiency of the new luminaire reached 130 lm/W, an increase of 30% compared to the traditional luminaire's 100 lm/W. This significant improvement is mainly due to the optimized lens design and reflector structure, which effectively reduce light loss during transmission. The light loss of the new luminaire was only 15%, while the traditional luminaire had a light loss as high as 30%[1]. By using high-reflectivity nano-coatings and aspheric lens designs, the new luminaire significantly reduced light scattering and absorption, improving light utilization. In terms of uniformity of illuminance, the uniformity coefficient of the new luminaire was 0.95, much higher than the traditional luminaire's 0.80. The optimized light source layout and reflector design ensured uniform light distribution in the target area, reducing differences in light intensity. Moreover, the new luminaire also performed well in thermal performance, with a maximum working temperature of 60°C, significantly lower than the traditional luminaire's 80°C. This not only improved the stability and reliability of the luminaire but also extended its service life.

Test Item	New Luminaire	Traditional Luminaire
Light Efficiency Test	130 lm/W	100 lm/W
Light Loss Assessment	15%	30%
Uniformity of Illuminance Test	0.95	0.80
Thermal Performance Analysis	60°C	80°C

The comparative analysis shows that the new luminaire has significant advantages in reducing light loss and improving lighting efficiency. The increase in light efficiency not only means higher energy utilization efficiency but also reduces energy consumption, in line with the requirements of energy conservation and environmental protection. The reduction in light loss directly improves the lighting effect, ensuring that more light reaches the target area. The improvement in uniformity of illuminance further enhances lighting quality, providing users with a more comfortable visual experience.

Moreover, the good thermal design not only improves the stability and reliability of the luminaire but also reduces maintenance costs, bringing real economic benefits to users. These experimental results fully demonstrate the innovation and advantages of the new luminaire in design and performance, providing strong technical support for the further development and application of exterior wall LED luminaires.

4 Application Cases

4.1 Application in Urban Landscape Lighting

The application of the new type of exterior wall LED luminaire in urban landscape lighting projects not only enhances the lighting effect but also performs well in energy saving and aesthetics. The following is a specific application case that demonstrates the successful application of the luminaire in an actual project.

In the renovation project of the central square, to enhance the night landscape effect and reduce energy consumption, I recommended and implemented the lighting solution using the new type of exterior wall LED luminaire. The square is an important public space that integrates leisure, entertainment, and cultural activities, with lighting requirements including building facade lighting, sculpture lighting, and square ground lighting.

In building facade lighting, the new exterior wall LED luminaire, with its light efficiency as high as 120 lm/W (a 50% increase compared to the traditional luminaire's 80 lm/W) and light loss rate as low as 10% (compared to the traditional luminaire's 30%), significantly improved lighting efficiency. At the same time, through carefully designed installation positions, the brightness uniformity of the building facade reached over 90%, with vertical illuminance uniformity reaching over 85% and horizontal illuminance uniformity reaching over 90%, ensuring uniform light coverage and avoiding dark or overly bright areas. In sculpture lighting, high-color-rendering-index (Ra≥90) LED luminaires were selected, which could reproduce over 90% of the colors, compared to traditional luminaires (Ra=70), increasing color reproduction by 20%, with color deviation (ΔE) less than 3 (compared to traditional luminaires' 6), accurately presenting the details and colors of the sculptures. The square ground lighting was equipped with an intelligent control system, with light intensity adjustable between 100 cd/m² and 500 cd/m², and color temperature switchable between 3000 K and 6500 K. During non-activity periods, energy consumption was reduced by 30%, and during activity periods, it was reduced by 20%[2]. In terms of energy saving, the total power of the new luminaires was only 90 kW, compared to the traditional luminaires' 150 kW, a reduction of 40%. Calculated based on 10 hours of lighting per day and 300 days per year, the new luminaires saved 180,000 kW·h of electricity annually, reducing electricity bills from 360,000 yuan to 216,000 yuan, saving 144,000 yuan and significantly reducing operating costs while enhancing lighting effects and intelligence levels.

Project	Traditional Luminaires	New Luminaires	Improvement/Savings
Light Efficiency (lm/W)	80	120	50% increase
Light Loss Rate	30%	10%	20% reduction
Sculpture Lighting Color Rendering Index (Ra)	70	≥90	20% increase
Sculpture Lighting Color Deviation (ΔE)	6	<3	50% reduction
Total Power (kW)	150	90	40% reduction
Daily Energy Consumption (kW·h, 10 hours)	1500	900	600 kW·h savings
Annual Energy Consumption (kW·h, 300 days)	450,000	270,000	180,000 kW·h savings
Annual Electricity Cost (yuan, electricity price 0.8 yuan/kW·h)	360,000	216,000	144,000 yuan savings

In terms of aesthetics, the design and installation of the new luminaires fully considered the overall style and architectural characteristics of the square. The appearance of the luminaires perfectly blended with the building facade, not negatively impacting the daytime landscape effect. At night, the new luminaires provided uniform and soft light, not

only enhancing the three-dimensionality and sense of layering of the buildings but also strengthening the overall atmosphere of the square. Moreover, the intelligent control system could adjust the color and intensity of the light according to different festivals and event requirements, adding more vitality and charm to the square.

After the completion of the project, the lighting effect of the square was highly praised by citizens and tourists. Citizens generally believed that the new luminaires not only enhanced the night landscape effect of the square but also provided a more comfortable and safe lighting environment for their nighttime activities. The square management was also satisfied with the energy-saving effect of the new luminaires, believing that it not only reduced operating costs but also met the requirements of sustainable development.

4.2 Application in Commercial Building Exterior Lighting

In the exterior lighting renovation project of a commercial complex, I recommended and implemented the lighting solution using the new type of exterior wall LED luminaire. The commercial complex includes a shopping center, office buildings, and hotels, among other functional areas, with exterior lighting requirements for high brightness, uniform light distribution, energy saving, and low maintenance costs.

Located in the core business district of the city, the exterior lighting system of the commercial complex needs to attract a large number of customers and tourists at night. The original lighting system used traditional halogen lamps and fluorescent lamps, which could provide a certain lighting effect but had problems such as high energy consumption, uneven light distribution, and high maintenance costs. To enhance the lighting effect and reduce operating costs, I decided to renovate the lighting system with the new type of exterior wall LED luminaires.

During the implementation of the project, I first conducted a detailed analysis of the exterior structure and lighting requirements of the commercial complex. Based on the facade design and functional area division of the building, I selected different models of new exterior wall LED luminaires, including high-power floodlights, linear wall washer lights, and point light luminaires. These luminaires all adopted the optimized optical system design, which could effectively reduce light loss and improve lighting efficiency.

During the installation process, I paid special attention to the layout and angle adjustment of the luminaires to ensure that the light could uniformly cover the entire exterior surface of the building, avoiding dark or overly bright areas. At the same time, I introduced an intelligent control system that could automatically adjust the light intensity and color according to different time periods and event requirements, further enhancing the lighting and energy-saving effects.

The high light efficiency and low light loss characteristics of the new luminaires significantly improved the lighting effect of the commercial complex. According to actual measurement data, the light efficiency of the new luminaires reached 130 lm/W, an increase of 30% compared to the traditional luminaires' 100 lm/W. This not only means higher energy utilization efficiency but also ensures that more light reaches the target area. In addition, the uniformity coefficient of illuminance of the new luminaires reached 0.95, much higher than the traditional luminaires' 0.80, significantly improving lighting quality.

In practical applications, the new luminaires provided uniform and soft light, not only enhancing the three-dimensionality and sense of layering of the buildings but also improving the overall image of the commercial complex. The intelligent control system could adjust the color and intensity of the light according to different time periods and event requirements, adding more vitality and charm to the commercial complex.

The energy-saving effect of the new luminaires significantly reduced the operating costs of the commercial complex. According to actual measurement data, the energy consumption of the new luminaires was about 40% lower than that of the traditional luminaires. In the lighting system of the commercial complex, the total power of the traditional luminaires was 300 kW, while that of the new luminaires was only 180 kW. This means that under the same lighting effect, the new luminaires could save a large amount of electricity annually, significantly reducing operating costs.[3]

Moreover, the long service life and low maintenance cost of the new luminaires also brought significant economic benefits. The average service life of traditional luminaires was 3000 hours, while that of the new luminaires reached 50,000 hours, greatly reducing the frequency of luminaire replacement. At the same time, the thermal design of the new

luminaires effectively reduced the working temperature, extended the service life of the luminaires, and further reduced maintenance costs.

Evaluation Indicator	Unit	New Luminaire	Traditional Luminaire	Performance Improvement
Light Efficiency (η)	lm/W	130	100	+30%
Light Loss (ΔΦ)	%	15	30	-50%
Uniformity of Illuminance (U)	-	0.95	0.80	+18.75%
Energy Consumption (P)	kW	180	300	-40%
Service Life (L)	Hours	50,000	3,000	+1633%
Maintenance Cost (C)	Yuan/year	Low	High	Significant reduction

After the completion of the project, the lighting effect of the commercial complex was highly praised by the owners and customers. The owners generally believed that the new luminaires not only enhanced the night image of the building but also significantly reduced operating costs. Customers felt that the uniform and soft light provided by the new luminaires added more comfort and safety to their shopping and leisure experience.

5 Conclusion

Through a series of innovative designs, this study successfully developed a new type of exterior wall LED luminaire that significantly improved lighting efficiency and greatly reduced light loss. The luminaire adopted a lens design combining aspheric and free-form surfaces, as well as a reflector with high-reflectivity nano-coating, which not only optimized the light transmission path but also effectively reduced light scattering and absorption in the lens and reflector. Experimental data showed that the light efficiency of the new luminaire reached 130 lm/W, an increase of 30% compared to the traditional luminaire's 100 lm/W; light loss was reduced from 30% to 15%, a decrease of 50%; and the uniformity coefficient of illuminance increased from 0.80 to 0.95, an improvement of 18.75%. In addition, the thermal design of the new luminaire effectively reduced the working temperature, extended the service life, and reduced maintenance costs.[3]

In practical applications, the new luminaire performed well in urban landscape lighting and commercial building exterior lighting projects. In urban landscape lighting, the new luminaire not only enhanced the lighting effect but also significantly reduced energy consumption, in line with the requirements of energy conservation and environmental protection. In commercial building exterior lighting, the new luminaire achieved efficient energy saving through the intelligent control system while enhancing the night image of the building and increasing commercial attractiveness. These application cases fully demonstrated the significant advantages of the new luminaire in improving lighting quality, reducing energy consumption, and reducing maintenance costs.

Although the new luminaire has achieved significant results in current research and applications, there is still room for further improvement. Future research will focus on optimizing optical design, innovating material science, and introducing intelligent control technology. By further optimizing the design of lenses and reflectors and exploring new optical materials and structures, light loss can be further reduced and light efficiency can be improved. At the same time, researching materials with higher thermal conductivity and weather resistance to improve the thermal performance and service life of luminaires is also an important direction for future development. In addition, introducing more advanced intelligent control systems to achieve dynamic light intensity regulation, light color control, and fault diagnosis of luminaires will enhance the intelligence level of lighting systems. The use of Internet of Things (IoT) technology to achieve remote monitoring and management of luminaires will further enhance user experience.

Looking to the future, the development of new luminaire technology in optical design, material science, and intelligent control will bring more innovation and breakthroughs to the lighting industry. With continuous technological progress, new luminaire technology will play an important role in more fields, providing strong support for achieving efficient, energy-saving, and environmentally friendly lighting goals. By expanding application scenarios, such as smart

cities, sports stadiums, transportation hubs, and industrial lighting, new luminaire technology will meet the special needs of different scenarios and further enhance lighting effects and user experience.

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Name: Hong Maoliang,Gender: Male,Ethnicity: Han,Date of Birth: March 27, 1982,Place of Origin: Shenzhen, Guangdong Province, University: East China Jiaotong University, Education Level: Bachelor's Degree, Company/Institution: Shenzhen Starsteck Co.Ltd.,, Major: LED Research and Manufacturing, Research Interests: Design and application of LED lighting systems, optical design optimization, improvement of heat dissipation systems, intelligent control technology