ISA
International SSL Alliance

Address: Room1305, Block 2D, Zhongguancun IC Park, No. 9 Fenghao East Road, Haidian District, Beijing, China (100094)
Tel: 86-10-62607581
Fax: 86-10-62607258
Email: secretariat@isa-world.org
Website: www.isa-world.org

ISA
International SSL Alliance

TOP 100

ISA

Global SSL Award of Innovations Top100

2021

Solid state lighting (SSL) after decades of development has gradually reached a mature stage in terms of characteristics such as light quality, luminous efficiency, reliability and intelligent feature. SSL products, services and system solutions have been widely used in most parts of the world.

With the in-depth research and development and the continuous innovation of manufacturing technology, the SSL's non-visual functions are also being rapidly explored. Various innovations and applications of "beyond lighting" are entering many aspects of society and life. SSL has been showing its tremendous application potential and R&D depth in agriculture, health, communications, high-definition display, polymer curing, disease vector control, high value-added application integration and so on. Integrated innovation and interdisciplinary innovations based on SSL technology have yielded a steady stream of achievements, marking a new stage of SSL development.

Innovation drives development, which in turn fosters innovation. From the advent of the first GaN-based blue LED in 1978 to the commercial manufacturing of the first high-brightness blue LED in 1993, and the commercial manufacturing of blue and green LEDs with InGaN quantum well (QW) structures, SSL has gone from laboratory to industrialization in merely fifteen years as well as from manufacturers to thousands of households, all are the result of innovation.

The ISA twelfth Executive Member Meeting decided to establish the "Global SSL Award of Innovations Top 100", and start the selection from the year of 2021. The award aims to encourage and inspire the global SSL industry to persist the spirit of innovation in the new era to make new discoveries, explore more unknown areas, and create more applications in the field of "beyond lighting", to benefit mankind with more SSL miracle. This is the purpose and ultimate goal of this award.

Jianlin Cao

Jianlin Cao
President of ISA

International SSL Alliance

ISA Introduction

ISA is a non-for-profit international organization consists of regional alliances, association/society, leading companies and renowned universities in global Solid State Lighting (SSL) field.

The Business of ISA members have covered the whole SSL value chain of upstream, middle stream and downstream of global SSL industry such as epitaxy, packaging application, materials and equipment, design system integration and testing etc.

The currently ISA 77 members, representing more than 4000 individuals & organizations includes major players (such as Signify, Osram, Smsung, GE Lighting, Cree, Veeco, AIXTRON etc.). The output of which covers more than 70% that of global SSL industry.

The ISA Board of Advisers consists of leading experts and academic "Founder" level experts, such as the inventors of blue LED, yellow LED, Red LED, and OLED. Amongst Professor Shuji Nakamura, the Laureate of Nobel Prize in Physics in 2014, is the Co-Chair of ISA Board of Advisors (BOA) and Professor Hiroshi Amano, the Laureate of the Nobel Prize in Physics in 2014 is the member of ISA BOA.

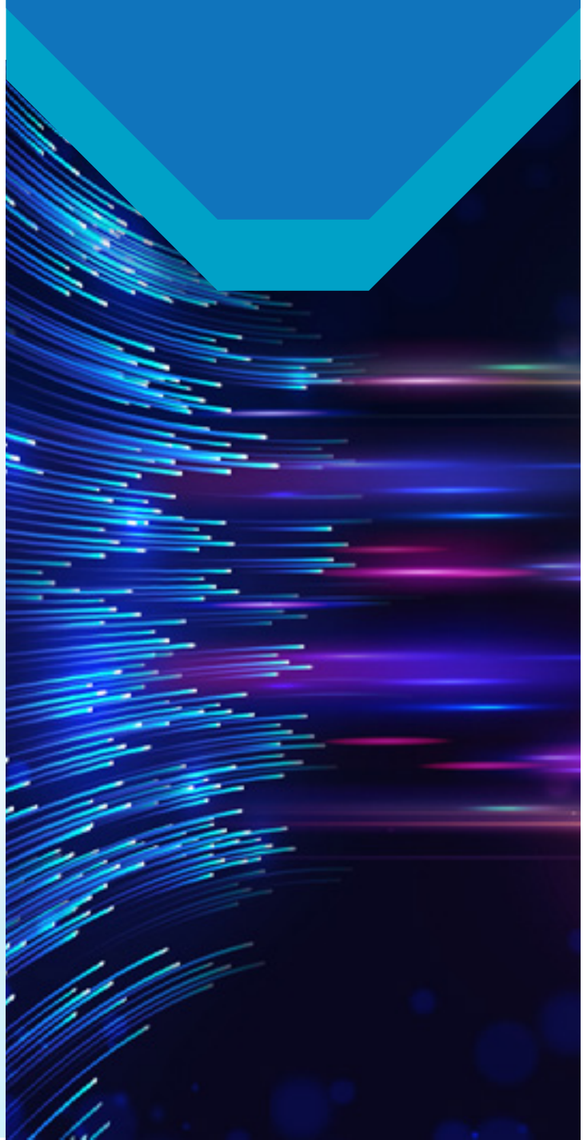
The major works of ISA are: provide services to promote the development and application of global SSL, standardization, annually Global SSL Industry Report, annually SSL Awards, promote international, national and regional cooperation on SSL, etc.

The Mission of ISA

Cooperation with the global resources and efforts, ISA looks forward to fostering a more appropriate "eco-system" for the health development of the global SSL and its application. Echo the needs of the society with more added value services to ISA members. Strive to improve people's living and contribute a sustainable human society.

Mission

To promote and stimulate the sustainable development of the global solid state lighting (SSL) industry, demonstrate the application and the innovation of the technology of SSL in the field of "beyond lighting", and push forward the global SSL into a new stage of development.



Global SSL Award of Innovations Top 100

The Scope of the Application

The applications must be the technological innovation, product innovation or integration innovation etc. related to the SSL technology in the field of beyond lighting.

Include but not limited to the following areas:

1. Agriculture Lighting
2. Health Lighting
3. Smart Lighting
4. Visible Light Communication (LiFi)
5. Mini/Micro LED
6. UV-Curing
7. Others (Please specify)

Criteria for Selection

The application (s) should be innovative in the country, region or the world, and the technology (ies) or product (s) should reach a certain advanced level, and solve some key problems in practical application.

Every year, according to the applications we received from all over the world, a certain number of SSL innovations projects will be selected as the winners of the "Global SSL Award of Innovations Top 100", which are judged by international authoritative experts. And medals, certificates and brochures will be given to encourage and praise.

Statement

Global SSL Award of Innovations Top 100

- Accept excellent applications
- Judged by authoritative experts
- Worldwide circulation and promotion
- Welcome elites of the industry to sign up

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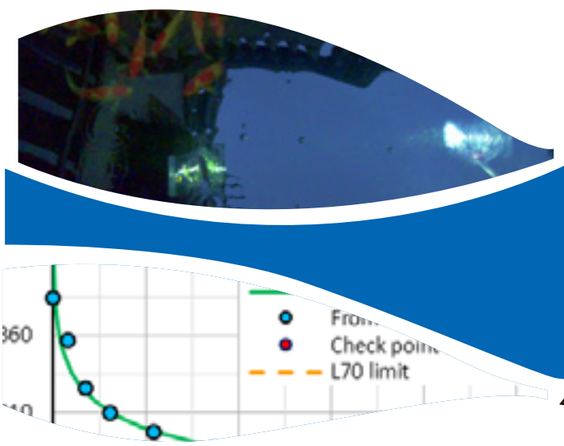
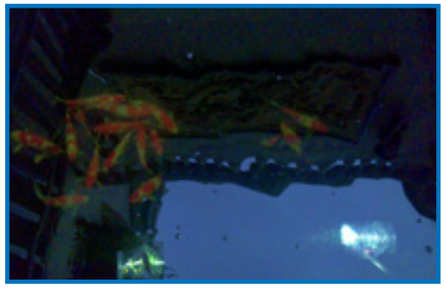
07
Mini/Micro LED Massive Transfer by High Speed Multiple Chips Bonding Technology and Equipment

08
A Kind of Medium-filled High Luminous Efficacy LED Street Lamp and Its Manufacturing Method



01 A Novel Robust Underwater Visible Light Communication System



Chi Lin, Lei Wang, Guowei Wu, Zhongxuan Luo
(Dalian University of Technology)

Brief Introduction

This project develops a highly robust underwater visible light communication system. For the first time, the circularly polarized light is introduced into the design of the underwater visible light communication system, and a dual-channel communication system based on circularly polarized light is established, which effectively solves the problems of (1) dynamic environment light interference and (2) transceiver displacement yielded by underwater equipment rotation and movement caused by water flows and waves. In addition, to increase the communication distance and reduce bit error rate, a novel underwater optical communication coding scheme, termed UBC, is designed, which is able to achieve reliable communication in the complex underwater environment.

This system can be widely used in underwater robot cooperative communication, underwater human-machine interaction, above-water and underwater cross-domain communication, and other fields to solve medium and short-distance underwater high-speed data transmission and robust communication. It has good application prospects in the fields of national defense, military, economy, and people's livelihood, such as underwater ships, unmanned submarines, submarine monitoring networks, marine ecological monitoring, and submarine resource assessment.

We test the performance of the system in different scenarios, including a lake, sea and indoor water pool. When conducting experiments in the lakeside and seaside, both transceivers are tied to 2-meter-long iron rods. For deeper water tests (depth>2 meters), the transceivers are both attached to two underwater robots. After conducting a large number of experiments, we proved that our system could effectively combat environmental interference and achieve robust performance in an underwater environment.

The Innovation Points

1. Innovation points

(1) We innovatively use circularly polarized light as the communication medium for solving the transceiver displacement problem. As shown in Figure 1, at first, we use the LED to emit unpolarized light. Then, the linear polarizer is used to convert the unpolarized light into linearly polarized light (LPL). Afterward, the quarter-wave plate is used to convert the linearly polarized light into circularly polarized light (CPL). Compared with LPL, CPL will not be restricted within a certain plane in the propagation process. Hence, the alignment requirement is no longer an issue for the transceivers, and the displacement problem caused by flows and currents can be successfully solved. Besides, CPL travels in a spiral way, which only has two rotation directions (clockwise and counterclockwise). Hence the propagation process can merely be affected by the natural light. As a result, even in the presence of strong ambient light (unpolarized light), the rotation direction of the CPL will not be changed from one to the other. Hence, our system has a strong ability in interference-resistance.

(2) Two communication links are utilized for removing dynamic environmental disturbance. As shown in Figure 1, except for the different angles of the polarizers, the overall architecture of the two channels is exactly the same. At the transmitting end, the LED emits unpolarized light, and then the linear polarizer and the quarter-wave plate convert the status of the optical signal. Finally, we can establish two channels with CPL in opposite rotation directions to communicate. The design of the receiver is similar to the transmitter. It is equipped with two receiving front ends, which convert the received circularly polarized light into linearly polarized light. The reason why we establish double links is that: although the circularly polarized light is quite different from natural light (ambient light noise), there will still be some residual noise in the optical signal received at the transmitter. Therefore, double links are established to eliminate optical noise. In the proposed system, the two links are physically close (<10 cm). Hence, the interference of the two links is approximately the same, which can be regarded as a common-mode signal. A differential amplifier is used to remove such interference, which performs a subtraction operation to obtain an effective and pure optical signal. With this design, ambient light interference can be successfully removed, and robust communication is achieved.

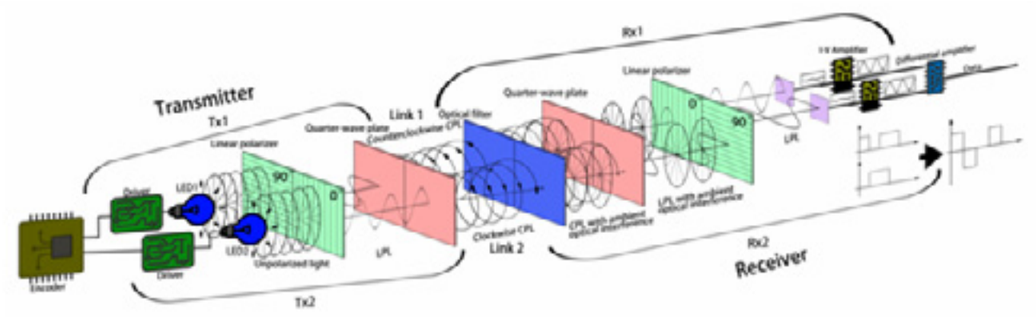
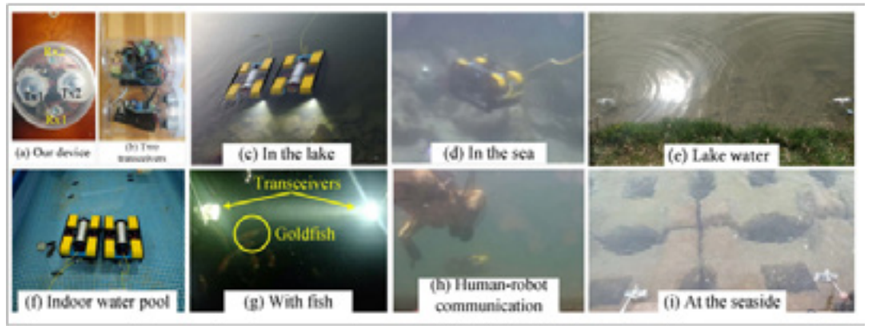


Figure 1 System architecture



Underwater visible light communication system

(3) Based on double link design, we develop a bipolar encoding method (UBC) for underwater optical communication for the first time. As shown in Figure 3, the original data is expressed with bipolar encoding at first. At the same time, to prevent the flicker phenomenon during the communication process, we avoid consecutive 0s or consecutive 1s in the encoding process. In addition, when considering the bandwidth requirements of the underwater environment, the encoding efficiency is emphasized when designing the encoding scheme. In our decoding scheme, 1 bit input corresponds to the output of 1 bit, which is much efficient than 4b6b or 8b10b encoding (4b6b encoding refers to the input encoding is 4 bits, and the output is 6 bits, this encoding method has a lower throughput rate, and 8b10b encoding is similar). In addition, to ensure that the system has a low bit error rate, the error checking method is designed during the decoding process.

(4) In the transmitter design, we prototype the system by modifying the cheap dive light, which is composed of an LED and its driver circuit, as shown in Figure 4. The LED emits unpolarized light under the control of the driving circuit, which can tune the light on/off rate and adjust the duty cycle (PWM) of the pulse width modulation. **Through modifying the driver circuit, the ON/OFF rate of the driver circuit is increased, and a higher data transmission rate is achieved.**

Figure 3 An illustration of the UBC scheme: (a) the encoding process and (b) the decoding process

(5) In the receiver design, we used the commercial off-the-shelf photodiodes to capture the received light signal and convert it into a current. The photodiode has a drawback in weak output current. For example, when the power intensity of the incident light is 1000W/m2, the output current of the silicon photodiode is about 900 uA. Such a weak current can be overwhelmed by hardware noise and this causes decoding errors. In the proposed system, **we designed and manufactured an I-V amplifier to amplify this current to solve the problem of decoding errors,** as shown in Figure 5. We also use the negative feedback capacitors to reduce the noise of the output signal.

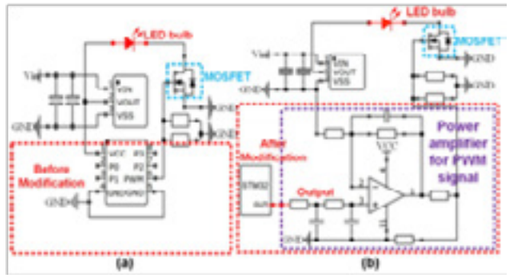


Figure 4 The circuit design of the dive light: (a) before and (b) after modification

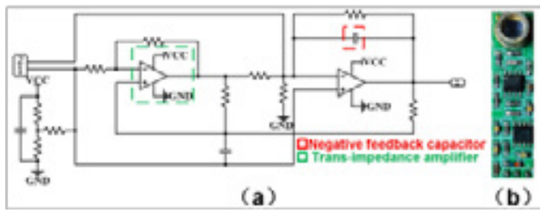


Figure 5 (a) The detailed design and (b) PCB implementation of the I-V amplifier.

A large number of experimental results show that the system has reached the leading global level in terms of interference resisting capability. As shown in Figure 6(a), compared with the widely used visible light communication platform OpenVLC, the ability of the proposed system in combating ambient light interference and rotation/displacement interference in the underwater environment is verified. The communication distance and data rate are depicted in Figure 6(b). The data rate of OpenVLC decreases to close to zero at a distance of about one meter. However, owing to the unique double CPL link design, the system can still achieve good performance in communication distance and speed. In particular, the system can further improve these two aspects when implementing with blue LEDs. When working in complex underwater situations, the ability to deal with complex environmental interference is much more robust, as shown in Fig. 6(c). For example, fish and obstacles in the water may block the communication link, and the system gets less affected.

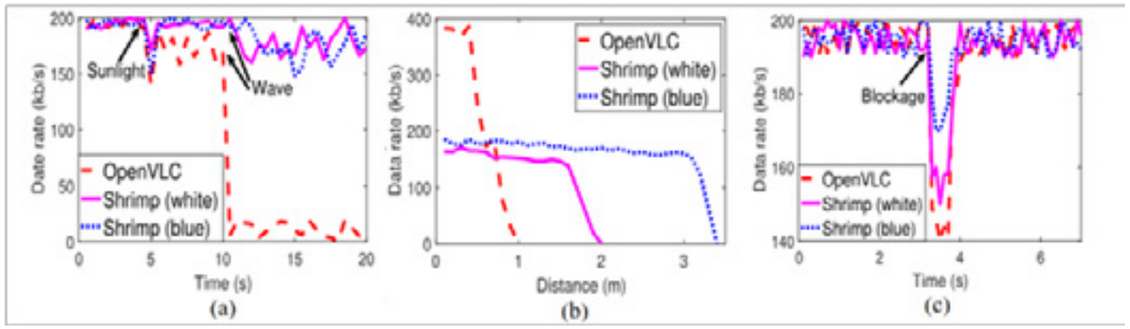


Figure 6 The performance of the proposed scheme with OpenVLC in (a) optical interference and water wave interference, (b) underwater communication distance testing, and (c) obstacle test.

The proposed communication system can realize a high-speed underwater communication system at a depth of 5 meters. As shown in Figure 7, when the water depth reaches 100 meters, the communication distance will further increase to 8 meters, demonstrating that the proposed system can realize a long communication distance in a complicated underwater environment.

From the industrial perspective, the top company of underwater communication in the world is Sonardyne, which is founded in 1970. Recently, they produced three types of underwater optical communication systems: Bluecomm 100, 200, and 200UV. Their price was £37679, £72891, and £79891, respectively. BlueComm 100 uses a high-power LED array to quickly modulate and transfer data, achieving 1 to 5 Mbps underwater communication with a distance of 10 meters. BlueComm 200 improves the communication distance and realizes a communication rate of 2 to 10 Mbps. Bluecomm 200 UV uses ultraviolet light as the communication medium. Its communication distance is slightly short. The common problem with Bluecomm products is that their devices are large and heavy. The weight of a transceiver is about 5 kg, which cannot be easily carried, especially in the underwater environment.

The proposed system is superior to the BlueComm system in communication distance, cost, power, energy consumption, volume, and weight. In addition, BlueComm cannot effectively solve the problems of dynamic environmental optical interference and transceiver displacement caused by water flows and waves.

In the future, we will use high-power LED arrays to improve the communication distance and data rate of the proposed system.

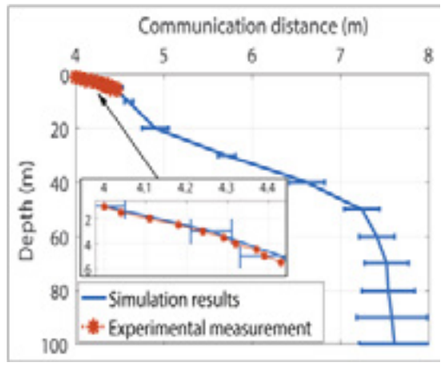


Figure 7 Effect of seawater depth on the communication distance

2. Key problems

(1) This system can solve alignment issues for the transceivers. The underwater environment is complicated, and the communication equipment is always suffering from the interference of water waves and ocean waves all the time. The rotation and displacement of the equipment will weaken the receiver of receiving the optical signal, which will affect the communication performance of the system, resulting in a higher bit error rate corrupt the communication links.

(2) The proposed system can solve the dynamic environmental sunlight interference in the underwater environment. The sunlight interference in the underwater environment is very strong, the ambient light on the sea is even more intense, and the light intensity changes greatly over time. The traditional visible communication system may not be able to distinguish the effective light information sent by the transmitter in the presence of the interference from strong sunlight, which leads to a large bit error rate.

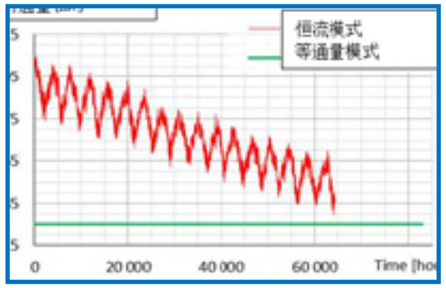
Possible Economic and Social Benefits

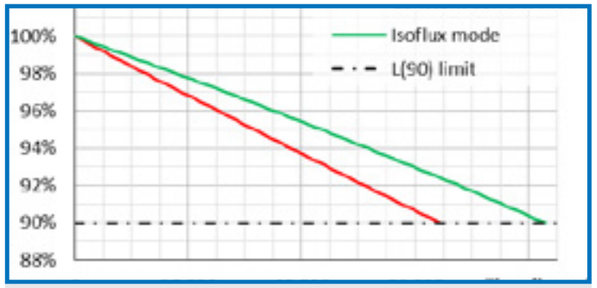
This system makes up for the shortcomings of the existing underwater visible light communication in interference resistance and alignment capabilities. It greatly enhances the system's communication capabilities in real and complex environments. The accumulated experience and technology of the system can not only provide products for underwater visible light wireless communication but also provide solutions for improving the robustness of visible light communication. This system can be used as an interference resistance component of optical communication to improve the reliability of optical communication and is expected to play an important role in the global optical communication market.

As a potential 6G communication method, visible light communication has great potential for development. In 2021, the global optical communications market will be about 16.6 billion U.S. dollars, and it is expected that the market will grow at a growth rate of 15%, reaching 33.4 billion U.S. dollars in 2026. This system provides medium-distance, high-bandwidth, high-speed, low-latency, high-robustness, and low-cost communication solutions and system prototypes. It solves the interference and alignment problems of water waves, ocean waves, and ambient light. It helps promote underwater wireless application and commercialization of optical communication systems. The system can be oriented to communication applications related to national defense, military, economy, and people's livelihood, such as underwater ships, unmanned submarines, submarine monitoring networks, and diver communications.

02

Research on Designing Solutions of Smart SSL Luminaires Providing Lifetime-long Constant Luminous Flux Output





Budapest University of Technology and Economics (BME),
Faculty of Electrical Engineering and Informatics,
Department of Electron Devices (EET)

Brief Introduction

In the previous decades, the design of light sources (incandescent, fluorescent) and luminaires were separated. The light sources were not sensitive to the ambient temperature, therefore the luminaire design was restricted mainly to the optics, while the electric and thermal coupling of the two worlds occurred at the socket in both physical and conceptual sense. With the advent of LED light sources, thermal aspects in luminaire design have become important because LEDs are very sensitive to the so called pn-junction temperature (i.e. the chip temperature). The “sockets” ceased to exist, and the close thermal coupling of luminaires and LEDs thus requires sophisticated electronic cooling design tools, such as CFD (computational fluid dynamics) based simulators.

Nowadays, the LED luminaire design is characterized by the presence of re-organized successors of previously known major players of the traditional lighting industry and also of many new, smaller start-up companies. These major companies have lots of expertise in the use of advanced CFD software for thermal-only simulations while start-ups have much less expertise and resources. The goal of a previous European H2020 project (in which our

department also played a significant role) was to develop new LED luminaire design workflows for both types of companies to support them in significantly reducing design costs and time-to-market, through virtual prototyping of luminaires, i.e., computer simulation of the luminaire. Inputs to such a digital design flow of LED luminaires are the overall lighting requirements, such as targeted minimal light output under application conditions, allowed maximal input electrical power, driver and optics efficiency etc.

In the bottom-up modular approach, the modelling starts from a multi-domain model of the LED chips, followed by compact thermal models of the LED packages and modules, and finally, luminaires. In the “Industry 4.0” language, these simulation models are called “digital twins” to represent the relevant aspects of the physical samples of LED chips, LED packages, modules etc. Thus, the ultimate goal is to be able to predict the total emitted luminous flux of different versions of a luminaire under thermally different application conditions.

The production of these multi-domain models of LEDs is one of the main research directions of our department.

Thermal issues of power LEDs are often discussed as the function of the ambient temperature, however, the forward voltage and the luminous flux values depend on the pn-junction which is significantly warmer than its environment. In many cases this inconsistency is present in manufacturer datasheets as well, but even providing the parameters at pn-junction temperatures will not allow getting a comprehensive and detailed view of the temperature dependences. The main reason can be that a so-called isothermal forward current – forward voltage – radiant flux characterization that conforms to the relevant JEDEC standards is rather complicated and time consuming. However, an appropriate and detailed LED model is required to perform system level simulations for the determination of the operating luminous flux, forward voltage, consumed electrical power and operating temperature conditions of LED based luminaires.

The main goal of the LED related research work at BME EET is to base an “Industry 4.0” compatible design solution for a control scheme that compensates not only the effects of the ambient temperature changes but also the effects of LED aging, so that the luminous flux output of the luminaire is maintained at a constant level throughout its whole lifetime. This method decreases the electric consumption while increases the expected product lifetime. Last but not least, this luminaire can enhance visual comfort as its luminous flux does not have to be overdesigned by 10-30% in order to compensate for the continuous luminous flux decrease of the LEDs throughout their lifetime.

The Innovation Points

In case of constant current driving, luminous flux of an LED based luminaire decreases with the increase of the ambient temperature, due to the decreased electrical power consumption and reduced efficacy of the LEDs.

In general applications, providing the minimum required luminous flux at any environmental condition means that the constant forward current of the LEDs should be set according to the highest expected ambient temperature.

This will, however, lead to higher luminous flux output than required throughout most of the year, which unnecessarily increases the electrical power consumption and accelerates the device aging. A similar situation occurs due to the continuously decreasing luminous flux output (known as total luminous flux maintenance) as the LEDs age during the operation time. To provide the required illumination at any time, the lamp should be designed so that its expected luminous flux remains above the specified value until the intended replacement time. This results in significant extra energy consumption and faster degradation of the device during the whole lifetime.

The new methodology is based on the so called multi-domain circuit simulation model of the LEDs that can appropriately describe the electrical, thermal and optical operation as well as their interactions. This model also contains the compact thermal model of the LED package which can be further extended by the compact thermal model of the cooling assembly. Input parameters of the Spice-like simulations are forward current and ambient temperature by which the operating parameters of the LEDs mounted onto the luminaire, such as the pn-junction temperatures, forward voltages, efficiency values and finally the total radiant and luminous flux values can be calculated.

To generate this LED model, the above discussed isothermal characteristics are needed. Exact values of the model parameters can be determined by an appropriate fitting procedure.

The most commonly used LED aging test is described by the IES LM-80 approved method, for which the TM-21-11 technical memorandum – and the Arrhenius-equation – provides a methodology to further extrapolate the test results. Having these complemented with the zero-hour multi-domain LED model makes it possible to perform lifetime simulations with some neglect; the final and complete solution would be provided by the elapsed lifetime dependent LED multi-domain model.

Constant light output driving mode and its board model

Due to the temperature dependent forward current – forward voltage characteristics of LEDs the operating “hot lumens” of a luminaire decrease with increasing temperature. The above discussed system-level simulations enable determining a driving scheme that provides a constant luminous flux output of the luminaire, independently of the ambient temperature changes. During our research work we had the opportunity to work with the CAD model and a physical sample of a real street lighting luminaire. The sample luminaire provided by the manufacturer was modified to match the new driving scheme and the methodology was verified both by field and laboratory measurements. To estimate the annual attainable energy savings, a case study was conducted using archive meteorological data. For this luminaire type the energy savings – as a function of the expected maximum temperature during its operation – was calculated to be 3 to 5%.

Lifetime-long constant luminous flux output

During the standard LM-80-08 life testing measurements of Luxeon Z LED samples, the discussed isothermal characterization was also performed. Using these results, the multi-domain models of the aged LEDs were

generated, which were then theoretically connected to the compact thermal model of the luminaire. In this way, the operating characteristics of a new and a virtually aged luminaire could be compared.

The luminous flux of the theoretical luminaire was calculated to be 8200 lumens at the nominal operating current of 700 mA. The operating conditions resulting in this 8200 lumens are indicated in Figure 1, see the curves with green and red markers for the new and aged luminaires, respectively. The 6000-hours aged luminaire needs ~780 mA forward current to provide the necessary light output; in case of constant current driving this should be the initially set value.

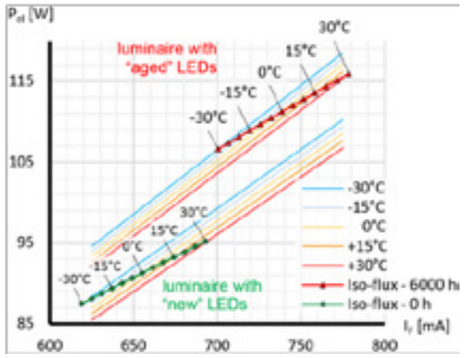


Figure 1: Simulated total electric power consumption of the PearlLight 48G luminaire theoretically assembled with Lumileds Luxeon Z LEDs; along with the iso-Φv curves defined for 8,200 lm (the corresponding ambient temperatures are indicated). The two characteristic sets correspond to the LED models before burning and after 6000 hours LM-80-08 compliant aging.

With the help of the constant luminous flux controlling scheme the operating temperature of the LEDs can be reduced, which significantly increases the expected lifetime of the LEDs.

In our publications, we proposed a new end-of-life condition for LEDs: in the case of aging-compensated driving methods, we proposed the possibility of using luminous efficacy maintenance (such as ηv90) instead of the luminous flux maintenance (like L90). For more details, see the corresponding article:

J. Hegedüs, G. Hantos, A. Poppe, "Light output stabilisation of LED based streetlighting luminaires by adaptive current control", MICROELECTRONICS RELIABILITY, Vol. 79, pp. 448-456, (2017), DOI:10.1016/j.microrel.2017.06.060

To investigate the increase of the expected lifetime thanks to reduced operating pn-junction temperature, we have developed a new theory that can describe the current status (i.e. the aging process) of the LEDs as the function of changing temperature and changing forward current.

Our base concept is that LEDs have a kind of “lifetime budget”, which (under nominal operating conditions) is consumed at a rate most dependent on the pn-junction temperature. We model the lifetime budget as a junction temperature, forward current and elapsed operating time dependent efficiency ηt (eta t) which is to be multiplied by the zero-hour value of the radiant efficiency ηe or the luminous efficacy ηv to get the prevailing light output parameters. It contains the effects of any aging phenomenon, at this point even including the change of the electrical consumption through the change of the forward voltage.

According to our theory the current value of the budget is not dependent of current value of temperature (such way keeping causality). Also, it does not carry any information on the temperature sensitivity of the parameters; therefore, the temperature sensitivity of the optical parameters should be applied when the junction temperature is out of the reference value. If the junction temperature remains constant during the test then the lifetime budget is identical to the luminous flux maintenance curve normalized to 100%.

With the help of the LM-80-08 test results and the initial multi-domain model of the LEDs, we generated a theoretical model for constant luminous flux control for the complete device lifetime (see in Figure 2 and Figure 3), furthermore we also examined its beneficial effects on both energy savings and increased lifetime (see in Table 1).

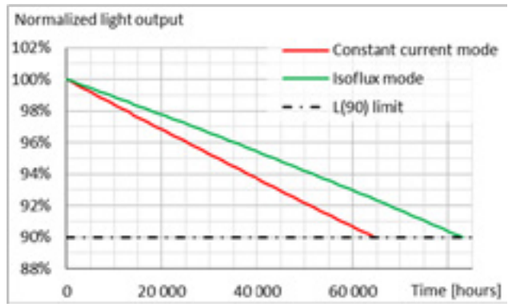


Figure 2: Simulated lifetime budget of a Luxeon Z LED.

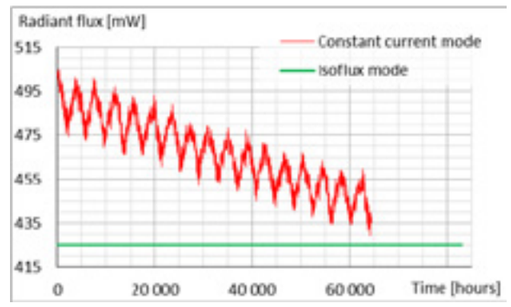


Figure 3: Simulated light output of a Luxeon Z LED.

Table 1: Estimated energy consumption and lifetime of the tested LED type for the constant current and the constant light output driving.

	Constant current mode	*Isoflux mode*	*Benefit of the isoflux mode*
L(90)	64.4k hours	83k hours	+29%
Years of operation until L(90)	16.7 years	21.4 years	+4.7 years
Electric consumption until 64.4k hours	130.8 kWh	112.8 kWh	-13.7%
Consumption in the 1st year of operation	7.9 kWh	6.5 kWh	-17.7%

For more details on our new theory on LED aging see the corresponding article:

J. Hegedüs, G. Hantos, A. Poppe, " Lifetime Modelling Issues of Power Light Emitting Diodes", ENERGIES, 2020, 13(13), 3370, DOI:10.3390/en13133370

Elapsed lifetime dependent multi-domain model

In order to create the elapsed lifetime dependent multi-domain LED model an LM-80-08 based test was performed on 18 blue mid-power LEDs of a well-recognized vendor. During the test even the isothermal characteristics of the samples were captured. Extremely high operating junction temperature of the samples even at the prescribed case temperatures caused fast and early failure of the LEDs. Due to the high failure rate of the test samples it was not possible to determine the forward current dependent LED aging model but a theory was set up to specify the Arrhenius equation's parameters from only one testing temperature, by the help of thermal transient testing. In this specific case the needed extra measurements of the proposed method added a 15% surplus to the life testing duration which is estimated to be one half or one third of the extra time ordinarily required.

As the first approach of the Spice compatible LED lifetime multi-physics modelling a mid-power LED was modelled from its captured aging results up to the L(78) level. The created LED model matches the measured values with a misfit less than 1.2%.

Simulations with higher time resolution had shown that the achieved model became inconsistent in the very early burn in period, therefore a new aging model was set up. In the meantime, two LED samples were reinstated to the test in order to show extrapolation abilities of the lifetime multi-domain LED model. The model in case of one of the samples performed over expectations (see Figure 4 and Figure 5), although, in case of the other one the extrapolations proved to be fairly inaccurate. The cause of the modelling mismatch may be the fact that at this development and research state the LEDs have to be displaced from the aging chamber to perform the necessary measurement in an integrating sphere – it is still an issue that should be solved by a new, appropriate combination of the characterization and life testing methods.

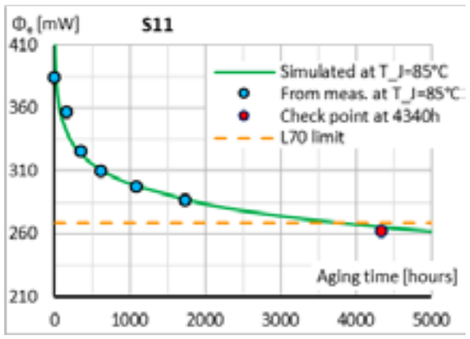


Figure 4: Simulated and measured total radiant flux maintenance of sample #S11.

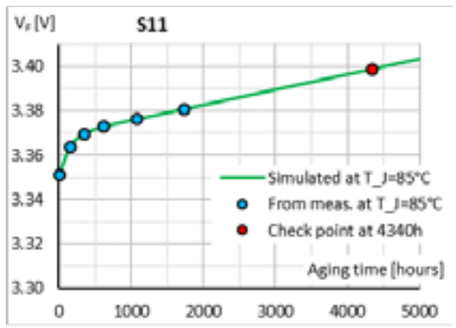


Figure 5: Measured and simulated time function of the forward voltage of sample #S11.

At the academic level the currently running national R&D project allows resources only to such scale of studies. Our theory should be supported by testing and measurement results of much higher number of LED samples in order to represent appropriately the whole LED population and also the general aging physics of LEDs. Increasing the throughput of the presently applied LED characterization methods would also be needed. We are currently making efforts to develop new procedures to reduce measurement time and also to set up an international joint project consortium to enhance the statistical background of our theory.

Possible Economic and Social Benefits

Thanks to the proposed new luminaire designing method based on our multi-domain LED model, 28% of the total design costs can be saved for SMEs, while this value can be as high as 42% for large, "Major" companies with a long history in the market.

For more details, see the corresponding article:

G. Martin, C. Marty, R. Bornoff, A. Poppe, G. Onushkin, M. Rencz, J. Yu, "Luminaire Digital Design Flow with Multi-Domain Digital Twins of LEDs" ENERGIES 2019, 12(12), 2389; DOI: 10.3390/en12122389

Assuming 1000 pieces of 8000 lm luminaires and based on our calculations, the savings potential that can be achieved with the help of our proposed lifetime operating scheme may reach the value of 85,000 EUR over the entire 17-year operating period. For a city of the size of Budapest with about 200,000 light sources, it would mean a savings of about 1 M EUR per a year, even not calculating with the proportionally reduced installation costs thanks to the increased product lifetime.

Web source of the "Budapesti Dísz- és Közvilágítási Kft." (the Budapest Decorative and Public Lighting company):

http://bdk.hu/cegbemutatas/kozvilagitasi-es-diszvilagitasi-adatok/

03

Sympholight Smart Control Software

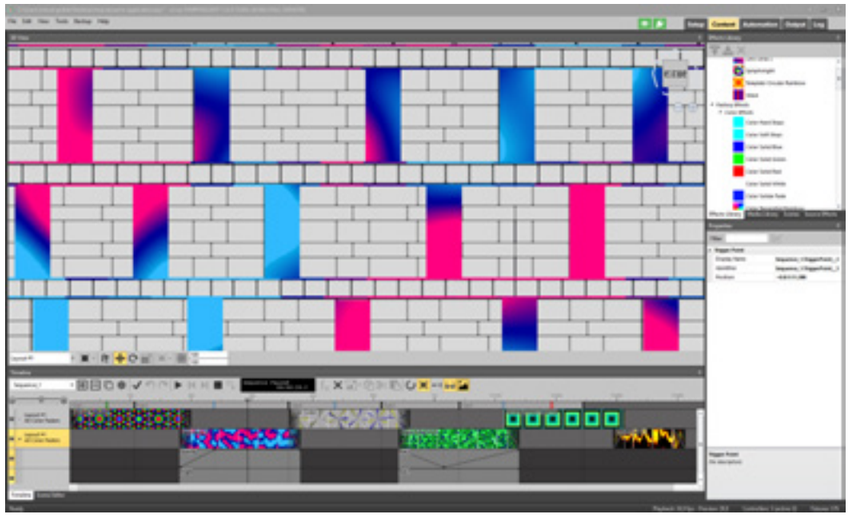
Traxon Technologies Ltd.

Brief Introduction

In the past decade, digital systems have gradually replaced traditional analog lighting control instruments, and media LED solutions that manage thousands of RGB pixels have also become mainstream. Lighting is gradually shifting from focusing on equipment to focusing on content. Sympholight is an integrated smart control software developed in response to this trend. With the original intention of "one software fits all", it is also one of the few control systems on the market that can integrate various indoor and outdoor communication interfaces and protocols (such as RS232/485, UDP, DALI, MIDI, DMX) commonly used in China and overseas.

The software integrates lighting equipment management, project settings, content creation, automation and execution control, mobile control, API application programming interface, third-party software data exchange, language selection, etc. through an intuitive graphical user interface based on advanced timeline programming – all these functions are integrated in one system. Its powerful functions make it suitable for lighting projects of all scales, from the human-centric lighting control of a single room to the platform management of city-level lighting infrastructure, delivering excellent results as desired

At present, our software has been widely used in indoor and outdoor smart lighting projects around the world, including the Fifth Nanjing Yangtze River Bridge, Guangzhou Chimelong Waterpark, "Europe's Tallest TV Tower" Moscow Ostankino TV Tower, Switzerland Säntispark Slide World, Pearl Bangkok, Osram Opto Semiconductors Regensburg Headquarters (indoor and outdoor lighting), Calgary Palliser One, Bandung Thee Matic shopping mall, Sonepar Greater China office, the Century Tower of the University of Florida, the campus concourse of the University of Sheffield (Winner of IALD 2020), the Dena'ina Civic and Convention Center in Alaska, etc.



The Innovation Points

This software is currently one of the few lighting control systems on the market that can support both indoor and outdoor communication interfaces and common protocols used in China and abroad. Its compatibility, intelligence and cost-effectiveness enable it to take a leading position in the global lighting control system market. In many practical applications, this software has solved several key problems in smart lighting projects as follows:

1. In response to the difficulty of synchronizing indoor and outdoor luminaires and systems of varied protocols, our software integrates an array of communication interfaces and common protocols (such as RS232/485, UDP, DALI, MIDI, DMX) used in China and overseas, seamlessly and efficiently accepting LED fixtures from different manufacturers or brands, eliminating the need for third-party controllers to save construction time and cost, and finally form an interconnected lighting network to achieve synchronization with the upper-level system.

2. To deal with challenges of complex lighting effects and ensued cumbersome creation process in smart lighting projects, our software arranges the content creation of the light shows in a sequence through the Workflow Designer. And at the same time, its powerful capabilities allow for programming the operating controller quantity, video data, and control workflow in the way of icons/buttons and lines, simplifying content creation and logic

management.

3. Aiming at the problem of complex lighting effects and unsmooth presentation of colors in smart lighting projects, our software sets a control layer in the content sequence, and directly controls the RGB function of the luminaires through the color channels to ensure the accurate presentation of lighting colors. It offers video management functions such as independent fade-in and fade-out settings to ensure effect transition is natural, effect layers management, light fixtures grouping and video reading, and the ability to adjust lights of a certain area to change video content etc. Through these functions, our software has greatly shortened the time of creating and confirming the lighting effects, which helps designers achieve the final result, and expedite construction of the project.

4. In response to the owner’s need for rapid and timely lighting management, the powerful programming function of our software can realize unattended automatic triggering, and enable installation on the tablet and smart phone through the App to realize real-time remote control on controller operation, effect change or lighting turn-off.

Innovation points of the software

1. With superb compatibility, our software is one of the few control systems on the market that can integrate both indoor and outdoor communication interfaces and various common protocols (such as RS232/485, UDP, DALI, MIDI, DMX) , reducing the need for third-party controllers to save construction time and cost;

2. With extremely powerful functionalities, our software can meet almost all lighting design needs, making it suitable for projects of all scales, from the human-centric lighting control of a single room to the platform management of city-level lighting infrastructure.

3. With innovative sequence arrangement, our software simplifies the process of creating lighting effect content, making content creation much easier;

4. With innovative layer management, our software allows for precise control over the lighting color, brightness, color temperature and beam angle, helping to achieve "precise lighting on demand" and "moderate light use";

5. Easy-to-use Web user interface and mobile remote controllability ensure more convenient and timelier lighting management.

Possible Economic and Social Benefits

Our software provides extremely high interconnectivity and convenience, achieves "on-demand lighting", and glamourous lighting effects on low energy consumption (for example, it’s expected to help the Fifth Nanjing Yangtze River Bridge to save more than 15% on energy use). This is a response to the national call for energy conservation and environmental protection, practicing the low-carbon concept of life, while calling for the entire lighting industry to the direction of health-centric and green illumination.

2. The superb compatibility of our software eliminates the use of third-party systems and converters, and reduces the consumption of engineering materials, production processes, energy consumption and pollution to the environment

3. The software's intelligent and precise control of color temperature, brightness, and beam angle can effectively limit glare, thereby reducing outdoor light pollution, eliminating glare of indoor lighting on human eyes and visual fatigue, and helping to achieve on-demand lighting and human-centric lighting (HCL).

4. Our software has been widely used in indoor and outdoor smart lighting projects around the world, including smart lighting schemes for the Fifth Nanjing Yangtze River Bridge, the Ostankino TV Tower in Moscow, the Pearl Bangkok of Thailand etc. It is able to achieve desired marvelous lighting effects with reduced energy consumption, providing the most cost-effective method to elevate architectural, entertainment, hospitality, and retail environments around the world, revitalize local night economy, and enhance growth.

5. The powerful content creation function and compatibility of our software help lighting designers to instantly present the effects they have in mind, accelerating the implementation of design solutions and reducing project costs. This also tremendously facilitate the implementation of SSL related design ideas, which will be beneficial to the growth of global SSL industry, the smart lighting design industry and the smart city development in China and even the whole world.

04 Connected LED Media Solution

Traxon Technologies Ltd.

Brief Introduction

The Connected LED Media Solution is an all-in-one vertical solution consisting of lights and control. Based on the project requirements and budget, the solution integrates SSL LED technology, lighting design and control technology to create the desired dynamic lighting effects for architectures or art installations. From LED equipment to control technology, it flexibly provides luminaires and corresponding control systems to build connected, cost-effective dynamic SSL lighting schemes.

In terms of luminaires, the solution provides standard or customized lights such as LED strips, LED dots, LED washers etc. based on project requirements; as per control technology, the solution integrates high-performance servers to connect pixels ranged from 10,000 to 3 million, enabling contractors/system integrators to choose the best fit option for the projects of almost any size.

The solution is widely used in such applications as building façade renovation, façade dynamic lighting, LED media façade, bridge illumination, indoor and outdoor art installations. Thanks to the compact size of hardware, the solution easily fits in narrow, curved or free-shaped building spaces and corners, which makes it suitable for most modern architectures and art installations. The solution has been applied in the dynamic lighting schemes for the Qingdao Haitian Center, the Beijing CITIC Tower (aka Z15/China Zun), the Beijing Olympic Observation Tower, the Suzhou Center and Gate to the East building (winner of the ISA Global SSL Showcase Top 100), the Zhuhai Grand Theater (winner of the ISA Global SSL Showcase Top 100), the Hong Kong V-Point, Europe's tallest TV tower – the Moscow Ostankino TV Tower, the Pearl Bangkok in Thailand and the NOMA Earth Tubes, an art installation in Manchester, UK, among many other projects.

The Innovation Points

The solution has been widely used in LED media lighting of various scales around the world. Its practicability, advanced qualities and cost efficiency have been proved by multiple projects, and it is in a leading position in the field of global smart LED media lighting. In practice, this solution mainly solved the following issues:

1. In response to the high standard for color rendering in LED media lighting projects, our solution provides lights with different versions of DMX512 controller (RGBW) or stroboscopic phase dimming controller (White). Colored lights allow for 16.7 Million additive RGB colors. Integrated algorithm ensures accurate control over the RGBW through different channels, producing red, green, blue or white lighting with the required saturation.

2. In response to the high standard for precise control in LED media lighting projects, our solution provides high-performance servers integrating DMX input and output, RDM communication, dry contact input and relay output, which supports a variety of Ethernet-based protocols, and can be accurately controlled. The lighting brightness, color temperature, color and even the beam angle can all be precisely adjusted to offer the required lighting effects.

3. To cope with challenges by narrow and irregular/free-shaped installation spaces in LED media lighting projects (such as facades light-up and art installations), our solution provides compact lights and palm-sized control hardware. And the lighting fixtures can be extended via daisy chain topology, shortened by cutting or bended, flexibly adapting to different architectural spaces or structures.

4. In response to the varied sizes or budget plans of LED media lighting projects, our solution integrates high-performance servers to connect pixels ranged from 10,000 to 3 million, which enables contractors/system integrators to choose the best fit option, catering for projects of almost any size, saving costs and reducing waste.

5. In response to the high standard for equipment stability in media lighting projects, our solution offers all lighting fixtures and control hardware rated at IP66 and above, and certified by CE, UL, ANSI and other standards, withstanding both Moscow's ice and snow and Zhuhai's heat and humidity etc.

Innovative Points of the Solution

1. With extremely compact equipment and hardware, it can flexibly adapt to spaces of varied sizes and shapes,

speeding up the installation process (Patent number 201730634723.1).

2. This extremely flexible solution can control pixels ranging from 10,000 to 3 million, enabling contractors/system integrators to choose the most appropriate version according to project needs, saving costs and reducing waste.

3. Revolutionary intelligent algorithm can control RGBW through different channels to render light color accurately as desired.

4. Customizable pixel length and daisy chain topology allow the luminaires to flexibly adjust to the installation space, whether it is narrow, curved or irregular/free-shaped.

Possible Economic and Social Benefits

Our solution provides extremely high intelligence and convenience, so that the central control room can see the real-time status of each operating circuit at a glance, reducing maintenance time, manpower and cost, and accurately achieving "lighting on demand” as well as energy conservation. This is a response to the national call for energy conservation and environmental protection, practicing the low-carbon concept of life, and calling for the entire lighting industry to the direction of health-centric and green illumination. The solution helped the China Zun Building obtain the LEED-CS Gold certification in July 2020, letting the building’s green practices recognized by renowned international organizations.

2. The solution enables architectural LED media façades to be a glamourous addition to the city nightscape, which helps revitalize the night economy and enhance local growth.

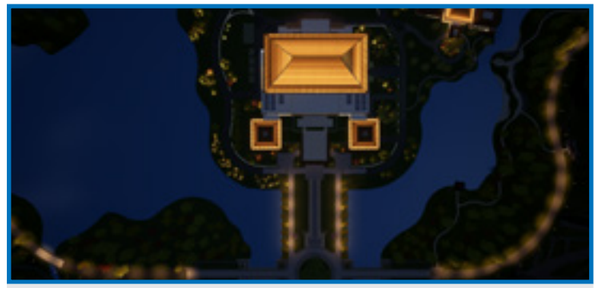
3. The solution enables LED media façades to be windows for information display, which favored by commercial brands or manufacturers and become one of the important profit channels for building owners.

4. The solution enables architectural LED media façades to be an effective channel for municipal communication, helping to effectively and extensively release public information and assisting city management. For example, the China Zun building LED media façade has demonstrated a powerful role in publicity and communication in major events such as the National Day celebrations and the "Belt and Road" initiative.

5. The solution has developed a number of patented innovations during its practice, which provides useful reference experience for the implementation of smart lighting and art installations in China and the world and will help further enhance the realization of more SSL-related lighting designs.

05

Virtual Lighting Simulation System



Beijing Heguanghui Technology Co., Ltd.

Beijing Qingkong Research Institute of Human Settlement Environment Co. Ltd.

Brief Introduction

Composed of two softwares, Lighting Simulation Production System V1.0 and Virtual Test Light Field System V1.0, the Virtual Lighting Simulation System is mainly used for design support work such as lighting effect simulation production, real-time preview, immersive animation production, and high-efficiency luminaire selection under actual simulation of lighting effects, so as to improve design production efficiency, avoid productive inefficiency caused by the lack of experience, and in the meantime visually display the lighting database, farsightedly evaluate the lighting effect, and ensure the implementation of the project. It also makes it possible both for the future control system to establish a docking and having a visual prefabrication of control and debugging.

The technical principle is: calculate and optimize on the basis of the UE4 Engine Optical Mapping Calculation, standardize and correct the input source of the illuminated surface material data and the optical data of the lamps and lanterns, and carry out the lighting effect simulation in the system (98% or above compatible with professional inspection data); Based on open source code, develop lighting plug-ins, which can realize the entrance of lamp library and material library, operation functions including data statistics, data index calculation, batch copy, lamp replacement, and carry out professional optimization and development in allusion to adjustment operations for lamp placement and projection angle. The Virtual Test Light Field System is a lightweight version based on the Lighting Simulation Production System, which is easy to operate and adapts to rapid light selection operations.

Up till now, the first stage of market promotion has been carried out, including the simplified version, has served 300 users, among whom are government owners, research institutions, universities and colleges, design units, construction units, and lighting manufacturers, and are applied in more than 50 engineering projects. It is used for: the lighting simulation production of various key projects such as Tian’anmen Square, the National Museum, the Great Hall of the People, Tongzhou Administrative Sub-center, Shenzhen Qianhai Development Zone, etc.; demonstration of lamp selection for installation nodes in the surrounding buildings of Changzhou elevated, Tianning Pagoda in Changzhou, Suzhou Lion Mountain Museum, Xi'an Silk Road International Convention and Exhibition Center and other projects. Beijing Sanseshi, Shenzhen Dasheng, Chinese Academy of Sciences Architectural Design and Research Institute and many other design units have integrated the software into the design workflow to cooperate with design business; many project companies and lighting manufacturers have adopted the Virtual Test Light Field software to carry out product selection and sample matching.

Tianning pagoda

The Innovation Points

Domestic and international level: Currently, the commonly used auxiliary lighting design softwares includes DIALUX 4.13, DIALUX Evo, Lumion, 3DsMax, Virtual Simulation System, etc., which can be roughly divided into four categories based on software capabilities:

1. Auxiliary calculation software: Supporting design with strong calculation ability, but the simulation of effect is relatively low;

2. Effect performance software: Centering on real-time rendering of effect, displaying simple light and shadow, with adjustable light type and strong subjectivity.

3. Modeling+effect performance software: Centering on modeling function, while possessing baking and rendering functions, with adjustable light type and strong subjectivity.

4. Virtual simulation software: possessing both real-time calculation and real-time rendering functions, with objective and real effect lighting simulation.

Key technologies and innovation points: optimization of software optical calculation methods; standardization and correction of optical data source files for materials and lamps; brightness/illuminance data calculation function; data statistics function; overcoming key technical difficulties in terms of development of operating methods to ensure the authenticity and digitization of lighting effect; the innovation point of this software system lies in making full use of the real characteristics of virtual simulation technology to establish a real material library and a lamp library based on testing for the production and call of lighting effects; providing a convenient and fast operation mode that can simulate the debugging process of the lamp to carry out lighting design selection; realizing real rendering highly similar to human eyes, so that the simulation results can reach higher data accuracy; the simulation results are presented in real time, without waiting, and what you see is what you get; combining with VR hardware to achieve an immersive experience of the scene.

Major technological innovation points

1. Material library made by real measurement

For the material of the illuminated surface, collect color and texture information under professional and uniform conditions, calibrate standardized material data through color calibration software, and import the software; simultaneously attach the material reflectivity data collected by field test, and produce real material information in the software system; various materials are accumulated to form a material library to ensure the true reflection characteristics of the illuminated surface, which can be called with one key when the software is operated. The first batch of material library contains nearly 150 material data such as stone, metal, glazed brick, concrete, grass, asphalt, brick and so on.

2. Massive lamp library based on inspection data

For the lighting effect simulation, adopting real optical data (third-party testing agency testing of CNAS, CMA certification and ELI certification qualification), and through optimizing the optical data structure, combined with software identification characteristics, establishing a set of standard lighting effects production method to ensure the authenticity of the lighting effect. In comparison with the test data, the matching degree of the lighting index data reaches more than 98%, which is guaranteed to be within the deviation range recognized by the naked eye; Meanwhile, the appearance, size, and material of the luminaire are modeled 1:1 according to the actual luminaire situation to ensure the authenticity of the appearance of the lamps; A large amount of lamp data is accumulated to form a lamp library, which can be inquired, filtered and called with one key during software operation. The first batch of lamps and lanterns library includes more than 350 types of lamps including line lamps, flood lamps, underground lamps, semi-underground lamps and waist drum lamps. The light shape of the lamps in the library cannot be changed in the software, so as to avoid the interference of human operation on the real effect of the lamps.

3. Operation method that fits design habits

Based on the design business habits of the lighting designer, the software operation simulates the luminaire layout and on-site debugging actions, and develops functions such as luminaire query and filtering, which makes it convenient to find products in the luminaire library that meet the design requirements according to the design needs; Meanwhile, the operation functions such as lamp placement, lamp projection angle adjustment, and color temperature adjustment are developed, and the on-site debugging operation is simulated, and the design and on-site debugging are integrated. At the same time, the plug-in realizes the replacement function. The unqualified lamps can be replaced with one key after re screening; For the lamps that meet the requirements, they can be copied and arranged in batches at equal intervals, and deleted in batches. In the process of realizing the scheme design, synchronous visualization is used for the convenient operation of deepening design (including lamp arrangement and lamp selection).

Simulation effect of Xi'an project

Real scence of Xi'an project

4. Convenient data calculation aided evaluation

The software possesses a brightness calculation function, which can instantly generate a pseudo-color map mode of the whole scene with one key to view the brightness level; the brightness data of a specific area can be quickly calculated through frame selection, which is easy to operate; this function can be used in the process of lamp selection of the lighting design to carry out the conformity check of the index and the upper planning index, and assist in the evaluation of the design brightness ratio and the rationality of the matching of the lamps.

5. Real-time lamp data statistics function

The software plug-in contains a statistical interface, which displays the statistical results of the type, quantity, power and other data of the lamps in the operation scene. The lamps can be increased or decreased during the operation, displaying the quantity in real time, and generating data statistics forms. Besides, statistical data types can be customized and increased according to needs.

6. Rich display experience mode

The lighting effects produced by this software are accompanied by lamp layout and lamp information, with highly realistic simulation effect, and what you see is what you get. The produced project file can quickly capture multi-view (upward, downward, and head-up) lighting effect pictures; edit and output bird's-eye view and human viewing angle roaming animation; also be combined with glasses, helmets and other hardware devices for immersive viewing experience.

Possible Economic and Social Benefits

Select lamps through the simulation, reducing the technical requirements of practitioners and labor costs. In the design process, new designers can intuitively and quickly accumulate experience in lamp selection (without accumulating experience through a large number of on-site lamp watching practices), which reducse the training cost and cycle. Providing efficient and accurate auxiliary tools for design.

By simulating the installation of lights on site, guiding the construction, installation and debugging process, reducing the project cycle, avoiding the repetition of multi link docking, and greatly improving the design and production efficiency. Saving a lot of manpower, material and financial resources. Providing accurate installation and debugging guidance and reasonable product selection suggestions for the construction party;

By comparing and selecting numerous real products that meet the lighting objectives, you can pick out products with high cost performance to be applied in the project, which guides the rationalization of project investment to a certain extent, and indirectly reduces the operation and maintenance management cost. Ensuring the implementation of the design scheme, avoiding the situation of "beautiful effect but out of shape implementation". Ensuring the quality of the project, and indirectly reducing the management pressure. Avoiding excessive lighting and light pollution, protecting the ecological environment balance at night. At the same time, providing product application direction for product suppliers to guide R&D. Promoting the healthy and orderly development of the lighting industry.

The result file produced by software covers the digital asset information of carriers and lamps, and will be in line with digital city management in the future. It can carry out the digital experience of night space and digital asset management, form an objective and unified digital standard for the whole scene space, realize integration of software, hardware and management services, visualized and seamless connection with night management scenes, promote the improvement of urban lighting facilities management level, and faciliate the sound development of industrial ecology.

06

Innovative Eco-friendly Campus Lighting

Tongji University

Brief Introduction

Innovative Eco-friendly Campus Lighting of Tongji University, on the basis of protecting the normal activities and growth of animals and plants at night, lights up the campus at night to create a background for campus stargazing. As the initiator of the Global Alliance of Universities for Environment and Sustainable Development (GUPES), Tongji University is a demonstration base for ecological civilization, caring for every plant and tree, and caring for life. The university uses "sustainable development" in personnel training, scientific research, social service, international communication, cultural inheritance and innovation, campus construction and other work. In the construction of eco-friendly campus night view, we adhere to the lighting principle of “moderate lighting, low brightness, low color temperature, and no glare”, introduce smart lighting system, protect the campus cat ecology, consider the demand for stargazing at night, improve the vitality of open space at night, and highlight the cultural and architectural characteristics of Tongji University.

Tongji campus has a strong cat culture, and cats represent the ecological vitality of the campus. Cats are nocturnal animals, and the eco-lighting was designed and implemented with full consideration to reduce the negative impact on cats. The main public Spaces and typical buildings of the campus were selected to focus on building, avoiding the main activities of cats. The area includes the school gate, library, statue of chairman, North and South Building, Auditorium 129 and Cherry Blossom Avenue. For the Sanhaowu area where cats are active intensively, the “weak” treatment method is adopted to reduce the lighting brightness and install the lamps without glare to create a hazy and beautiful night landscape and highlight the characteristics of Chinese garden. In response to the call of Comrade Wen Jiabao -- look up at the sky, down to earth, “I hope that students often look up to the sky, learn to be a man, learn to think, learn to learn knowledge and skills, to be a concern for the fate of the world and the country.” The project eliminates over-lighting, and avoids people ignoring the beautiful night sky because of too bright artificial light. Moderate lighting in the campus creates a good background brightness for students to watch the stars. In addition, the project has improved the entire functional lighting of the campus to eliminate dark areas and ensure the safety of teachers and students traveling at night. At the same time, the lighting connects many important activity nodes and cultural signs in the campus, showing the wisdom and cultural heritage of Tongji science and technology innovation. From the design, construction, use to maintenance and operation of each stage, give full play to the enthusiasm of teachers and students to participate in the creation of a beautiful campus night scene, guide teachers and students to participate.

The Innovation Points

1. Eco-friendly, protecting the law of nocturnal growth of animals and plants

The campus cat culture atmosphere is strong, the night lights consider the cat ecology. Cats are nocturnal animals. The influence on cats should be fully considered in the design and implementation stage. The safety

of cats should be guaranteed and the normal life of cats should be avoided when the lighting point, installation position and method of lamps are selected. Widely used low color temperature LED light source, low energy consumption, longer life; Customized lighting classification time division control scheme, set weekday mode and holiday mode, normal mode and late night mode, late night time only need to meet the basic functional lighting. On the basis of reducing the impact on the nocturnal activities of cats and protecting the normal growth law of plants at night, resources are saved and costs are controlled.

2. “See the light, do not see the light”, create the background of stargazing at night

In response to comrade Wen Jiabao’s call to “look up at the stars, down to earth”, moderate lighting is used to light up the campus. In terms of lighting, the method of washing on the top is used to create a soft lighting effect and create a beautiful background for stargazing at night. The lamps and lanterns are hidden behind the landscape and architectural structure as far as possible. Some of the exposed lamps and lanterns are specially treated with anti-glare treatment during the installation process. The Angle and brightness of the lamps and lanterns are adjusted one by one to reduce the stimulation of the light to pedestrians, cats and plants, so as to achieve the effect of “seeing the light without seeing the light”. The luminance of lamps and lanterns is suitable to avoid artificial daylight light pollution in the sky due to excessive brightness. Moderate illumination ensures people's demand for stargazing.

3. Intelligent lighting

In terms of intelligent lighting, the remote intelligent control of lighting is realized. Through the mobile terminal control system, the lighting can be switched on and off at any time, and the color temperature and brightness can be adjusted. It can not only create a warm and quiet atmosphere for the daily night scene, but also realize the lighting effect during festivals or large-scale activities, and save energy as much as possible. In addition, the intelligent light pole is introduced into the road lighting. On the basis of the "basic function lighting", it has the functions of security monitoring, alarm, human flow monitoring, information release, path guidance, wireless network, charging, noise (or air) monitoring and other functions. The interface can be reserved to realize the effect of multi-purpose and functional integration of one pole.

4.Pilot lighting, step by step

To be on the safe side, we selected areas that are far away from living areas, with landmark buildings and landscape as the main areas. First of all, the main school gate, Tongji Square, the chairman's statue, the library, the North and South Building, the auditorium and the Sanhaowu were completed. Meet the road functional basic lighting requirements, through landscape lighting to show the aesthetic feeling and interest of the campus environment. According to the night scene effect presented after the preliminary completion, actively absorb the suggestions of teachers and students, constantly optimize and improve the existing lighting effect, and timely promote the subsequent renovation work.

5. Full participation

Give full play to the rights of teachers and students to know, participate, express and supervise campus construction, and listen to the opinions of teachers and students through various forms and channels such as student symposium, questionnaire survey and teaching congress. Through the “Youth Tongji” public account of the Youth League Committee and online questionnaire survey, students’ opinions were collected. Most students supported the improvement and transformation of campus night scene, and put forward many valuable opinions based on their own practical experience. In addition, teachers and students of the light environment laboratory of our college conducted a net-cast survey on the current situation of the campus night scene before the renovation, measured the data of illumination, brightness, color temperature, uniformity and other data on the spot, sorted out the problems, and formulated the preliminary night scene lighting planning scheme and design guidelines. In the stage of building landscape lighting scheme, on-site test lamp was organized, and teachers and students made subjective evaluation to determine the best lighting brightness, color temperature, beam Angle, irradiation mode and other parameters; In the commissioning stage after completion of construction, lighting parameters will be adjusted according to the feedback of teachers and students to create a better night scene atmosphere.

6. The whole-process practice project of “Three-in-one education” in the school

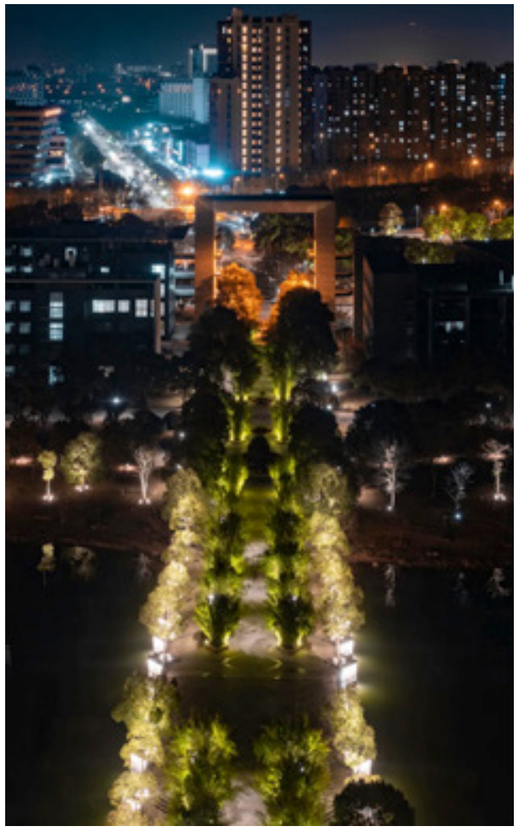
After the completion of the project, the project will be further promoted through microblog, public account and photo contest. Adhere to the design, construction and use as the school's “three complete education” practice project, strive to improve the sense of participation and identity of teachers and students, meet multi-level, differentiated and personalized needs, find the right combination of all sides, create a night cultural atmosphere with Tongji characteristics.

Possible Economic and Social Benefits

1.Build an ecologically active campus with the light environment as the medium

On the basis of protecting the campus ecological environment, promote the development of cultural places,

cultural activities, cultural impact effect, to build an ecological environmental protection, characteristic, dynamic and high-quality Tongji university. Respect the unique cat culture of the campus, create a good background for stargazing at night, and close the relationship between teachers and students and nature. At the same time, intelligent multi-mode control is adopted to meet the requirements of using intelligent campus night scene control with sub-scene mode, and create campus ecological vitality space at night.



2.Improve the image of campus night scene

The night view of campus is related to the quality of campus, campus image, and even campus safety. It is necessary to carry out systematic planning, design and renovation of campus night view lighting. Strengthening the construction of quality lighting environment at night not only needs to simply "illuminate", but also needs to fully combine the quality of Tongji University and protect the campus ecology. On the basis of humanity, we should respect the carrier, highlight the characteristics and form memories, so as to create the temperament of famous schools.

3.Completely eliminate dark areas on campus, no dead corners for safe lighting, and ensure basic travel

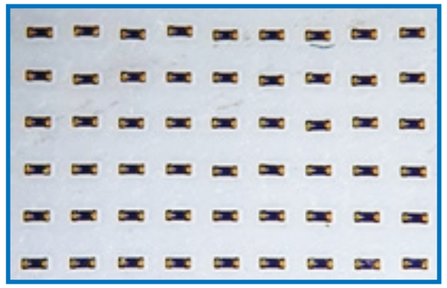
We should attach importance to the basic construction of functional lighting, marking lighting and so on. We should transform the functional lighting of roads and squares to improve the safety and ensure the safe travel of teachers and students at night. Analyze the landscape level to create a spiritual home with a sense of security and belonging.

4. Innovation leads, explore the demonstration path

In the future, the nighttime environment construction of Tongji university should be combined with the characteristics of disciplines, absorb innovative technologies, and display the innovation of Tongji University and promote the construction of quality demonstration effect of Tongji campus through the service of Tongji technology.

07

Mini/Micro LED Massive Transfer by High Speed Multiple Chips Bonding Technology and Equipment



Shenzhen FontAI Industrial Technology Co., Ltd.

Brief Introduction

Mini/micro LED bulk transfer high-speed poly crystalline solidification machine can overcome the shortcomings of low transfer efficiency of existing solidification process, and research and develop a mass transfer solution based on high-speed precision visbreaking UV film transfer technology, which is applied to the high-speed poly crystalline solidification machine / test separator project, and has complete independent intellectual property rights. The developed prototype has stable performance, high efficiency and yield to meet the requirements of mass production. It meets the conditions of mass production and realizes a revolutionary innovation on the existing solid crystal technology. The products are widely used in the fields of mini / micro LED display, intelligent landscape, lighting, home appliances and so on.

Compared with the traditional solidification machine, the transfer efficiency is as high as 30 times and it is more than 6 times higher than the technical efficiency of industry leading enterprises.

The Innovation Points

Mini/Micro LED massive transfer poly crystalline crystal technology using unique innovation based on high-speed accurate adhesive UV film transfer technology, its technology principle: through the use of ultraviolet light scanning, make FontAI industrial high-speed ultraviolet strip area designated UV lost viscosity, so that the row of wafers in the area of adhesion and high-speed ultraviolet adhesive, and then use the suction nozzle can transfer a row of wafers, high transfer efficiency. To solve the problem of efficiency, location and chip micro miniaturization of precision grasping, which makes it have many advantages beyond similar products.

Product core advantages

Transfer efficiency is high

Compared with the traditional solidification machine, the transfer efficiency is as high as 30 times and it is more than 6 times higher than the technical efficiency of industry leading enterprises;

High good yield

The unique and innovative UV film transfer technology based on high-speed precision debonding solves the problems of precision grasping efficiency, position and chip miniaturization; It is caused by the system.

Low cost of manufacturing

Because the project belongs to the self-developed and developed equipment with mature technology and low cost, it has more price advantage than the products on the market.

Category	Traditional Bonder	The current stage of the industry leading enterprises	FontAI Industry (the Project)
Carrier, Pang Shu	Traditional Bonder	VDW transfer	Giant transfer technology / high-speed Multi Chips Bonder
Transfer efficiency	80K/ hours (6 suction)	300K/ hours	1KK/ hour
Extreme transfer efficiency	120K/ hours	4KK/ hours	Mass transfer efficiency is related to the number of chips per row (no upper limit)
Limitations	For the small size chip yield risk is very high. The efficiency drops sharply	Film must be aligned in advance before the transfer of printing, and the efficiency depends on the existing transfer efficiency;	Without alignment in advance, the transfer printing sheet is done simultaneously

Product function

Fully automatic loading and unloading materials to reduce manual operation;

High speed high precision transfer and Bonding;

Can be finished with transfer without advance;

The upgraded version can be mixed with chips as needed;

Process characteristics

Max. collection and compatibility of the upstream and downstream chip manufacturing and packaging technology while realizing the integration of chip arrangement and high-speed transfer, all core components and consumables are localization.

General material box and material plate, automatic loading and unloading, maximize the improvement of huge transfer efficiency and reliability.

It can transfer multiple chips at one time, and the number of single transfers can be customized according to the chip arrangement and chip spacing requirements; the handling device is driven by a high-precision cable motor to ensure the transfer accuracy.

The number of handling can reach 2-3 times per second, calculated with 150 chips per time, and can transfer 1.08 million chips per hour.

It can be mixed and matched according to the different chip parameters to ensure the product quality;

It eliminates the front drainage process, truly realize huge transfer, help customers improve production efficiency while greatly saving equipment investment; semi-finished products after consolidation can use our vacuum high-precision temperature curve welding equipment.

Micro LED display technology can solve many problems in the future

The emergence and integration of new technologies such as Internet plus, Internet of things, AI and VR/AR have raised higher requirements for flat panel display, which will promote the rapid development and wider application of flat panel display technology.

In addition, the rapid development of VR / AR promotes the demand of near eye display. At present, the near eye

display system mainly uses LCD and OLED two kinds of micro display technology. However, from the technical characteristics of the display, micro LED based micro display technology has the possibility to replace LCD and OLED due to its better display characteristics.

Mini LED backlight + LCD can achieve more precise regional dimming technology, and the cost is lower than that of OLED, which is helpful for manufacturers to use existing capacity to improve their profit level.

Therefore, massive transfer technology can widely and actively promote faster market of Mini/Micro LED display and lighting industry.

Possible Economic and Social Benefits

Benefit analysis

This project is not only in line with the national macroeconomic policy, but also in line with the local development plan. It is a good project that can pull and promote the comprehensive and coordinated development of regional economy and economic society, realize the harmonious development of human and nature and sustainable economic development, and promote the sound and rapid economic development.

We will promote the benefits of industrial clusters and enhance our regional economic strength

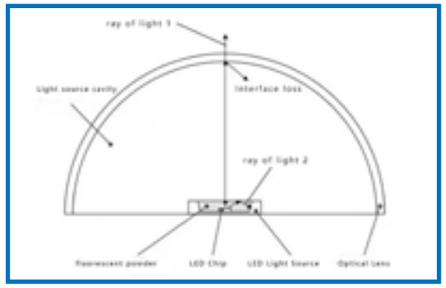
It is expected that in 2025, after the production lines are fully put into operation, the annual output value will exceed 10 billion yuan, and a centralized production area with advantages of mini / micro LED industry will be formed. The implementation of the project will become the core starting point of the industrial chain extension. Therefore, the company will establish extensive and in-depth cooperation with the industry-leading packaging enterprises and terminal enterprises, attract upstream and downstream enterprises to enter the park, form industrial clusters, and promote the sustainable growth of regional economy.

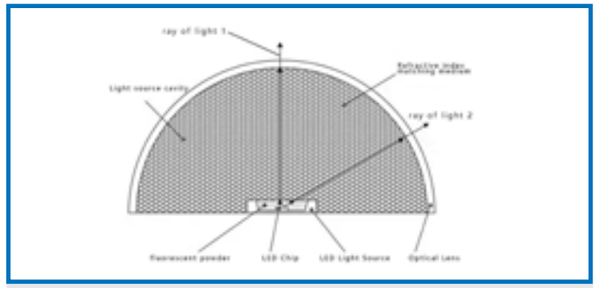
We will increase jobs and promote regional social stability

The Project plans to help our clients to establish more than 2000 Mini/Micro LED massive transfer production lines to support the production and sales of supporting downstream packaging industry.The construction of the project can maximize the employment of the local population, and it is expected to solve the employment of 5,000 people. At the same time, the implementation of new production lines in the next few years and driving the entry of upstream and downstream enterprises will continue to create new employment opportunities for the society, and effectively promote the prosperity and development of regional economy and social stability.

08

A Kind of Medium-filled High Luminous Efficacy LED Street Lamp and Its Manufacturing Method





CECEP LATTICETECHNOLOGY CO., LTD.

Brief Introduction

General introduction: when light passes through interfaces with different refractive indices, a part of light energy will be reflected by the interfaces and lost, which is called Fresnel reflection loss. Light emitted by the LED chip passes through the LED packaged fluorescent powder coating. Since the refractive index of the LED packaged fluorescent powder coating is greater than the air, the light emitted by the LED light source enters optically thinner medium from optically denser medium. Once the incident angle is greater than the total reflection angle, total reflection occurs. Light with total reflection angle or higher cannot be emitted and is converted into thermal energy loss. Due to the above two ways of light loss, refractive index matching medium is filled between the LED light source and the optical lens of street lamp, reducing the interface reflection and light loss caused by total reflection in the process of light transmission, taking out the light emitted by the LED chip to the greatest extent, thus improving the luminous efficacy of LED street lamp. Compared with optical lens, the optical characteristics of LED street lamp light source filled with medium will change, and accordingly, the light distribution curve and application scenarios of LED lamps will also change.

In the manufacturing process, the refractive index matching medium drops on the LED light source are subjected

to outward force perpendicular to the surface of the said LED light source by inverting or rotating the LED luminous substrate, so as to form the outer contour of the lower part curve of the quasi-droplet shape, which is baked for a certain time and then combined with a baked optical lens filled with refractive index matching medium. During the combination, the front end of the droplet on the contour of the lower part curve of the quasi-droplet shape reaches the refractive index matching medium in the cavity of the optical lens first, and as the liquid drops on the LED light source gradually merge with the refractive index matching medium in the cavity, the quasi-droplet shaped liquid drops squeeze the air out from the periphery of the quasi-droplet shaped liquid drops, thus avoiding the generation of bubbles in the filling medium.

Application scenarios: the technology of filling refractive index matching medium to reduce the light loss of LED chips has two main applications in current market. First, before the medium filling, the light distribution design of lens is not suitable for road lighting. Once filled with refractive index matching medium, the energy of emitted light changes in corresponding irradiation area, thus meeting relevant requirements of road lighting; second, the light distribution curve changes after medium filling, but it is still applicable to street lamps for road lighting. Taking dispensed street lamp of Lattice as an example: its technology is divided into two stages. First, in 2011, it was based on the lamp bead filling technology with lens (hemispherical lens) on the light-exiting surface, the light emitted by this kind of lamp bead chip entered the hemispherical lens approximately vertically, and the total reflection loss was small, so the LED lamp mainly had Fresnel reflection (interface reflection) loss. Fresnel reflection loss coefficient is related to the incident angle of light. When the incident angle of light is 0, that is, vertical incidence, the reflection loss is the minimum; while the incident angle of light increases, the reflection loss increases gradually. When the light enters vertically, the reflection loss coefficient is. In LED lighting applications, the refractive index of common optical materials is generally 1.5~1.6, and the refractive index of air was 1. According to the formula of reflection loss coefficient, the minimum reflection loss of primary interface is about 4%. Based on this kind of packaged medium filling technology, the luminous efficacy was improved by about 4%, a relatively low increase rate. Moreover, the filling medium was expensive and the application cost performance was not high. Second, since 2019, it has been based on the lamp bead filling technology with the light emitting surface being a plane (similar to EMC5050). It has a more significant increase in luminous efficacy after medium filling when compared with lamps adopting lamp beads with lens, and thus has a higher use value.

Practical effects: according to relevant test data of Lattice medium filled street lamps, the comparative analysis of data before and after filling shows that when the target color temperature is 4000K, 3200K LED lamp beads shall be used, at which time the light output ratio is about 104% ~ 106%; when the target color temperature is 3000K, it is necessary to use 2500K LED beads, at which time the light output ratio is about 108%~110%. The luminous efficacy of LED street lamps with high luminous efficacy from mass production of the Company can exceed 180 lm/W ~190lm/W, and the luminous efficacy value of street lamps with high luminous efficacy produced by experimental trial can exceed 200 lm/w.

The Innovation Points

Present key problems: the purpose of filling the lens of street lamp is to achieve higher luminous efficacy of LED street lamp. The convex cavity between LED light source and lens is filled with refractive index matching medium for luminous efficacy improving, which is filled by glue injection or dispensing. In the production process, dispensing or glue injection is adopted. Since the refractive index matching medium is viscous, pressing the outer surface of LED light source into the refractive index matching medium in the cavity may generate a large number of fine bubbles, which are difficult to be discharged and will remain in the refractive index matching medium, preventing the luminous efficacy of LED lamps after dispensing or glue injection from being greatly improved, thus failing to achieve the expected energy-saving effect, or even affecting the light distribution effect of LED lamps.

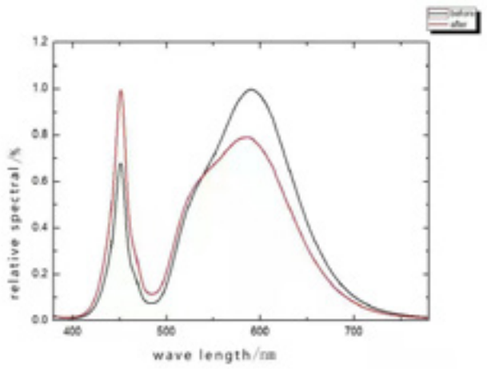
This project mainly has the following innovation points and technical problems solved:

1. It applies medium filling based on the existing LED street lamp lens; light distribution both before and after filling is applicable to road lighting, thus the problem that tooling for lens cannot be shared in new technology is solved; the photometric characteristics of lens both before and after medium filling can meet the requirements of road lighting, thus tooling for same lens model can be shared, reducing the production cost.

2. The light emitted by LED light source of high luminous efficacy lamps passes through the refractive index matching medium of the optical lens and then exits through the optical lens, which solves the problem of light waste and temperature rise caused by the conversion of some light rays which cannot exit into light energy in the lens, thereby improving the light-emitting efficiency of the LED lamp, as well as reducing the ambient temperature of the LED light source and prolonging its service life.

3. In the manufacturing process, the refractive index matching medium drops on the LED light source are subjected to outward force perpendicular to the surface of the said LED light source by inverting or rotating the LED luminous substrate, so as to form the outer contour of the lower part curve of the quasi-droplet shape, which is baked for a certain time and then combined with a baked optical lens filled with refractive index matching medium. During the combination, the front end of the droplet on the contour of the lower part curve of the quasi-droplet shape reaches the refractive index matching medium in the cavity of the optical lens first, and as the liquid drops on the LED light source gradually merge with the refractive index matching medium in the cavity, the quasi-droplet shaped liquid drops squeeze the air out from the periphery of the quasi-droplet shaped liquid drops, solving the problem in traditional dispensing operation that since the surface of LED light source squeezes the

air directly and cuts its dissipation path, a large number of fine bubbles are dispersed in the refractive index matching medium. Therefore, the technology has the beneficial effects of completely filling the concave cavity of the optical lens with refractive index matching medium and maximally improving the light out-coupling efficiency of LED lamps.



Possible Economic and Social Benefits

1. LED street lamps adopting medium filling technology are more suitable for roads with high lighting quality requirements than those before filling because of their large light distribution angle in the direction perpendicular to road, improved uniformity and lighting comfort. Starting from the road conditions and actual needs, the best lighting effect and energy saving effect can be obtained with the specific scheme for each road.

2. By analyzing the test data of luminosity distribution of the same LED street lamp before and after medium filling, the utilization coefficient (illuminance) and light utilization efficiency (brightness) of the lamps are compared and analyzed, and the following conclusions are obtained:

(1) Analyzing from the aspect of luminous efficacy and total luminous flux of lamps, medium filling not only reduces the interface light loss, but also takes out the light emitted by LED chips as much as possible, so that the light output ratio of lamps may exceed 100%, both the luminous efficacy and total luminous flux of lamps are greatly improved.

(2) From the aspect of road application, since the luminous flux distribution of the original LED street lamp is changed by medium filling, the road condition changes after filling, in which case the lighting angle of the V plane of the lamp increases, the maximum light intensity value decreases, the illumination uniformity increases, the glare value decreases, the illuminance value decreases or increases according to different road conditions, and the brightness value decreases.

Medium filling technology can adapt to road lighting both before and after filling, but the optical characteristics of lamp will change after medium filling. It is one-sided to think that because the medium filling improves the luminous efficacy of lamps, it also improves the energy-saving effect. Therefore, we need to select appropriate lamps according to the specific road conditions and lighting requirements, and calculate scientifically according to the changes of light distribution before and after medium filling to determine whether it is applicable or not, so as to obtain the best energy-saving effect and lighting effect.

Global SSL Award of Innovations Top 100

Jury Panel 2021

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