ISA
International SSL Alliance

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Solid state lighting (SSL) after 20 years' development has gradually reached a mature stage in terms of performence 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 high value added application integration e.g. agriculture, health, communications, high-definition display, polymer curing, disease vector control etc. 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 decades as well as from manufacturers to thousands of households, all of that 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 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 intention and ultimate goal of this award.

Jianlin Cao

Jianlin Cao
President of ISA

International SSL Alliance

Global SSL Award of Innovations Top 100

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.

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 83 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.

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. Smart Lighting
2. Mini/Micro LED
3. Health Lighting
4. Visible Light Communication (LiFi)
5. Agriculture Lighting
6. UV LED Application
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.

Statement

Global SSL Award of Innovations Top 100

- Accept excellent applications
- Judged by authoritative experts
- Worldwide circulation and promotion
- Manifest the achievement of innovation

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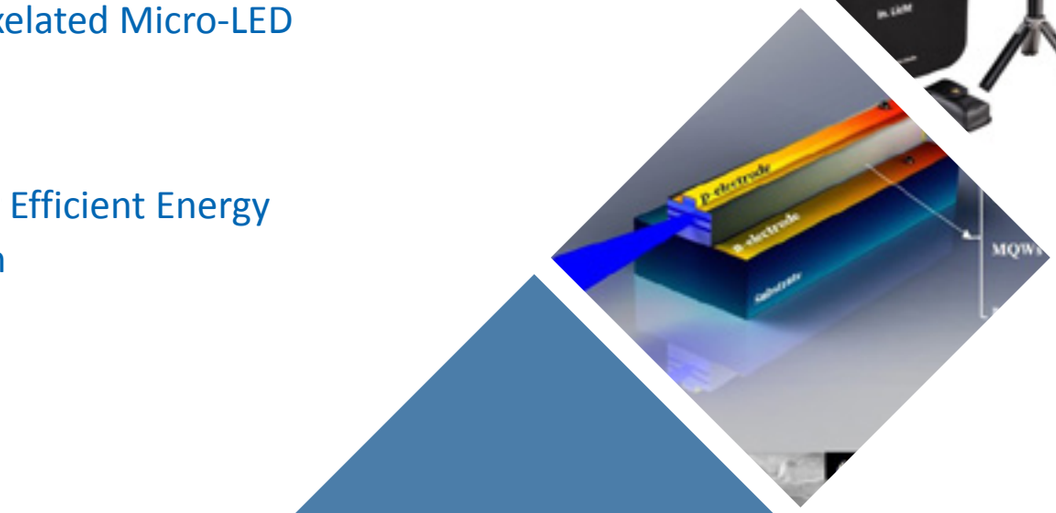


Smart Lighting

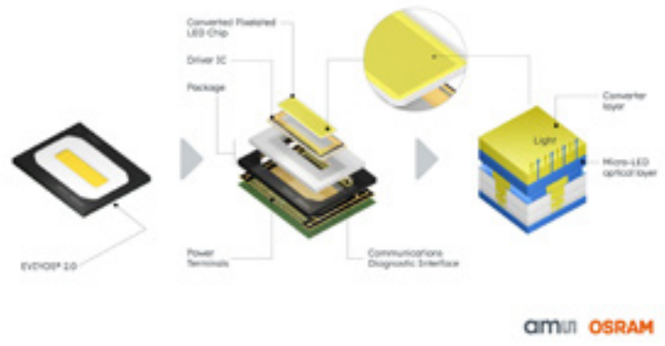
01

EVIYOS® Shape Intelligent Pixelated Micro-LED for Smart City Application

ams OSRAM

Brief Introduction

As urban areas advance, smart cities are increasingly using new technologies to improve residents' lives. A standout innovation in this area is the EVIYOS (Efficient, Versatile, and Intelligent micro (µ)-LED from OS), which is changing the way cities handle lighting, safety, and interactive features.



Efficiency and Versatility

The EVIYOS® Shape LED features up to 25,600 tiny micro-LEDs, offering remarkable efficiency and adaptability. Unlike traditional lighting, each micro-LED uses very little power while providing bright and clear light. This efficiency helps cities lower their energy use and costs, which is important for reducing carbon footprints and saving money.

Each individual LED can be controlled separately, allowing for a wide variety of lighting effects and setups. This means that EVIYOS® Shape can do much more than just light up an area; it can create customized lighting for different situations, whether it's for street lighting, decorative purposes, or displaying real-time information. This ability to tailor lighting to specific needs makes EVIYOS® Shape suitable for various urban environments.

Integration with Smart Sensors

A major advantage of EVIYOS® Shape is its integration with smart sensors, which boosts its functionality and usefulness in smart city projects. This feature transforms the lighting from a simple light source into an interactive part of the city's infrastructure.

Enhanced Safety

Safety is a major concern in urban settings, and EVIYOS® Shape helps address this through its smart sensor integration. For example, motion sensors can detect movement from pedestrians or vehicles and adjust the lighting accordingly. In busy areas or poorly lit streets, this adaptive lighting helps make sure that everyone can see clearly, which reduces the chances of accidents.

Additionally, EVIYOS® Shape can work with environmental sensors to provide real-time alerts. In case of emergencies like fires or chemical spills, the system can display warning messages or guide people to safety. This responsiveness greatly enhances public safety by providing clear, immediate information when it's most needed.

Smart City Integration

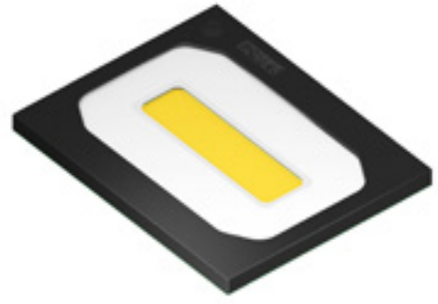
EVIYOS® Shape is designed to work with broader smart city systems. By connecting with other IoT devices and networks, such as traffic management systems or environmental monitoring stations, it helps create a more interconnected urban environment.

For instance, in a smart traffic system, EVIYOS® Shape can show real-time updates on traffic conditions, road closures, or changes in traffic signals. This integration helps manage traffic flow better and improves the experience for commuters by providing relevant information.

The system also adjusts based on weather conditions. During fog or rain, for example, the lighting can be increased to improve visibility and enhance safety on the roads.

Multifunctional Use Cases

The design of EVIYOS® Shape allows it to serve many functions beyond simple lighting, making it a valuable tool for smart cities. Here are some examples:



- **Signage and Advertising:** EVIYOS® Shape's high-resolution capabilities make it perfect for creating vibrant digital signs. Cities can use this for ads, public announcements, or interactive displays that engage residents and visitors.
- **Cultural and Artistic Projects:** The versatility of EVIYOS® Shape means it can be used for art installations or cultural displays. It can project light shows or interactive art, adding to the cultural life of urban spaces.
- **Event Management:** During city events, EVIYOS® Shape can display schedules, directions, or emergency information. This helps manage large crowds and keeps everyone informed with up-to-date details.
- **Energy Management:** The system's sensors can track energy use and optimize the LEDs' operation, supporting the city's energy management goals. This helps maintain efficiency and lower costs.

Conclusion

EVIYOS® Shape marks a significant step forward in urban lighting technology, offering exceptional efficiency, flexibility, and smart capabilities. Its ability to work with sensors and integrate into broader smart city systems makes it an important part of creating safer, more responsive, and visually engaging urban environments. As cities continue to adopt smarter technologies, EVIYOS® Shape will be crucial in shaping the future of urban living, combining innovation with practical use to meet the needs of modern cities.

The Innovation Points

As cities strive to become smarter and more efficient, the role of advanced LED technologies becomes increasingly important. The innovation of EVIYOS® Shape helps in advanced lighting solution by offering efficiency, adaptability, and intelligence, and is making a significant impact on how urban environments manage illumination and interact with technology.

Advancements in System-on-Chip Technology

At the heart of EVIYOS® Shape is its advanced system-on-chip (SoC) technology. Unlike traditional lighting systems that use multiple separate components, the SoC integrates all essential parts into a single chip. This integration boosts processing power and reduces delays, allowing each pixel to be controlled in real-time. This capability is crucial for applications that require adaptable and responsive lighting.

Compact Design

The integration of SoC technology in EVIYOS® Shape also leads to miniaturization. A lot of the control system is embedded within the micro-LED array, making the LED smaller and more versatile. This compact design makes it easier to be adopted into lighting systems in various urban settings and allows for creative and efficient use of space.

Energy Efficiency

The SoC design enhances energy efficiency by incorporating power management features directly into the chip. For smart cities, this efficiency translates to lower operational costs and supports sustainability goals.

Advanced Communication

EVIYOS® Shape includes advanced communication capabilities, allowing it to connect seamlessly with other smart systems. This enables real-time data exchange and synchronization with various Internet of Things (IoT) devices, improving the overall functionality and intelligence of the lighting system.

Solving Key Problems

Alternative to DMD Technology

Comparison with DMD

Digital Micromirror Device (DMD) technology has been used in projection systems for its high-resolution capabilities. However, DMD systems tend to be large, complex, and expensive. EVIYOS® Shape offers several advantages:

- **Flexibility:** EVIYOS® Shape allows for individual control of each pixel, enabling customizable and dynamic lighting effects. DMD systems, on the other hand, often require complex mechanical components for similar effects.
- **Size and Integration:** The compact nature of EVIYOS® Shape means it takes up less space and integrates control functions within the system, eliminating the need for separate optical units.
- **Power Efficiency:** EVIYOS® Shape is more power-efficient due to its consolidated design, which is important for large-scale urban use.

Applications and Benefits

EVIYOS® Shape can effectively replace DMD technology in several areas:

- **Dynamic Signage:** EVIYOS® Shape's ability to display interactive and real-time updates makes it suitable for urban signage, where changing information and customizable content are needed.
- **Decorative Displays:** Its flexibility allows for creative, real-time artistic installations, enriching public spaces and cultural landmarks.

Integration with IoT

Real-Time Adaptability

EVIYOS® Shape's integration with the IoT ecosystem is a significant advantage for smart cities. The technology supports real-time data processing and communication with other IoT devices, allowing the lighting system to adapt to changing conditions, such as traffic patterns or weather. For instance, the system can adjust streetlight characteristics based on pedestrian traffic to enhance visibility and safety.

Multifunctionality

Unlike traditional lighting systems that are limited to illumination, EVIYOS® Shape is designed to be multifunctional. Its advanced SoC technology supports various applications:

- **Signage and Advertising:** The high-resolution capability of EVIYOS® Shape makes it perfect for dynamic digital signage. Cities can use it for advertising, public announcements, or interactive displays.
- **Cultural and Artistic Installations:** EVIYOS® Shape can create vibrant visual effects for artistic displays and cultural events, enhancing public spaces and cultural experiences.
- Event Management: During public events, EVIYOS® Shape can display schedules, directions, or emergency alerts, helping manage crowds and keeping attendees informed.
- Applications in Smart Cities

Safety and Security

Safety is a major concern in smart cities, and EVIYOS® Shape helps address this by providing enhanced visibility and real-time alerts. For example, in emergencies like fires or natural disasters, the lighting system can display clear information to guide residents to safety.

Energy Efficiency

The energy efficiency of EVIYOS® Shape supports sustainability goals. By lowering power consumption and extending the lifespan of lighting systems, it helps minimize environmental impact and operational costs. The data collected through IoT integration can also be used to optimize energy usage further.

Conclusion

EVIYOS® Shape represents a major advancement in LED packaging and lighting solution in urban cities setup. Its efficient, versatile, and intelligent design, combined with advanced system-on-chip technology, addresses key challenges in smart city applications. EVIYOS® Shape offers a compact and power-efficient solution, providing a strong alternative to traditional DMD systems. Its integration with IoT enhances real-time adaptability, making it an innovation for modern cities. By improving safety, and supporting energy efficiency, EVIYOS® Shape is helping to shape the future of urban living, blending innovation with practical use to meet the diverse needs of smart cities.

Possible Economic and Social Benefits

EVIYOS® Shape is reshaping urban environments with its advanced micro-LED technology, offering significant economic and social benefits that are transforming cities into smarter, more vibrant spaces.

Economic Benefits

Cost Savings

EVIYOS® Shape are highly energy-efficient, consuming far less power than traditional lighting systems. This reduced energy use results in lower electricity bills for cities, cutting operational costs and supporting budget management.

Job Creation and Growth

The adoption of EVIYOS® Shape creates jobs across several sectors, including technology, engineering, and construction. The development, production, and installation of these systems stimulate employment and contribute to broader economic growth.

Attracting Investment

Cities using cutting-edge technology like EVIYOS® Shape attract investment from tech companies and venture capitalists. This influx of capital not only boosts local economic development but also fosters further innovation and infrastructure improvements.

Economic Efficiency

The flexibility of EVIYOS® Shape allows cities to adjust lighting in real-time based on current needs, optimizing energy use and further enhancing economic efficiency. This adaptability leads to greater cost savings and more effective resource management.

Supporting Local Businesses

By improving the visual appeal of urban areas, EVIYOS® Shape encourages more visitors and shoppers, benefiting local businesses. The enhanced ambiance increases foot traffic and sales, providing a boost to the local economy.

Social Benefits

Public Safety

EVIYOS® Shape enhances safety with better illumination and integrated warning signals in public spaces. Improved visibility helps deter crime and reduces accidents, making streets, parks, and other areas safer for residents and visitors.

Aesthetic Appeal

With high-resolution capabilities, EVIYOS® Shape enables the creation of visually striking urban environments. Cities can use these lights for public art installations or to highlight landmarks, boosting the overall aesthetic and fostering community pride.

Community Engagement

EVIYOS® Shape supports interactive public spaces by allowing for informational displays, public announcements, and interactive art. This fosters greater community engagement and responsiveness to residents' needs.

Accessibility

Integrated with smart sensors, EVIYOS® Shape enhances accessibility for people with disabilities. Adaptive lighting improves the visibility of pathways and obstacles, making urban areas safer and more navigable for those with visual impairments.

Smart Technology Integration

EVIYOS® Shape fits into the broader smart city ecosystem, working seamlessly with other IoT devices and environmental sensors. This integration contributes to a more responsive and efficient urban environment, improving overall city management.

Smart Lighting

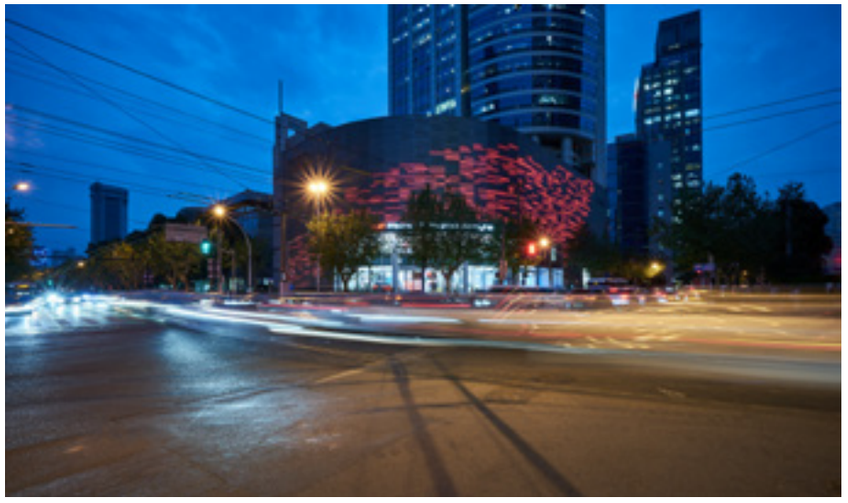
02

DALI PRO 2 IoT Controller for Efficient Energy Saving and Carbon Reduction

Inventronics

Brief Introduction

"House of Progress" is the largest global store of an automobile brand, the concept of "House of Progress" is more of an art gallery or a brand museum. It interprets the brand's design philosophy of sensuous aesthetics and humanized technology and also integrates the unique Shanghai-style culture in many details, allowing users to immerse themselves in an atmosphere full of art and technology to explore and experience the brand's history, culture, and technology. In the early design phase of the concept store, the concept of energy efficient



and environmental protection was proposed, by reducing carbon emissions and the energy consumption. The lighting system must meet the expectations and values of a high-tech brand, especially to the advancement of smart control, which is very demanding. It was not only required to control lighting fixtures individually but also needing the lighting control to be integrated into the building management control platform, offering a holistic smart user experience of a complete intelligent building.

The illuminated space in terms of brightness level and the color temperature need to be matched with exhibits, which requires lighting can be regulated according to the incoming amount of sunlight for energy saving and to enhance the display and presentation of the exhibits through proper lighting environment. For example, in the café, it is to ensure visitors' demand on comfort at the greatest extent while providing considerable energy efficiency and cost savings."

The Innovation Points

DALI PRO 2 IoT controller is the world's first DALI2-certified lighting system controller integrated with an IoT gateway and an open application programming interface (API). The DALI PRO 2 IoT controller supports DALI-2 data devices based on the global standard of DALI specifications. It collects and exchange data from lighting

nodes to the IoT platform via open API, laying the foundation of creating digital twins for smart buildings.

It is a future-proof and upgradable system with robust hardware design and powered by Linux OS.

The graphical user-friendly interface software provides a fast, intuitive, and efficient new commissioning experience, offering comprehensive and flexible options for lighting control strategies and settings – Group control, scene control, Mobile APP control, Occupancy control, Daylight harvesting, Time scheduling, sequencing, human-centric lighting, TW and RGB(W) dimming and color changing, etc.

The built-in gateway offers cutting-edge internet services, such as firmware updates, remote access and auto-test & reporting for emergency lights.

It supports bi-directional communication with KNX systems, e.g. Lighting control and status feedback, enabling seamless integration of the lighting system to the BMS building automation control systems.

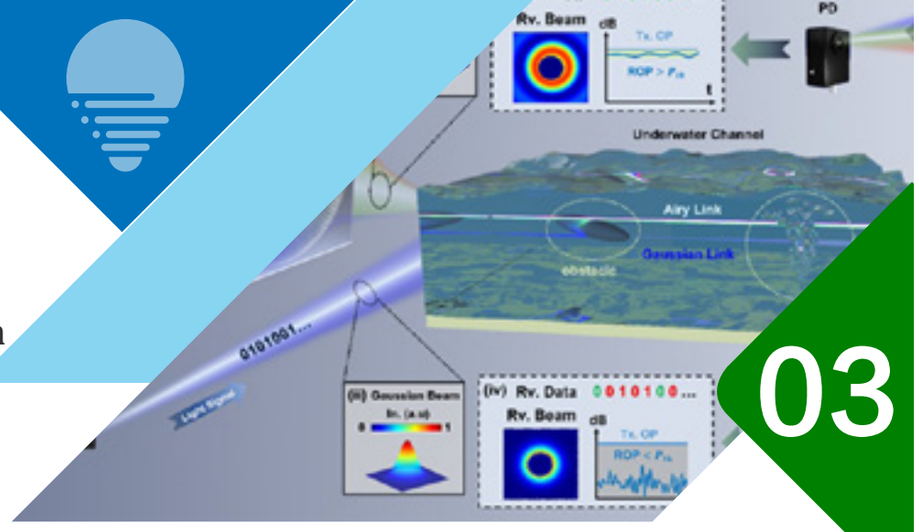
Possible Economic and Social Benefits

DALI PRO 2 IoT lighting system offers comprehensive control strategies, by applying a combination of one or more control strategies flexibly, the lighting can be easily adapted to the actual project requirements, creating the best lighting environment for multiple spaces at various time spans, while saving significant amount of energy and costs.

Data collected from lighting nodes allows the lighting system to create visualized user interface for a clear visibility of the light status and energy consumption in the project at anytime and anywhere. It helps for optimization of the system continuously, improving energy efficiency, maximizing space utilization, and reducing the carbon consumption. At the same time, it allows efficient overviewing of the system for predictive maintenance and to reduce operational costs.

With remote access enabled, engineers can optimize or adjust the system configuration of the project without the need to travel to the site, saving time and money.

The open API enables the lighting system to be integrated into large-scale IoT application platforms in a quick and fast way, empowering interconnected systems being one complete intelligent platform especially for commercial building scale applications – e.g. office buildings, industrial and warehouse, and transportation hubs. This brings users a holistic and total smart experience.



Visible Light Communication (LiFi)

03

High-speed GaN-based Semiconductor Lasers

Fudan University (Chao Shen, Nan Chi)

Brief Introduction

In view of the future explosive growth of wireless communication transmission capacity and the significant demand for high-speed access, to solve the electromagnetic spectrum crisis and to lay the foundation for the transformation of next-generation wireless communication technology, it is necessary to expand new types of spectrum carrier resources, carry out the research on 6G ultra-high-speed visible light transmission, and explore new theories and device breakthroughs. As the current visible light communication mainly focuses on the research of direct modulation and direct detection systems, the communication system is facing a series of "neck" problems such as limited bandwidth, strong modulation nonlinearity, low reception sensitivity, etc. Exploring the new high-capacity visible light communication system based on nitride and designing high-speed light source devices with high modulation bandwidth will be expected to Fundamentally improve the sensitivity and transmission rate of visible light communication system and realize 100G or even T-bit scale ultra-high-speed visible light transmission.

GaN-based light sources, due to the unique underwater light transmission characteristics of the blue light band, can be used for underwater communication and seamlessly integrated with the space wireless communication system to realize a unified communication network across water and air environments. To date, visible light communication systems based on miniature GaN light-emitting diodes (LEDs) have achieved a record data rate of 7.91 Gbps. However, the rapid demand for high data rates has increased demand for visible light communication systems. The bandwidth of light-emitting diodes (LEDs) always limits the data rate of visible light communication systems based on LEDs because the carrier lifetime of LEDs is in the order of nanoseconds. In contrast to light-emitting diodes, the modulation response of laser diodes is controlled by photon lifetime, which is in the order of picoseconds. Therefore, lasers have higher modulation bandwidth and are more suitable for high-speed visible light communication. In addition, the lasers have better collimation and monochromaticity, which contribute to

Figure 1. Microscope of the fabricated laser diode

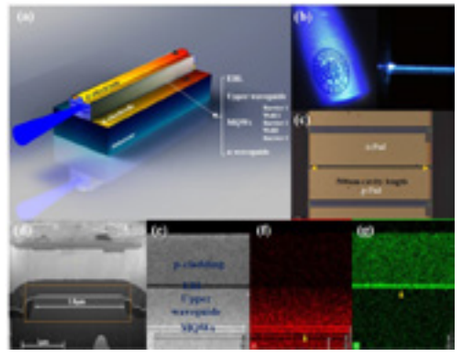


Figure 2. Macroscopic and microscopic structures of laser (a) 3D-illustration of the fabricated laser. The annotation on the right shows the epitaxial layer structure of the active region from top to bottom. (b) Far-field emission pattern of laser. (c) Optical microscopy image of fabricated laser. The n-and p-electrodes are marked in the picture. (d) Scanning electron microscope (SEM) image of cross-sectional view. The ridge waveguide width is ~1.8 μm. (e) STEM image of the active region. From top to bottom are the p-cladding layer, electron-blocking layer (EBL), upper waveguide, and MQWs. (f) Indium mapping of the active region. The two high-brightness lines (marked with yellow triangles) are quantum wells separated by a quantum barrier. (g) Aluminum mapping of active region. The line with high brightness (marked with yellow triangles) is the EBL (electron blocking layer).

longer transmission distances in visible light communication systems.

The applicant designed and prepared a high-speed blue laser diode on a c-plane GaN substrate. The laser achieves 450 nm single longitudinal mode high-speed blue light output by active region design and size minimization. The device also has a low threshold current of 31 mA and a slope efficiency of 1.02 W/ A. The device is characterized by a high efficiency of 1.02 W/ A and a low threshold current of 31 mA. Frequency response tests show that the intrinsic bandwidth of the laser is as high as 5.9 GHz, the highest record achieved by c-plane GaN-based lasers worldwide. A high-speed visible light communication system was built based on this laser, and high-speed data transmission of up to 20.06 Gbps was realized by using the bit and power-loaded discrete multi-tone (DMT) modulation technique. The BER in the test was 0.003, satisfying the forward error correction standard. The applicant's invented mini-GaN laser significantly improves the data transmission rate in the blue light band, paving the way for energy-efficient visible light communication systems and integrated photonics in the visible region.

The Innovation Points

High-speed GaN blue lasers are key devices in visible light communications. Shuji Nakamura first invented GaN-based blue-violet lasers in 1996. With the development of gallium nitride (GaN) growth technology and the increase in p-doping level, GaN-based lasers have proven suitable for applications such as optical storage, biomedical therapeutics, and high-brightness illumination. However, the design and preparation of high-speed lasers for visible-light communications have not been thoroughly investigated. The modulation bandwidth of lasers in the visible band is much lower than that of InP- and GaAs-based near-infrared lasers. Recent research results show that the modulation bandwidth of c-plane GaN lasers is still limited to 3 GHz, which cannot meet the

rapidly growing demand for communication data rates. From the energy consumption point of view, low slope efficiency and high threshold current density are also problems that need to be solved. Although lasers grown on semipolar GaN substrates have modulation bandwidths in excess of 5 GHz, issues such as high substrate cost and immature material growth processes remain. Therefore, it is crucial to design and fabricate high-speed GaN-based blue lasers on c-plane substrates.

The applicant has developed a dynamic response model based on GaN-based quantum well lasers and deeply analyzed the effect of the active region design on the modulation response bandwidth. In this design, a multilayer quantum well/quantum barrier structure is used, and the active region is size-minimized, which can effectively optimize the frequency response characteristics of the device by increasing the differential gain and threshold current. Modeling and simulation of the structure yielded a -3dB modulation bandwidth of up to 6G. Subsequent experimental verification based on the simulation results shows that the prepared GaN quantum well laser has a low threshold current of 31 mA, a high slope efficiency of 1.02 W/A, good collimation, and monochromaticity. In the frequency response test, the laser has a -3dB response bandwidth of up to 5.9 GHz, which, to our knowledge, is the highest record that a c-plane GaN-based blue laser can achieve. A high-speed visible light communication system was built based on this laser. High-speed data transmission of up to 20.06 Gbps was realized by using bit- and power-loaded discrete multi-tone (DMT) modulation techniques. The constellation diagrams obtained from the test were clearly outlined, and some of the symbols sent and received exhibited a high degree of overlap. The BER in the test was 0.003, satisfying the forward error correction standard.

The laser can address many critical issues in visible light communications, including:

Transmission rate enhancement:

High modulation bandwidth blue lasers can support higher data transmission rates, a significant pain point in developing current VLC technology. Compared with traditional LED light sources, lasers provide higher modulation speeds, which can significantly improve data transmission efficiency and communication rates to meet the demand for high-speed data transmission.

Energy consumption optimization:

Low-power blue lasers help reduce the system's overall energy consumption. This is especially important for communication systems that require long periods of continuous operation, extending the battery life of the equipment, reducing energy consumption, and improving the system's sustainability.

Signal Quality Improvement:

Blue lasers have a high signal-to-noise ratio (SNR) due to their high coherence and directionality, improving communication systems' signal quality and reliability. This is critical to overcome ambient light interference and improve communication stability.

Expanded coverage:

Blue light has a shorter wavelength and can achieve a smaller spot size than red or infrared light, which is conducive to achieving higher spatial resolution, thus providing better communication coverage and performance over a certain distance. This is important for application scenarios such as high-density cell deployment and indoor positioning.

Integration and miniaturization:

The laser's small size makes integrating into various electronic devices, including smartphones, tablets, and smart home devices, more accessible. Integrating the blue laser can simplify the system architecture and enable visible light photonic integration.

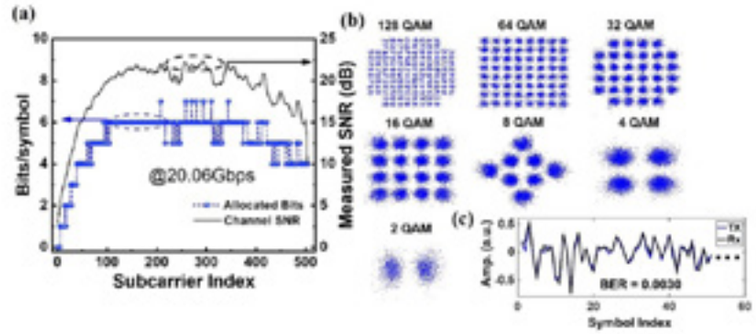


Figure 3. Experimental results of VLC system using fabricated mini-LD. (a) Bit-power loading scheme of each subcarrier according to measured channel SNR. The effective carrier number is 504. (b) The received constellation diagrams of the system, including 128 QAM, 64 QAM, 32 QAM, 16 QAM, 8 QAM, 4 QAM, and 2 QAM. (c) A partial T/R symbol of the mini-LD-based VLC data links. The tested BER is 0.0030.

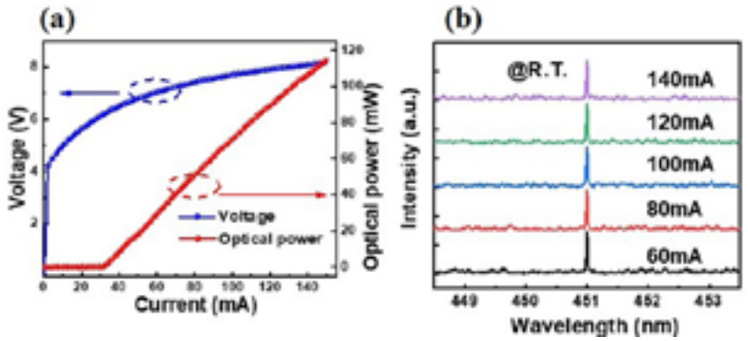


Figure 4. (a) Light–current–voltage (L–I–V) characteristic of the laser under the condition of continuous wave (CW) injection. (b) Spectra of the mini-LD for injection currents ranging from 60 mA to 140 mA at room temperature.

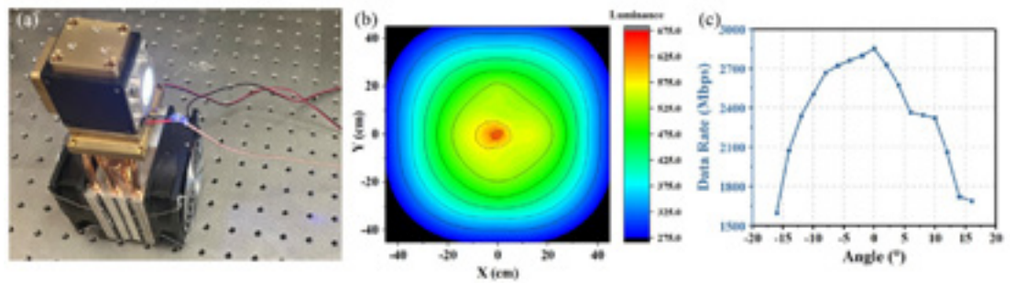


Figure 5. (a) A high-power laser-based white light emitter; (b) the luminance distribution of the laser-based white light emitter at 1 m; (c) measured data transmission rate vs. tilting angle at a transmission distance of 2 m.

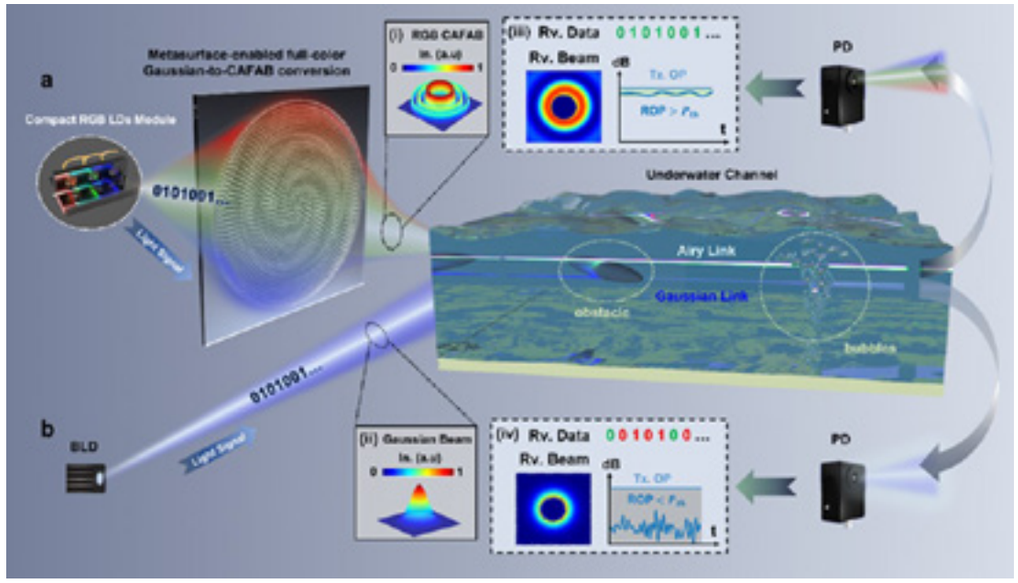
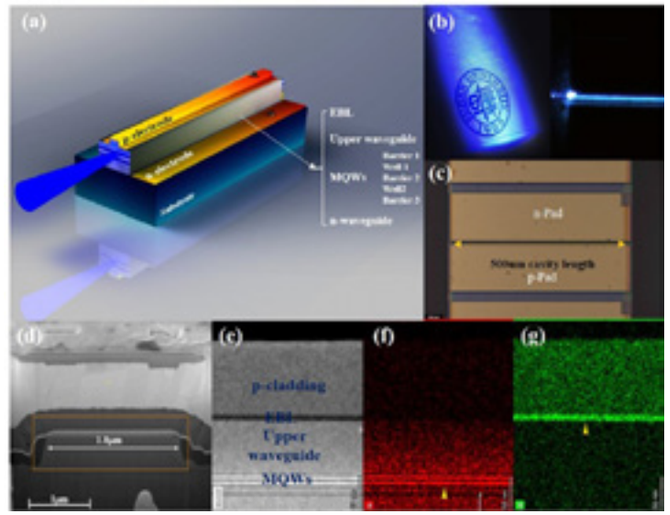


Figure 6. Schematics of conventional Gaussian beam based UWOC system and our adaptive link with multi-wavelength Airy sources transformed by an ultra-broadband metasurface platform. a Tri-color Gaussian beams are generated by a compact 6×4.4×3 cm3 LDs module. The conversion of Gaussian to circular Airy light is accomplished by a high-efficient metasurface covering the visible band. And multiple wavelengths are used to achieve WDM scheme. Inset (i), (ii) represent the intensity profile of CAFAB and Gaussian beam, respectively. Insert (iii), (iv) represent received information of link a and link b, respectively. Rv. stands for received. b traditional UWOC links usually use blue Gaussian beam as the emission light source. Complex underwater environment limits the receiving performance of the system, including beam quality and bit error rate (BER).

Possible Economic and Social Benefits

The application of high-speed visible light communication light source devices will bring considerable benefits to economic development. Firstly, the widespread adoption of new technologies will promote the upgrading and development of the communication industry, giving rise to new industry chains and value chains, including chip manufacturing, equipment production, and communication operations. Secondly, the innovation in communication technology will create numerous job opportunities, fostering sustained economic growth and stable employment. Additionally, the widespread adoption of new technologies will stimulate the replacement of various communication devices and terminal products, stimulating consumer demand and driving market demand, thereby boosting the overall development and expansion of the entire industry chain. This will create significant market opportunities and development space for related industries, promoting structural adjustments and upgrades in the economy.

In terms of social benefits, high-speed blue light laser diodes can meet the urgent demand for high-speed data transmission, greatly improving people's communication experience and quality of life. Furthermore, the innovation in laser chip technology will propel the application of visible light communication technology,



contributing to the modernization of smart city construction and management. Visible light communication can enhance urban operational efficiency and service levels, creating a more comfortable and convenient urban living environment for residents. Moreover, the application of visible light communication will promote the digital transformation and intelligent development of society, accelerating the digitization process across various industries and enhancing productivity and service efficiency. This will not only help businesses enhance their competitiveness but also provide consumers with more diverse and personalized service experiences, driving economic and social development towards a more intelligent and convenient direction.

In. Licht ultra Spectrum/WELL Meter

Lighting Recipe Studio Limited

Brief Introduction

Health lighting (or Human-centric lighting, non-visual lighting) has opened a new chapter in the study of non-visual effects of light in recent years due to the discovery of IpRGCs. Following the 2017 Nobel Prize in Physiology and Medicine awarded to three scientists, Michael Rosbash, Jeffrey Hall and Michael Young, who discovered circadian rhythm, relevant research has sprung up. In addition, due to the rapid development of solid-state lighting technology in the past 20 years, the technology of sun-like spectroscopy, mixed spectrum and dimming color has become more and more mature, and intelligent lighting technology has further promoted the rapid development of human-centric lighting applications.

However, due to the relative lag of relevant regulations and technical definitions, because the development of new technologies has also given rise to new topics for various applicable light environment scenarios, such as circadian rhythm stimulation threshold confirmation, spatial strobe caused by dynamic dimming and color adjustment, and the guarantee of the consistency of white light with the black body curve in the process of dimming and color adjustment... For all kinds of groups under demand for lighted environments have become an urgent need to provide convenient and appropriate tools for detection, evaluation and even monitoring.

Based on these needs, In. Licht series lighted environment detection and monitoring equipment/system can solve these increasingly rising problems for the lighting industry.

In.Licht ultra is not only a powerful spectrum, strobe and illuminance measurement equipment, but also has been combined with intelligent building systems such as Delos Welltek OS. In addition to providing real-time lighted environment data and comparison of light quality and light health-related standards (such as WELL Standards) can be interacted with the connected lighting system (such as InSona) to ensure that the adaptive lighting data

meets the relevant standards. In.Licht ultra can be said to provide a perfect data channel for sensor-driven intelligent lighting systems, making the application of "intelligence + health" from dream to reality.

The Innovation Points

Modern people spend 87% of their lives in indoor space. Indoor space is highly dependent on artificial lighting, so the indoor lighted environment is the cornerstone of health that cannot be ignored. However, because the existing indoor lighted environment and relevant regulations and equipment only focus on visual safety, visual comfort and energy-saving requirements, it ignores physiological rhythm and emotional and psychological needs. Fortunately, with the progress of life science and the advancement of solid-stats lighting technology, it is possible for all to use light in a timely and appropriate manner. Looking forward to the future, using intelligent means to achieve healthy light, in addition to realizing the diversified value of light and improving human physical and mental health, it will also open a new track for the global lighting industry and improve output value and value. Due to the interaction between artificial lighting, especially light and health, how to strive to use light-based science to create a better light environment for human beings, and the advanced life science research on light, emotion and brain cognition can promote outstanding results. Based on the WELL standards of the International WELL Building Institute (IWBI), In. Licht Ultra and In. Licht pro, respectively, won the world's first two lighted environment meters approved by IWBI's Works with WELL program. We continue to work with IWBI and more partners to create a life-friendly light environment for the people, and start a new path to intelligent and healthy lighting for the lighting industry.

Use In. Licht Ultra is evaluated according to WELL standards.

In. Licht Ultra is the world's first professional photometer approved by the Works with WELL program, which can provide professional monitoring management for the 9 important terms of the WELL v2 optical concept. In fact, In. Licht Ultra can be directly used for testing under the following terms:

- L01 Light exposure
- L02 visual lighting design,
- L03 Circadian Lighting Design,

- L04 Electric light glare control,
- L05 daylight design strategy,
- L06 daylight simulation,
- L07 Visual balance,
- L08 Electrical Lighting Quality

In addition, by embedding the "welltek OS" ecosystem, it provides the service of L09 users to control the lighting environment to help you easily achieve all-round pre-detection and scoring of the light concept of the WELL project.

The concept of Light under WELL v2 is different from other building detection, paying attention to the influence of users in the light environment, so the detection method (such as detection location, technology) is also quite different from general light environment detection. Therefore, In. Licht Ultra is specially designed for these unique measurement techniques, measurement plane and detection height. For example, we separate the luminous screen from the detection equipment to avoid the accuracy of low-light interference to meet the measurement requirements of WELL's bright and dark areas; it can be placed on a plane without hand-held to avoid shadow interference of the inspectors; the detection of EML must be on a vertical plane 45 cm above the height of the human eye (or the working platform) Measurement, with the company's exclusive ultra-light WELL detection adapted to the panoramic gimbal aluminum alloy tripod, there is no need for additional adjustment and setting, ready-to-install and test, which will effectively save you the hassle of testing work.

Regarding the information of using this product for optical performance verification, the following key information is aligned from THE WELL PERFORMANCE RATING GUIDEBOOK, and the conditions apply to WELL v1, WELL V2 pilot, WELL v2 and WELL performance rating, the latest testing regulations, please refer to the information released by the IWBI official WELL Performance Verification Guide Manual.

Possible Economic and Social Benefits

In. Licht Ultra is an all-round portable handheld spectrometer specially designed for lighting equipment manufacturers, lighting designers, professional inspectors and photo-biological research and application industries. It can be hand-held, placed on a flat or matched with a panoramic tripod for fixed-point detection, allowing you to free your hands and unlock other handheld spectrometers. The detection of the dead angle; the detection value beyond the visible ultra-wide spectrum, whether it is visible light or invisible photo-biological effects, can be captured sharply. With a single device in hand, it can be done in one go, just like a personalized mobile professional optical laboratory loaded in your pocket. The light feel in the palm of only 59g allows you to freely master the perception ability of full true spectrum. It is the world's lightest professional spectral measurement equipment. And it is the world's first human health light detector that meets the IWBI Works with WELL certification.

- Provide 23 more accurate measurement parameters (EML, m-EDI, CCT, LUX, CRI, Flicker index, CIE (1976/1931), CQS, Duv, λP, S/P ratio..., etc.), and can be continuously provided through App updates. Upgrade service
- Professional detection items for human-centric lighting and healthy lighted environment: circadian rhythm parameters, flickering risk, spectral detection, etc.
- With spectrum + illuminance + flickering + outstanding human-centric lighting algorithm, the core biological lighting impact indexes of light can be viewed in an all-round way.
- Bluetooth transmission spectrometer, separate detection, to meet the flexibility and accuracy of multiple test scenarios
- Accurately measure various hybrid artificial light sources and natural light sources

The scope of industrial application and convenience of use have been greatly improved, which can meet the needs of professional fields of human health lighting, plant cultivation, biochemical research and special light source design, and continue to provide upgrade services.

05

Intelligent Bionic LED Mosquito Light Trap

Ningbo Dayang Technology Co., Ltd.

Brief Introduction

Mosquito-borne infectious diseases pose one of the severe challenges confronting humanity. Amidst global climate warming and accelerated urbanization, not only have the scope, frequency, and intensity of existing mosquito-borne diseases expanded and intensified, but new infectious diseases have also emerged continuously. Statistics indicate that over 40 types of newly emerged or re-emerged infectious diseases have been recorded, accounting for more than two-thirds of all newly emerged infectious diseases, with incidence rates on the rise. For instance, the incidence of dengue fever alone has surged 30-fold in the past 50 years. Furthermore, mosquito-borne infectious diseases are characterized by rapid transmission and ease of epidemic outbreaks, posing a grave threat to public health. According to the World Health Organization's (WHO) "Global Vector Control Response 2017-2030," 80% of the world's population is at risk of one or more mosquito-borne diseases. In recent years, outbreaks of vector-borne diseases have threatened China, necessitating research into mosquito biology, enhanced sustainable and precise vector control measures, and the development of novel technologies and products as crucial steps towards safeguarding public health and achieving the objectives outlined in the "Healthy China 2030" plan, including effectively controlling major health risks and eliminating the hazards of a range of major diseases.

Vector control is a vital aspect of public health. Mosquito control involves inhibiting mosquito breeding and activity, shortening their lifespan, limiting their contact with pathogens, suppressing or reducing their efficiency in acquiring and transmitting pathogens, and minimizing human-mosquito interactions, thereby eliminating or mitigating the risk of mosquito-borne diseases. For a long time, chemical control has been the primary means of vector control. However, extensive and improper use of chemical insecticides has led to issues such as increased

mosquito resistance, environmental pollution, and loss of mosquito diversity. According to WHO, at least 57 countries or regions have reported insecticide resistance or suspected resistance issues, with approximately 3 million pesticide poisoning incidents occurring annually, resulting in over 250,000 deaths. Consequently, there is a growing interest in exploring novel, green, and environmentally friendly non-chemical control technologies to address pest problems. Among these, intelligent bionic LED mosquito control products represent a significant advancement, leveraging mosquitoes' behavioral tendencies towards light sources, pheromones, carbon dioxide, and other stimuli for mosquito control. These products are increasingly being applied in mosquito monitoring and control.

The Innovation Points

The innovative smart bionic LED mosquito control product stands out with the following key advancements:

1. Proprietary LED Encapsulation Technology for Mosquito-Attracting Lamp Beads:

Based on the patented invention (Patent No. 201711342996.4 for a processing method and dispensing device for surface-mount light-emitting diodes), our LED encapsulation technology fine-tunes the silicone content and adjusts parameters across processes like die-bonding, wire-bonding, encapsulation, binning, and taping. This results in:

(1) A more rational 35x28 aspect ratio, closely resembling a circle, optimizing refractivity and enhancing test results.

(2) A convex lens design, differing from traditional flat-surfaced beads, which narrows the transmission angle, boosting refractivity and transmittance.

(3) The use of custom-imported wavelength chips and 99.99% pure gold, typically found in high-end CPUs and memory sticks, enhancing durability and tolerance.

2. CO_2 Biomimetic Trapping Module:

Leveraging electrolysis to generate CO2, grounded in the patented invention (Patent No. 201710214571.9 for a graphite electrode, its preparation method, and a CO2 generator), this module allows for precise CO2 output regulation by controlling the electrolysis current between the pressed positive plate and stainless steel negative plate. This technology addresses the uncontrollability and high risk associated with conventional CO2 production methods, fostering strategic collaborations with multiple companies.

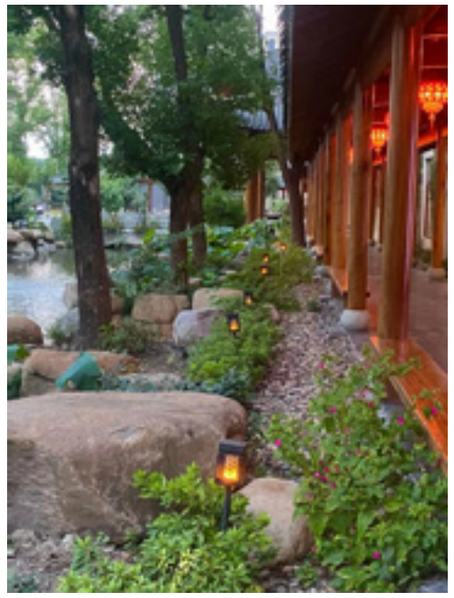
3. Pheromone Biomimetic Trapping:

Mimicking human skin odors, this module employs high-molecular-weight sustained-release technology and nanoemulsion preparation techniques. The sustained-release technology, underpinned by patents (No. 201610128201.9 and 201210086452.7), selects low-density hydrophobic polymers as carriers, utilizing supercritical rapid expansion of solution (RESS) or capillary adsorption to create nano-capsules embedded within the polymer matrix. The nanoemulsion technology enhances the solubility and bioavailability of bioactive components, facilitating high drug loading.

To safeguard our intellectual property, we have secured patents for this product, which has garnered exceptional market feedback both domestically and internationally. We prioritize product quality, evidenced by compliance with international standards such as CQC, FCC, SAA, EMC, UL, and TUV. As a result, we have forged key partnerships with industry leaders like Philips, Honeywell, WOODSTREAM, SC Johnson, and Rentokil Initial. Furthermore, our product's effectiveness has garnered widespread recognition on renowned e-commerce platforms like JD.com, Amazon, Xiaomi, and Taobao.

Possible Economic and Social Benefits

Social Benefits



The economic advancement of China is intricately intertwined with globalization, and the establishment of the Asian Infrastructure Investment Bank (AIIB) and the proposal of the Belt and Road Initiative (BRI) have ushered in a new era of globalization. Concurrently, the transmission of vector-borne diseases such as dengue fever, malaria, and Japanese encephalitis has also exhibited a globalizing trend. Regions along China's BRI routes, including Southeast Asia, South Asia, the Middle East, and Africa, are hotspots for these vector-borne diseases. While malaria has been largely eradicated in China, it still claims hundreds of thousands of lives annually in Africa. Therefore, conducting research on mosquito ecological behaviors and strengthening sustainable and precise control measures for vector mosquitoes are crucial to safeguarding the health of the Chinese people and achieving the objectives set forth in "Healthy China 2030," particularly the effective control of major health risks and the elimination of a number of major disease hazards. The intelligent bionic LED mosquito control product, as an environmentally friendly, healthy, and green sub-segment of vector-borne disease prevention and control, lays a solid foundation for implementing China's BRI policy and "Healthy China 2030" strategy.

Economic Benefits

With the ban on highly toxic insecticides and the increasing frequency of international travel and trade, vector-borne diseases are experiencing resurgence worldwide. China is likely to become one of the countries more severely affected by vector-borne organisms in the near future. The implementation of this project holds significant practical importance in promoting the development of environmentally friendly, efficient, and intensive green control technologies, ensuring personal safety, and enhancing the quality of life for the general public. This product, which precisely addresses the need for sustainable mosquito control and improved quality of life, is projected to generate a production value of 45 million yuan and sales revenue of 40 million yuan, indicating vast market potential and economic benefits.

Ecological Benefits

As living standards rise, so does the public's concern over pesticide residues in the environment. Consequently, the sole reliance on insecticides for mosquito control is no longer the preferred choice among residents, and more households are opting for integrated pest management (IPM) or non-chemical control methods. This product, employing attraction and scent-based mosquito trapping technology, avoids the problematic "3R" issues (resistance, resurgence, and residue) associated with chemical pesticides. Furthermore, it mitigates the environmental pollution and health risks posed by difficult-to-degrade insecticides. By achieving timely monitoring and effective elimination of vector-borne diseases, this product exhibits remarkable ecological benefits.

06

Ultra-high Power Density TFV LED Chip with Circular Emission Area

LatticePower Corporation Limited

Brief Introduction

Ultra-high power thin film LED chip with circular emission area is developed using Latticepower's GaN on Silicon technology. Comparing with the sapphire chip, the circular light-emitting chip possess the advantages of more uniform circular beam, high brightness, good heat dissipation, good reliability, strong directionality, uniform color over angle, ultra-large current operation etc; It is especially suitable for mobile lighting such as flashlight, headlamp, miner's lamp, mobile phone flashlight, automobile lighting, spot lighting and other applications with high brightness and color quality requirement.

Figure 1:
Ultra-high power density TFV LED chip with circular emission area

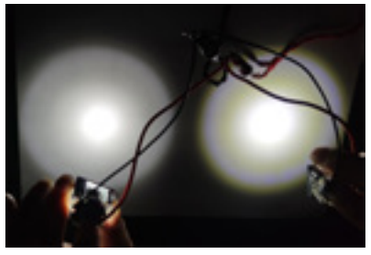


Figure 2:
Left: LP' s TFV chip (no yellow circle)
Right: Normal competitor chip (have yellow circle)

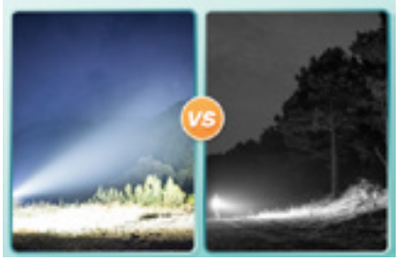


Figure 3:
Left: Flashlight Effect of the LatticePower Light Source
Right: Flashlight Effect of ordinary Light Source

The Innovation Points

In addition to the advantages of traditional Thin-Film LED, such as good heat dissipation, high current density, and no yellow circle in the light spot, High energy density chip with circular emission area made from LP's GaN-on-Silicon technology have the following innovation:

1. Circular luminous surface. The light-emitting area is designed to be circular and thin film, no side light, so that the light presents a perfect symmetrical circle. The industry-leading circular light emitting surface design breaks the design tradition of square or rectangular chips, greatly improves the lighting effect for some special directional lighting applications.

2. Metal-Insulator-Metal (M-I-M) stacking technology. The p-side metal and the n-side metal are placed at the bottom of the GaN, the p-side metal and the n-side metal are separated by an insulating layer, and the n-side electrodes are uniformly distributed in the light-emitting area, thereby replacing the conventional n-side electrode lines on the surface of the LED. The advantages of this design are: 1) The current distribution inside the chip is more uniform, and even if the diameter of the light-emitting area of the circular chip reaches 120 mil or more. 2) the light-emitting and the reflection area inside the chip are maximized to achieve highest reflectivity for maximum optical extraction efficiency. In practical application, taking the 80 mil diameter chip as an example, The operation current can be as high as 8A without optical saturation behavior.

The ultra-high power density TFV LED with circular emission area chip overcomes a plurality of process technology difficulties:

1. Groove optimization： Optimize the cutting process to ensure the high chip reliability and reduce the risk of leakage. Further reduce the cost and improve the production efficiency, while optimizing the epitaxial process (luminous efficiency and wavelength, etc.).

2. Source tracing optimization: The wavelength uniformity of large-size silicon substrate LED epitaxial wafer is one of the keys to determine its production yield, and the wavelength uniformity mainly depends on the uniformity of the temperature field in the wafer. By adjusting and controlling the stress release layer, the epitaxial wafer bowing is reduced while ensuring no cracks, the compressive stress on the InGaN multi-quantum well is also relieved. The improved wafer bowing significantly improved wafer level wavelength uniformity, IQE uniformity and thickness uniformity.

3. Electrode surface optimization: The ultra-high power density TFV LED with circular emission area is mainly used for high-end mobile lighting, mobile phone flashlight, automotive lighting and other applications. This wire bond quality is the key to achieve good reliability. The roughened surface N electrode can hide contamination due to its rough surface, and will reduce the contact area of the solder ball. In order to ensure the quality of the wire bonding, the electrode design is optimized to reduce surface metal roughness.

Possible Economic and Social Benefits

Compared with the traditional sapphire substrate, The ultra-high power density TFV LED with circular emission area not only has a substrate cost far lower than that of the sapphire material, but also can be removed by chemical etching, so the reliability and yield are higher than laser liftoff process using a sapphire substrate wafer. The single-sided light emitting vertical chip is combined with a die level phosphor process in which the phosphor area exactly matched the chip emission area to ensure highest optical density and brightness. The process also achieves higher performance, including the improvement of luminous flux, the improvement of Color over Surface and the increase of axial light ratio, which provides unlimited possibilities for high-quality lighting. The use of silicon-based LED enables better lighting quality, lower system cost, more flexible design, and more innovative LED lighting solutions.

Global SSL Award of Innovations Top 100

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