LED professional Review

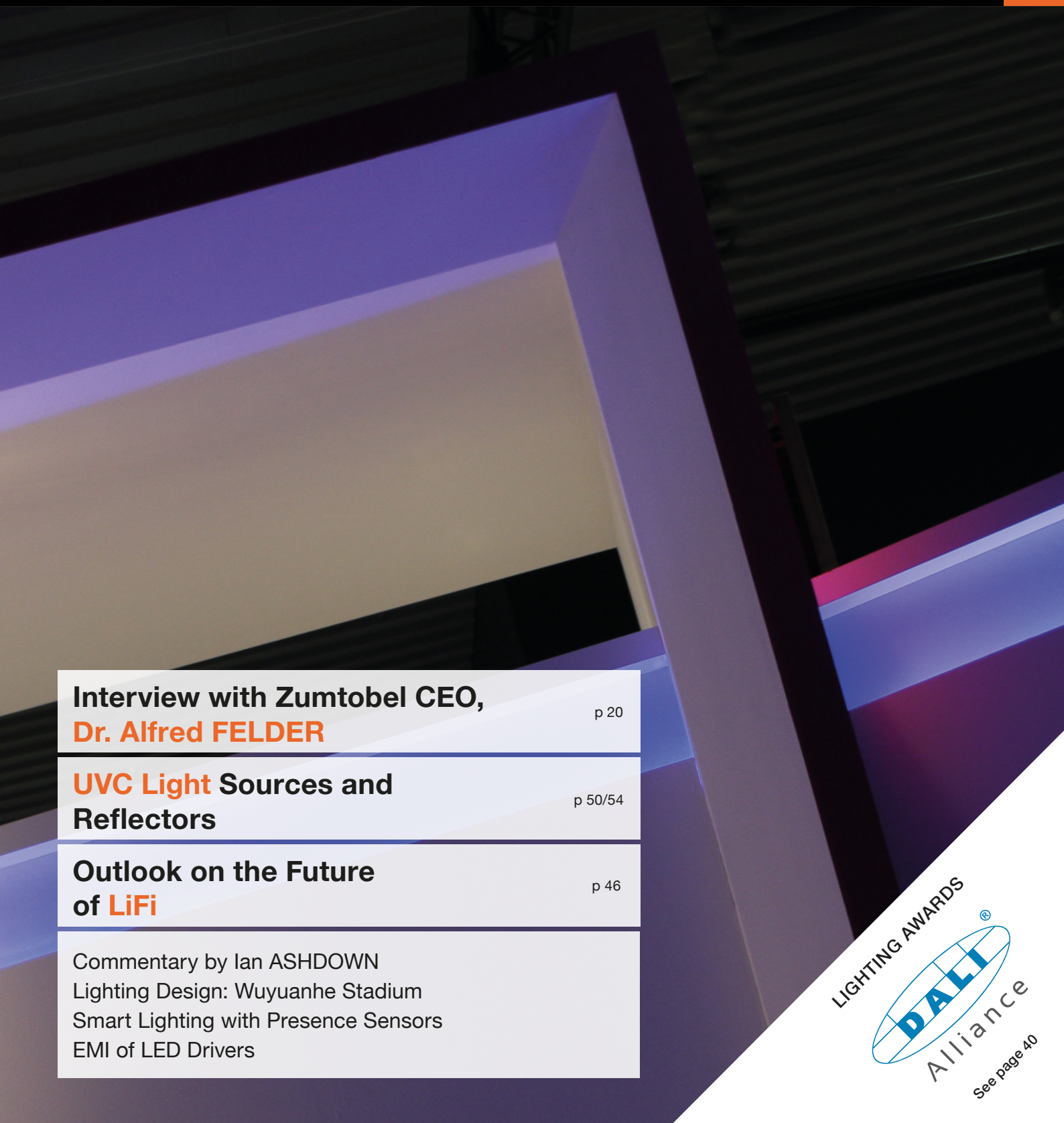
www.led-professional.com

ISSN 1993-890X

LpR

The Global Information Hub for Lighting Technologies and Design

March/April 2022 | Issue 90



See page 40

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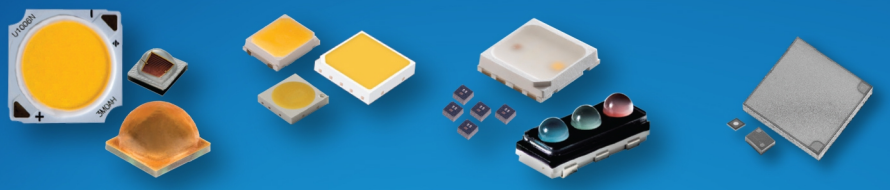

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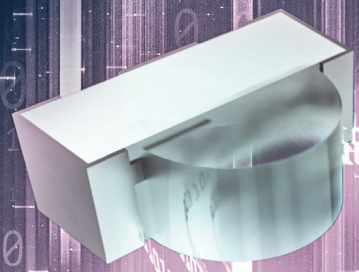
WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

INFRARED DREAM TEAM



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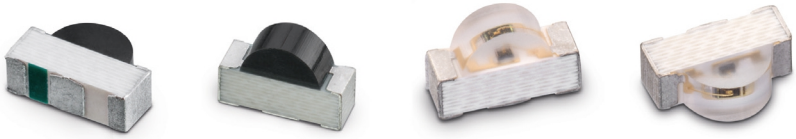


Retrospect and Outlook

This issue of the LED professional Review, LpR90, is dedicated to some lighting topics that we review in retrospect as well as some topics relevant for the future.

In this context, it is fascinating to look at the winning projects of the DALI Lighting Awards. The smart lighting solutions are awarded in eight different application areas.

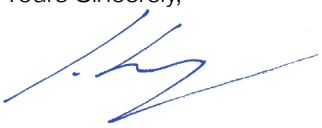
We present a unique lighting solution with the Wuyuanhe Stadium, where an outstanding combination of lighting design and architecture has been achieved. The presentation of lighting projects should inspire us to understand lighting solutions better and gather ideas from the component up to the realized project.

We were also particularly pleased to interview Zumtobel Group CEO Dr. Alfred Felder for this issue. His retrospective and, above all, his strategic considerations for the future of lighting are inspiring and show us the paths of the lighting world of the coming years.

The future topics of communication such as LiFi, Smart Lighting and the current UVC topic for disinfection with light are covered very comprehensively in this issue. Of course, as always, we are also providing the latest lighting news.

I hope you enjoy reading this issue.

Yours Sincerely,



Siegfried Luger

Luger Research e.U., Founder & CEO
LED professional, Trends in Lighting, LpS Digital & Global Lighting Directory
International Solid-State Lighting Alliance (ISA), Member of the Board of Advisors
Member of the Good Light Group and the European Photonics Industry Consortium

For PLEXIGLAS®, reincarnation is old hat. We call it “recycling.”

We believe in reincarnation. The reincarnation of PLEXIGLAS®, at least. Because PLEXIGLAS® is so pure that it can be broken down into its basic components again to be reborn as new PLEXIGLAS®. Few plastics can achieve a rebirth of this kind – this is not downcycling, but true recycling in the interests of a circular economy! Make the most of the versatility of PLEXIGLAS® for long-lasting and more sustainable products. For inspiration, go to **www.plexiglas-polymers.com.**

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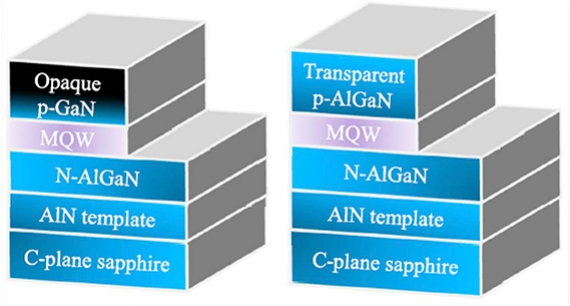
THE ORIGINAL BY RÖHM

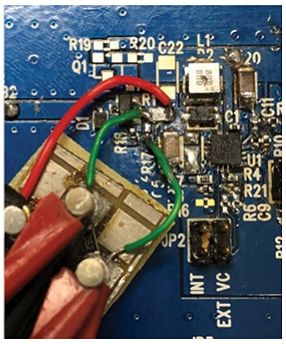
UVC



UV REFLECTORS

PRESENCE SENSORS

LED DRIVERS



ADVERTISING INDEX

Ian ASHDOWN

Ian Ashdown is cofounder of the All Things Lighting Association (ATLA), a non-profit organization whose purpose is to advance, support, promote and contribute to innovation, science, and engineering in lighting, including lighting for health, horticulture, architecture and entertainment.

He is also President and Senior Scientist for SunTracker Technologies Ltd., where he develops lighting design and analysis software for horiculture, architecture, entertainment, and ultraviolet germicidal disinfection. He has been doing lighting research for thirty years, and currently holds 75 patents in many fields of lighting science and technology.

Lighting Design as a Cross-Disciplinary Science

What does the *metaverse*, the promised "next chapter for the Internet" (Mark Zuckerberg, 2021), have to do with architectural lighting? It will be after all an immersive virtual world where people will gather to socialize, play, and work.

The first and obvious answer is that the metaverse will be a reflection of our physical world, where companies will want their virtual storefronts and gathering spaces to be as engaging as their physical counterparts. This will give professional lighting designers the opportunity to design lighting for virtual spaces in much the same manner as we do now with lighting design software for physical spaces.

We can do better, however. The second and more subtle answer lies in what we already know about the psychophysics of spatial and temporal human vision. There is a much richer and more rewarding set of opportunities and challenges for start-up companies that may come from applying this knowledge.

Think about it: the metaverse will be nothing more than the projection of images onto the viewer's retinae. With eye tracking technology, we will know the viewer's gaze direction and hence the spatial distribution of cones, rods, and ipRGCs onto which the images are being projected. From vision and color science, we already know that our perception of reality can be influenced by what our retinae see and how our visual cortex processes the flow of information – we can manipulate this information frame-by-frame to our advantage.

The knowledge is there for all to see, published in peer-reviewed academic journals. What is often not there, however, is an understanding of how it can be applied to lighting design, or more specifically to how we perceive our environment through optical radiation. To apply this knowledge, we need to thoroughly understand the topic from our perspective.

Speaking more generally, lighting design is inherently a cross-disciplinary science. Think, for example, of circadian-based lighting, light pollution, light-based communications, Internet of Things, ultraviolet germicidal disinfection, and horticultural lighting. We invariably ask, "How can I apply existing products and technologies to these market opportunities?" This is, however, precisely the wrong question. We should instead ask, "What is missing here?" To answer this question, we ourselves need to become experts in the specific field, whether it is circadian rhythms, light pollution, virology, or botany. We do not need to understand every detail, but we do need to understand how the field relates to optical radiation. Only then will we see the true opportunities and challenges related to lighting, even though they may not be evident to acknowledged experts in the field.

Take, for example, horticultural lighting and its relation to botany. Should you as a lighting entrepreneur care about the spectral and temporal responsivity of the photopigment phytochrome in relation to the end-of-day responses of plants, and in particular diurnal and circannual changes in atmospheric sky color? If you want to be on the cutting edge of lighting technology, the answer is unequivocal: yes.

Horticultural lighting is not about using blue InGaN and red AlInGaP LEDs to maximize photosynthesis; it is about manipulating the spectral and temporal properties of light sources to optimize the multidimensional aspects of plant growth and development. From the molecular underpinnings of plant photomorphology and (in this case) atmospheric physics, we need to look well beyond lighting science.

The same principle applies everywhere that lighting of any sort has an impact: the opportunities and challenges come from fully understanding the potential scope of the application. It is not about how we illuminate something, but how that something responds to and utilizes light. ■

I.A.

Light is “ON AIR” – with OT Wi.

For more versatility and endless customization – choose the brand new OT Wi LED driver portfolio.

With the launch of compact and linear wireless LED drivers, OSRAM is opening up unprecedented design freedom and usability for complex lighting systems. How do we achieve this? By being able to deliver our new driver portfolio with many of the desired communication protocols.

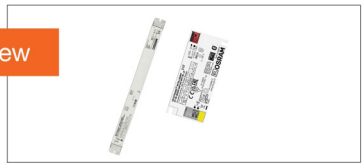
In their standard version, our compact and linear wireless LED drivers are equipped with Qualified Bluetooth Mesh (QBM) or Casambi. On request, other proprietary protocols such as Wirepas and upcoming standards like DALI+ and Matter can be provided.

The new QBM components work perfectly in the OSRAM HubSense ecosystem. This allows us to specify wireless lighting systems as an all-around package in line with customer requirements and to deliver each component in well-known OSRAM quality. HubSense enables wireless and decentralized lighting control via the open radio standard Qualified Bluetooth Mesh (QBM) and is thus the ideal basis for modern lighting management.

No matter which configuration you choose, OSRAM will always deliver exactly the light you need.

Small but powerful: our compact LED driver for wireless systems gives you all the flexibility you need.
With wattages of 15, 25 and 40 W, this product offers plenty of flexibility for your designs. The driver can easily control linear and area LED modules, as well as chip-on-board LEDs. This versatility is boosted by the compact size of only 22 mm.

New



Modernizing wireless light installations with a unique linear LED driver
In the area of linear luminaires, we now offer you the first non-isolated drivers that are compatible with the Casambi communication protocol. With wattages of 35, 75 und 100 W – and a communication range of up to 10 m – our components redefine contemporary lighting infrastructures.

We understand that every installation is different. Our customer support is here to help you design exactly the light you need.
Our experienced design team can provide you with expert and detailed advice on the new wireless LED drivers, as well as on the optimized use of your desired communication protocol.

We’re now multilingual. Our new wireless drivers can be provided in different versions to “speak” most common communication protocols.
Do you or your customer require lighting installations equipped with Casambi, DALI +, Matter or OSRAM’s QBM for our HubSense ecosystem? Depending on which communication protocol you request for your product, our LED drivers can then be provided in line with your specifications.

For expert advice and to find out how you can best work with the new wireless LED drivers, reach out to the OSRAM team via: **www.osram.com/linear**

Light is OSRAM

Chris Kazazis

Chris Kazazis is Product Portfolio Manager of Compact Constant Current Systems, with a 24-year career with OSRAM, starting from lamp development and extending to electronic drivers and LED modules.

Nicolai Heber

Nicolai Heber is Product Portfolio Manager of Linear Constant Current Systems. He has worked in lighting for 16 years – in Sales, Business Development and Product Marketing.

How you can benefit from our new wireless driver portfolio:

- Compatibility through certified protocol QBM
- Flexibility through adaptability for other ecosystems, e.g.
- DALI+, Casambi, Wirepas or Matter – for both linear and compact drivers
- Easy retrofitting and modernization
- Efficient lighting control with sensors
- Cost savings and CO2 reduction
- Future-proof and scalable option for office buildings, industry and retail spaces
- Expert support through our experienced design team

OSRAM. The light you need.

OSRAM Digital Systems delivers technology for successful LED projects. From components to complete systems, from individual solutions to large-scale installations. Whether in industry, at trade fairs, in parking garages or in retail stores – you can always rely on OSRAM quality components.

OSRAM

BUSINESS

Department of Energy Announces Phase 1 Winners of L-Prize Lighting Competition

U.S. Secretary of Energy Jennifer M. Granholm announced the four winners in Phase 1 of the U.S. Department of Energy's (DOE) Lighting Prize (L-Prize®) at the Building Technologies Office's annual Solid-State Lighting Workshop. The L-Prize® is a $12.2 million prize lighting competition launched by DOE in May 2021. The L-Prize® is designed to spur groundbreaking innovation, domestic manufacturing, and the benefits of an inclusive, clean-energy economy for next-generation lighting solutions in commercial buildings.

"The lightbulb is the universal symbol of a great idea and making lighting systems even better for people and the planet may be our brightest idea yet," said Secretary Granholm. "Investing in next-generation lighting solutions is key to tackling the climate crisis, boosting American supply chains and manufacturing of these technologies, creating good-paying jobs, and Building Back Better."

The L-Prize® targets commercial sector lighting, which accounts for 37% of national lighting energy use, and encourages lighting innovators to design systems with breakthrough energy efficiency (25–50% above today's products), quality, functionality, and sustainability. The category of equity and inclusion is another emphasis of the competition, as extra points are awarded for innovation in diversity, equity, and inclusion in how these lighting systems are designed, produced, and installed. A full realization of L-Prize®-winning technology envisions LED products manufactured with significant domestic materials, while demonstrating exceptional energy efficiency, data connectivity, seamless lighting control, and excellent visual quality, with all products designed for recycling and remanufacturing. The competition is organized into three phases. This announcement recognizes the winners of Phase 1, the Concept Phase.

The L-Prize® Concept Phase invited participation by nontraditional innovators such as students, individuals, and those outside the lighting industry as well as known manufacturers. The competition provided an opportunity in the Concept Phase for these participants to receive feedback on their proposed innovations from an Expert Review Panel made up of eight independent, external thought leaders from industry and academia. While the Concept Phase winners each receive a price of $20,000, all serious entrants are welcome to submit to any phase of the L-Prize.

The L-Prize® Concept Phase winners are:

Project Tango, submitted by QuarkStar of Las Vegas, Nevada. The networked, white-tunable luminaire concept leverages innovations in optics, LED, and power conversion technology to deliver high efficacy, exceptional quality of light, and precise control of light distribution.

Sustainable and Connected Troffer Retrofit, submitted by Orion Energy Systems of Jacksonville, Florida. The concept offers a high-efficacy, networked LED luminaire with advanced controls that can be retrofitted in less than two minutes to an existing fluorescent luminaire.

Laterally Symmetrical Level 3 Engine for 3D Printing, submitted by Smash the Bulb/Bridgelux of Mountain View, California. This 3D-printed semi-indirect luminaire concept uses a high-performance light engine that requires no secondary optics and delivers high efficacy and excellent quality of light; an innovative optical design that reduces losses and addresses glare; and a luminaire housing that can be 3D printed on the job site.

Papaya Modular Lighting Ecosystem, submitted by Papaya of Evanston, Illinois. This highly modular luminaire platform designed by a team from outside the lighting industry uses a unique community-based approach; an all open-source aspect offers opportunities for innovators of all types to participate in evolving and innovating this lighting solution over time.

Looking ahead, the subsequent phases of the L-Prize® will present fresh opportunities for awards and recognition. All eligible entrants are welcome to participate in any of the L-Prize® phases and participation in one phase is not required to be eligible for another. Phase 2, the Prototype Phase, opens this year and calls for prototype lighting systems allowing hands-on evaluation for technical performance and innovation. Phase 3, the Manufacturing and Installation Phase, will reward U.S. manufacturing and installation of lighting systems that meet rigorous L-Prize® technical requirements. Participants are encouraged to form teams as necessary to turn great ideas into real products and installations.

The first Lighting Prize was awarded by DOE in 2011 to recognize a high-efficiency LED replacement for the traditional 60-watt A19 incandescent bulb. Just as the winning A-Lamp was a breakthrough and signaled a turning point in commercially available LED lighting, the current L-Prize® is seeking comparable impact from the next generation of lighting en route to decarbonizing the built environment. ■

National Lighting Bureau Announces 2022 Board Members

The National Lighting Bureau (NLB), the independent, not-for-profit, lighting-education foundation sponsored by professional societies, trade associations, manufacturers, utilities, and agencies of the U.S. government, announces the appointment of its new Board members.

Mary Beth Gotti, retired after a long illustrious career with GE Lighting, was elected Chairperson.

Ruby Jadwet was elected as NLB Vice Chairman. Ms. Jadwet is the owner and founder of Truly Green Solutions. Karen Willis, currently Industry Director of the National Electrical Manufacturers Association (NEMA), was elected Secretary. Glen Gracia, Head of Communications & Brand of LEDVANCE, now serves as Treasurer.

In addition, five at-large directors were elected. Howard Lewis, who vacated the Chair position, is with Spectro Lume and represents the Illuminating Engineering Society (IES). Cary Mendelsohn, the previous Treasurer, is the CEO of Imperial Lighting Maintenance Company and represents the interNational Association of Lighting Management Companies (NALMCO®). Ray Kasmark (International Brotherhood of Electrical Workers/IBEW), Terry McGowan (International Dark Sky Association/IDA), and Jeremy Yon (GE Current, a Daintree company) remained as at-large directors.

The key programs of the NLB include: the Tesla Awards™, honoring excellence in new

The right LED light strip makes the difference

We know that every project requires unique lighting solutions. This is why we're now offering an improved portfolio for LED light strips and LED drivers.

Illumination in upmarket interior spaces like hotels and private residences require one thing: uniform, dot-free light lines with elegant, smooth dimming functions. And of course, the same is true for their façades and external architectural features. To help you deliver the highest-quality LED light strips that are flexible in their use and versatile in their installation, we have now further improved our LED light strips and matching LED driver portfolio.

The LINEARlight Flex DIFFUSE Generation 2 and TEC Flex Shortpitch CRI90 LED light strips have been developed with your freedom of design and light inspiration in mind. So whether you're looking for best-in-class LED light strips that can be endlessly scaled and extended or homogeneous illumination for elegant living spaces, you can be sure to find the perfect LED strip to match your requirements. Combined with the matching LED drivers OTi DALI G2 and OT FIT Phase Cut both OSRAM flexible LED light strips will result in exactly the light system you and your clients need.

Designed for iconic architectural and hospitality projects, **LINEARlight Flex DIFFUSE** in combination with **OPTOTRONIC 24V DALI** drivers offers the best-in-class system for perfect light uniformity. Thanks to 10 m operable LED strip, 5 cm cutting unit and shadow-free junctions, this solution enables limitless curvilinear diffusive lighting.

LINEARlight Flex DIFFUSE in combination with our **OPTOTRONIC OTi DALI** power supply provides dimmable luminous flux down to 0-1%, avoiding any flickering effects. The operable driver-to-LED strip cable – up to 50 m – makes the system installation-friendly, and the embedded Safe Dimming Technology ensures a reliable experience for indoor & outdoor high-end solutions.

TEC Flex Shortpitch CRI90 and **OT FIT Phase Cut** LED drivers are ideal for general lighting applications, specific luminaires, coves and shelves. The strip cuttability and the driver-optional cable clamps permit not only fast installation but also easy modernization of older dimming setups.

The **OPTOTRONIC Phase Cut** LED drivers and the **TEC Flex** LED strips deliver a functional linear solution in combination with our shallow profiles and accessories, while providing simple dimming control. The high-frequency PWM dimming of the driver prevents stroboscopic effects while ensuring excellent interoperability with tested third parties dimming devices.

Ivo Folle

With more than 25 years of experience, Ivo Folle is OSRAM's Product Portfolio Manager for Linear Flexible Solutions. He is eager to share his expertise and provide his contribution to shape the future of creative light.

Thomas Zampieri

Thomas Zampieri is Senior Product Marketing Manager at OSRAM. With his expertise, he manages a comprehensive OSRAM portfolio in the field of constant voltage technology and is keen to take your projects to a new level.

Why you can rely on light strips by OSRAM

- Comprehensive portfolio of matching LED light strips and LED drivers – for any project and any application
- Best-in-class OSRAM quality both in LED components and offered LED drivers
- Our tailored design-in service helps you develop the perfect systems for your lighting installations
- Generate fully customized components with our online speaking code generator

OSRAM. The light you need.

OSRAM Digital Systems delivers technology for successful LED projects. From components to complete systems, from individual solutions to large-scale installations. Whether in industry, at trade fairs, in parking garages or in retail stores – you can always rely on OSRAM quality components.

To integrate reliable, luminous lighting into your projects, reach out to us via **support-DS@osram.com** today.
More information: **www.osram.com/flexible**

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construction and retrofit designs that enhance the value of lighting for people; the Trusted Warranty Evaluation Program, certifying those companies that complete and pass the documentation process to validate their warranty; the Art and Science of Lighting Awards, recognizing two products, one that demonstrates exceptional technical innovation and another that provides outstanding aesthetic appeal and high-quality lighting.

Obtain more information about the Bureau by visiting its website, nlb.org, or by contacting its staff at info@nlb.org or +1 615-379-7707. ■

GE Current Announces Post-Merger Executive Leadership

Courtney Abraham, Joe Cenin, Tom Boyle, Mark LeClair, Jason Sherrill, Chip Taylor, Manish Bhandari, Inger Eckert, Dan Phalen, Jim Farrell, Tom Benton (left to right)

Current, the new company formed through the merger of GE Current, a Daintree company, and Hubbell® Incorporated's commercial and industrial (C&I) lighting business, announced its new executive team for the combined company located across its offices in Greenville, SC, and Cleveland, OH.

"As a larger enterprise, we are focused on customer centricity – ensuring our customer innovation and execution needs are rapidly fulfilled by our business units, while leveraging the combined scale of our facilities and supply chain in a continually volatile environment. I am therefore delighted to have a complete management team in place, and in charge, on day one itself," said Manish Bhandari, President & CEO, Current.

Chip Taylor, with an established track record in the lighting industry, has been appointed the Chief Commercial Officer.

The business units at the core of the company will be led by:
Tom Benton as VP & GM of Fixtures, including the recently acquired Forum business
Jason Sherrill as VP & GM of Controls and Software, including the NX and Daintree platforms
Dan Phalen as VP & GM of Growth Markets, including Lamps, Roadways, Signage and Horticulture

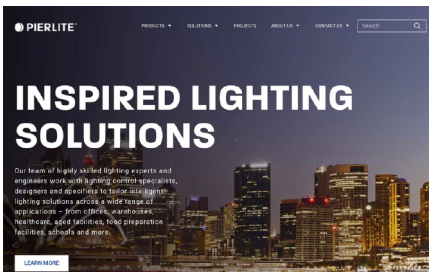
Tom, Jason and Dan have extensive lighting industry experience, which will help us drive customer-focused innovation and high-performance levels.

Joe Cenin will expand his role as Chief Supply Chain Officer to now include the acquired facilities in Juarez, Mexico; Tijuana, Mexico; Christiansburg, VA; and Plympton, MA.

James "Jim" Farrell, previously President – Hubbell Lighting, recently rejoined the company as the Group Chief Financial Officer of the combined enterprise. Courtney Abraham will lead the development of people resources as the Chief Human Resources Officer.

Tom Boyle will take on the newly created role of Chief Development Officer leading the company development and integration efforts. Mark Ward has been appointed as Vice President – Business Transformation entrusted with Performance Excellence across the enterprise. Mark LeClair will lead the digital-connect efforts as the Chief Information Officer, and Inger Eckert will be the General Counsel of the business. ■

Signify to Acquire Pierlite to Strengthen Position in Australian and New Zealand Lighting Markets



Signify announced that it has entered into a definitive agreement with Australian based Gerard Lighting Group to acquire their Pierlite business. The acquisition is in line with our strategy to expand within highly attractive market segments and will bring together the strong R&D and innovation capabilities of a global leader with the significant expertise and network of a local brand.

The union will strengthen our position in the Australian and New Zealand lighting markets and provide us with growth opportunities – including those that exist between Pierlite's luminaire portfolios and Signify's connected lighting solutions.

Customers in Australia and New Zealand are early adopters, and can be regarded as pacesetters when it comes to the latest lighting trends around the globe. This transaction will provide them with the best of global and local lighting technologies.

Combining Pierlite's strong customer relationships and excellent indoor portfolio with Signify's comprehensive 'Philips' brand of indoor and outdoor portfolios will create a substantial breadth of offer and market coverage in the Pacific region. We also see synergies stemming from alignment with Signify's 'Interact' and 'Dynalite' control platform brands. Furthermore, Pierlite has wide access to the wholesale channel that is complementary to our own channel strategy in the Pacific.

"We're excited to announce our intention to acquire Pierlite, bringing together two companies and brands that have a long history in Australia and New Zealand. Aligning Pierlite's strong local network and well-recognized brand with Signify's global brands and expertise will help us to strengthen our position in the Pacific's lighting market," said David Gardner, Cluster Leader Pacific at Signify. "Uniting the organisations ensures that we offer best in class global and local solutions for our chosen segments and helps us to answer the growing desire for Australian-made/Australian-owned products, systems and services."

The acquisition is expected to close in the second quarter, subject to customary closing conditions. ■

HC Semitek Cooperates with AIXTRON on Micro LED Display Technology

Dr. Felix Grawert, Chairman of the Executive Board (CEO & President)

Micro LED technology is on the verge of revolutionizing the display industry. The market demand for self-emissive Micro LEDs in the primary colors (RGB: red, green and blue) begins to rise strongly. HC Semitek, a leading enterprise of the semiconductor technology, will use AIXTRONs Planetary Systems to meet the emerging market demand for Micro LED displays.

For this purpose, the Chinese chipmaker now relies on the AIX 2800G4-TM (IC2) and AIX G5+ C MOCVD systems from AIXTRON SE (FSE: AIXA, ISIN DE000A0WMPJ6), a leading provider of deposition equipment to the

semiconductor industry. All AIX 2800G4-TM (IC2) and AIX G5+ C tools will feature a configuration of 8×6 inches and have been shipped in Q4/2021.

Micro LED technology is a game changer for the display industry:

HC Semitek is positioning itself for Micro LED technology, a strong emerging market and game changer for the display industry. This groundbreaking technology enables unmatched pixel resolution, superior display quality and more important much higher current efficacy than existing display technologies. To achieve these benefits, the next generation of LED displays will require millions of micron-range LEDs to be transferred onto one single display, which has urged LED suppliers to develop new mass transfer technologies.

To enable this, large arrays of LED are taken directly from the processed LED wafers, making any upfront wafer binning or sorting of defective chips obsolete. Consequently, it is essential that all epitaxial wafers produced have very tight wavelength distribution and very low level of defects on their surfaces, calling for innovative and new MOCVD approaches.

The Planetary System of AIXTRON features a wafer-level control of the film surface temperature during the epitaxial process. This warrants a very accurate control of the Indium incorporation into the Multi-Quantum Wells (MQW), which will ultimately define the wavelength consistency among all produced wafers. Cassette-to-cassette automation coupled with in-situ cleaning ensure that no particle will contaminate the films during handling or the epitaxy processing.

"AIXTRON has been our trustable and reliable partner for MOCVD solutions over the past 15 years. We are delighted to now strengthen our cooperation in the area of Micro LED products. AIXTRON's Planetary Technology has been well proven for the best uniformity and low particle performance. We believe this is a key step for the commercialization of Micro LEDs and will reinforce HC Semitek's leading position in the Display Market," says Dr. Jianhui Zhou, CEO of HC Semitek.

"We are very pleased that HC Semitek, as the key player in the market, has selected our AIXG5+ C and AIX2800G4-TM systems for their further development of Micro LED production processes. We are looking forward to supporting the acceleration of the roll out of Micro LEDs for displays. Micro LED technology is disrupting the existing display ecosystem embracing methods and approaches only seen in the semiconductor industry. Our Planetary Technology platform solutions perfectly fulfill these stringent epitaxial requirements," says Dr. Felix Grawert, CEO and President of AIXTRON SE. ■

Siklu and Signify Announce Agreement to Integrate Gigabit-Speed Wireless Connectivity into Lighting Infrastructure

Siklu, a global leader in millimeter wave (mmWave) solutions for Digital City, Gigabit Wireless Access (GWA), and Mobile x-Haul, and Signify, the world leader in lighting, announced a strategic partnership agreement to add Siklu's MultiHaul™ TG multi-gigabit wireless connectivity technology to Signify's BrightSites portfolio. This combination will result in an addition to the BrightSites portfolio, which will be known as Broadband luminaires.

Signify's new innovative BrightSites solution is converting streetlights into a wireless connectivity grid which can facilitate a wide

range of digital city services, such as: IoT, security and traffic monitoring, 4G/5G small cells, as well as "digital inclusion" initiatives including municipal Wi-Fi and residential broadband access. BrightSites helps cities to meet the needs of citizens, businesses, and visitors by delivering faster and more accessible broadband connectivity that helps ensure constant access to their digital world.

The new broadband luminaires, integrate Siklu's Terragraph-compliant MultiHaul™ TG multi-gigabit wireless connectivity technology to significantly reduce the dependency on fiber deployment and enable municipalities to create a wireless mesh network by replacing their luminaires with Broadband luminaires. This will significantly accelerate city-wide scalability for secure and reliable multi-gigabit wireless connectivity, at a fraction of the cost and time compared to an all-fiber network deployment.

Siklu's MultiHaul TG is Siklu's third generation 60 GHz point-to-multipoint product line and fifth generation overall of V-Band products. Overall, Siklu has hundreds of thousands of products installed in hundreds of cities around the world and offers advanced software tools to design and operate a network. Siklu's MultiHaul TG continues this tradition of excellence by creating secure and reliable fiber-like multi-gigabit wireless mesh networks to support any type of network topology from a small campus up to city and regional deployments.

Both companies have collaborated over the past year in the development of the Broadband luminaire portfolio, based on Siklu's MultiHaul N366 TG node. Following successful market validation, the two companies have agreed to expand the collaboration to jointly develop and commercialize solutions for street lighting infrastructure.

"We aim to radically accelerate the transition to smart cities by enabling the lighting infrastructure as a primary platform for cost-effective and scalable broadband connectivity. With our combined solution we overcome significant hurdles for the creation of dense networks by ensuring every light point acts as a data hub. This reduces time and cost, and most importantly, it improves the environmental impact as compared to legacy means. By integrating Siklu's Terragraph-compliant MultiHaul TG multi-gigabit wireless connectivity technology into our BrightSites portfolio, over the future of Smart Cities is a reality now," said Khalid Aziz, Head of Connectivity Solutions at Signify.

"Siklu products are already enabling a wide range of urban and industrial services that require gigabit broadband access. With the increasing demand for high-speed internet connections everywhere, especially in the COVID era, we share Signify's vision of utilizing the lighting infrastructure as the connectivity grid of the future," said Ronen Ben-Hamou, CEO of Siklu. "Signify is the global leader in lighting infrastructure, and we are excited to collaborate in the digitalization of cities and transforming our vision into reality." ■

Acuity Brands Partners with Microsoft to Enable Sustainable Building Solutions

Acuity Brands, Inc., a market-leading industrial technology company, announced it is expanding its collaboration with Microsoft to bring new capabilities to Acuity Brands smart lighting, lighting controls, and building automation solutions.

Acuity Brands has a bold goal to avoid 100 m metric tons of carbon emissions as a result of projected 2020–2030 sales of LED luminaires, lighting controls, and building management systems replacing older technologies in existing buildings. By combining the power of Microsoft's Cloud for Sustainability and Microsoft Azure IoT with Acuity Brands customer solutions, Acuity Brands and Microsoft will jointly enable end customers, operating many types of facilities and buildings, to forecast and calculate the environmental and financial impacts that these new lighting and building management technologies deliver.

"We estimate that building operations contribute 28% of global carbon emissions. By developing, deploying, and operating building systems with a focus on sustainability, we can materially reduce energy usage from facilities," said Neil Ashe, Chairman, President and Chief Executive Officer of Acuity Brands. "Together with Microsoft, our goal is to integrate foundational technologies like Microsoft Azure IoT and AI with Acuity Brands solutions that allow companies to reduce carbon emissions while saving money on operating expenses."

Acuity Brands provides industry-leading lighting and lighting controls technology. The company's nLight® digital lighting controls platform, the Compact Pro™ High Bay by Lithonia Lighting®, and its other lighting and lighting controls offerings are currently deployed across 15 billion square feet of commercial real estate, including office space, retail stores, hospitals, and airports. Additionally, the Acuity Brands smart building and energy management portfolio includes the ECLYPSE ® line of edge controllers by Distech Controls® to automate building functions and energy management services such as the Atrius® Building Manager.

Acuity Brands and Microsoft will collaborate to bring the Acuity Brands portfolio of applications to Azure, standardizing data ingestion and analysis via Azure Digital Twins and analysis of this data via Azure's AI offering. Microsoft and Acuity Brands will also look to explore technology solutions that further evolve the way spaces can be evaluated, managed, and optimized in the future.

"Consistency and accuracy in calculating carbon reductions are critical to tracking progress towards corporate climate commitments," said Matt Renner, President, U.S. Enterprise Commercial at Microsoft. "Acuity's end-to-end portfolio of smart lighting, building controls, and building management technology, built on Microsoft Azure and Microsoft Cloud for Sustainability, will deliver immediate energy savings to companies across all vertical markets operating facilities and buildings, by integrating sensing, analysis, and actuation. Microsoft has bold commitments to be carbon negative, water positive, and zero waste by 2030, and we are pleased to partner with Acuity on its digital transformation journey. Together we will accelerate development of solutions that immediately impact carbon emissions from building operations and extend these solutions to companies of all sizes that will need simple solutions to meet their own climate goals." ■

Lumitronix Becomes Official Distributor of Optics Manufacturer Gaggione

The Swabian LED company Lumitronix and the French optics manufacturer Gaggione have agreed on a joint path. The optics company, which was founded back in 1948 with headquarters in Montréal-la-Cluse, has selected LED specialist Lumitronix from Hechingen to distribute its high-quality optical solutions for LEDs and other lighting applications. The official distribution by

Lumitronix covers Europe, with a focus on the DACH region.

For more than 40 years Gaggione has been developing and manufacturing optical components in plastic injection, using several types of polymers such as PMMA, PC, or silicone. As one of the pioneers in the manufacture of LED optics – starting with the development of the first collimator for a Barracuda LED back in 1996 – the French company utilises its immense experience and resources to produce optics and systems for almost any kind of usage.

Gaggione's standard collimators are compatible with the main brands of LEDs and can be adapted to different fields of lighting applications. Moreover, depending on the customer's specifications and requirements, it is possible to design the complete optical system and provide the appropriate optics to meet the desired requirements.

"Gaggione is also well-known for producing excellent optics for colour mixing applications and we believe that these applications will become more important for us in the future. In addition, the customised individual optics give us the opportunity to offer excellent total solutions in combination with our LED modules and control technology," says Christian Hoffmann, CEO of Lumitronix.

The French company's decades of experience and the flexible manufacturing capabilities on the part of Lumitronix enable a fruitful collaboration and thus the creation of individual solutions in the field of LED lighting. ■

Casambi Appoints Mark McClear as New General Manager for North America

Global smart lighting control company Casambi announced the appointment of Mark McClear as its new General Manager for North America in a move to expand operations in the region. He will be based out of Casambi's North American headquarters in Atlanta, Georgia.

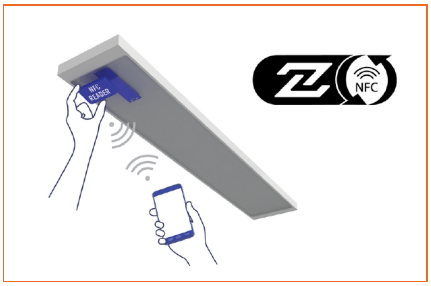
Mark is an important figure in the LED and SSL sectors having previously held numerous high-profile positions, including Vice President Global Sales at LED manufacturer, Cree, Chief Operating Officer at BIOS Lighting, and having led the LED components business as President of North America for Seoul Semiconductor.

Commenting on the appointment, Kari Mettälä, CEO, Casambi Technologies said: 'Mark is a popular leading authority with an unmatched understanding of the smart lighting movement. His unique knowledge gained over decades working at the heart of the industry will undoubtedly accelerate our plans to expand Casambi's global footprint. Mark will grow Casambi into the leading US wireless lighting control provider.'

Mark McClear commented: 'Wireless control is the next big leap forward for the lighting industry. Casambi's open ecosystem architecture is a generation ahead of the proprietary legacy systems currently on the market. Together with the US Team, we will provide service and support, and expand Casambi's commercial network across North America.' ■

TECHNOLOGIES

Zhaga Approves Book 25 "NFC Readers with Bluetooth Interface for In-field Programming"



This new Zhaga specification defines a Bluetooth Low Energy communication protocol for the communication between the field-maintenance application on a smart device and the NFC reader. Together with Book 24, which describes the programming of luminaire components using NFC, these specifications solve the data management problems of smart luminaires with interoperable maintenance tools enabling configurable luminaires easy to service over their entire lifecycle.

An increasing number of lighting applications requires reading out parameters and changing of settings of LED drivers in the field. Manufacturers of LED luminaires currently use a variety of methods for in field programming. Zhaga gives installers, system integrators and utility companies the option to select only one programming tool which works with all field-maintenance applications from all vendors implementing Book 25 and all NFC-programmable devices implementing Book 24.

Zhaga Book 25 builds on Book 24 "Programming of luminaire components using NFC", and adds mobile NFC Readers with a Bluetooth Low Energy interface. It enables maintenance and replaceability with a cross vendor harmonized method of NFC programming for in-field use. The specification defines a Bluetooth Low Energy GATT-Service which NFC Reader manufacturers can implement for the communication between the field-maintenance application on a smart device (cell phone, tablet, etc.) and the NFC reader. This allows the field-maintenance application to read and write parameters on NFC enabled LED drivers without the need for a cable-based connection. Field maintenance with Book 25 may also be used for other components requiring programming, such as sensors or connectivity nodes.

Zhaga has also developed the Zhaga-NFC certification program for Book 24 and Book 25 which is available for Regular and Associate Zhaga members and is provided by Zhaga accredited test centers listed on the Zhaga website. Only certified NFC readers and NFC-programmable devices can carry the Zhaga-NFC logo. This certification builds trust in the interoperability of components. ■

Read more

New Horticulture Lighting Standard Released

Humans and plants use light in different ways. Check out the newly available standard, ANSI/IES RP-45-21 Recommended Practice: Horticultural Lighting, to learn about the differences between architectural and horticultural lighting design. Published by the Illuminating Engineering Society (IES).

"Horticultural lighting is a science in its own right, bridging horticulture, botany, and illumination engineering, We wrote this document with one purpose in mind: To provide a framework for discussions between horticulturalists and lighting professionals," said Ian ASHDOWN, IES Horticultural Lighting Committee Chair. ■

How to order the new Horticulture Lighting Standard:

Read more

Retail Lighting Efficacy Improves With 3% to 5% lm/watt Increases for 90 and 95 CRI LUXEON CoBs with CrispWhite Technology

Lumileds announced substantial performance improvements for its 90 and 95 CRI LUXEON CoBs with CrispWhite technology. Now, the two CRI versions offer light output within 1–2% of each other and efficacy within 1–2 lumens per watt. Lumileds patented CrispWhite technology brings a vivid and bright look to retail settings. Its unique ability to highlight bright whites while also revealing the richest colors found in clothing, paints, and other goods results in more inviting and attractive displays.

Proper lighting is central to the perception and evaluation of goods. It is a critical component of branding, highlighting, and presenting merchandise, and creating a space where shoppers want to visit. CrispWhite Technology has proven to be stable and reliable. Lumileds scientists succeeded in developing the technology so that it would improve color

rendering without sacrificing efficacy and they continue to improve this technology in our CoB products.

With CrispWhite Technology, whites appear brighter and sharper – like they do in outdoor lighting conditions – than is possible with standard LEDs. And with 95 CRI, color fidelity is as good as it gets. Lumileds LUXEON CoBs with CrispWhite Technology are available with light emitting surfaces (LES) of 6 to 19 mm at 3000 K and with CRI of 90 or 95.

“We’ve seen widespread adoption of CrispWhite Technology and now with 95 CRI performance breaking the 100 lumen per watt level, we’re seeing a majority of new designs adopt the higher CRI option,” said Keen Oun Yap, Sr. Product Manager at Lumileds. ■

Read more

Osaka Umeda Twin Towers South Chooses Nichia’s Vitasolis™ LED Technology

Nichia’s Vitasolis™ has been implemented in lighting at the recently completed Osaka Umeda Twin Towers South. Osaka Umeda Twin Towers South is a large-scale complex constructed by Hanshin Electric Railway Co., Ltd. and Hankyu Corporation. While construction began in 2014, it was just recently completed in its entirety on February 25, 2022. The office zone from the 11th floor to the 38th floor of the building was designed with three concepts in mind: “Heart of Umeda,” “Huge hospitality services,” and a “Wellbeing experience.” This building actively installed a facility contributing to wellbeing with the focus of WELLCO, a floor dedicated to office workers on the 12th floor.

Vitasolis™ is installed in Mitsubishi Electric Lighting Corporation’s fixtures and equipped in the working space of WELLCO. This product is effective in reducing eye strain, stress, and improving work efficiency by regulating circadian rhythms which are the biological rhythms of humans. These benefits are the reason the Vitasolis™ was selected for this project as they fit the purpose of the space and the concept of the building.

Mr. Shogo Yamazaki, Group Leader of Design Department at Takenaka Corporation, noted "After a long 7 years, the building has been completed. From the onset of a comprehensive planning stage, we searched for the right office technology that would be suitable for this project and happened to come across the light of Vitasolis™. We believe that the comfort and work efficiency gained by the spectrum of Vitasolis™ will contribute to improved workers' productivity. Therefore, we decided to install it in the building."

Professor Masayoshi Kamijo at Shinshu University proved the effects from Vitasolis™. "Upon measuring the level of physical and mental comfort and the level of stress, there has been a tendency that people working in a room lit with the Vitasolis™ spectrum experienced reduced tiredness and stress, and an increase in work efficiency in terms of psychology and physiology."

Nichia continuously explores how light brings value and enhances people's life and will endlessly pursue the ideal light source. ■

Read more

EDISON Opto Delivers Flexible Design & Manufacture Custom Modules

Edison Opto provides design and manufactures advanced module customization services. In addition, we offer the L.D.M.S. "Lighting Design Manufacture Service" is the integration technical service. With the high efficiency/Intensity, Premium CRI90+, and a long-life span of over 100,000 Hrs LM80 design and manufacture service. We provide professional and complex design and customized services for any application, performance requirements in AC and DC, and any shape. We work with customers to simplify processes, save production costs, expand their capabilities to new fields and more diverse projects without adding equipment or labor, and quickly gain a place in the market.

AC professional module provides solutions for all kinds of lighting, which power range from 6 W to 300 W and with types ranging from round, linear, ring to dimmable luminance and color. Unique optical design with modules can greatly enhance uniformity and performance. The exclusive ES IC AC module can integrate Wi-Fi, Bluetooth, and DALI control schemes. What's more, it can also combine under 10% flicker function while dimming and exceeding the Title 24 for USA market and commission regulation of PstLM and SVM product standards for the EU market. ■

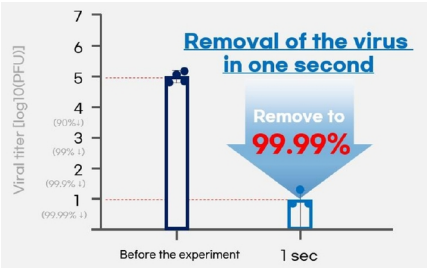
Read more

Violeds Sterilizes Omicron Variant As Well

Seoul Viosys, a company specializing in optical semiconductors, announced an experimental result confirming that its Violeds technology sterilizes 99.99% Omicron Variant (SARS-CoV-2 Variant: B.1.1529) in one second, which has been spreading around the world.

Seoul Viosys conducted the Omicron sterilization test at the Virology Research Institute of Korea University College of Medicine, and it was confirmed that the Omicron virus exposed to the Violeds LED was sterilized 99.99% in only one second.

Seoul Viosys has been conducting various sterilization experiments using its Violeds technology since 2019. In July 2021, in a joint experiment with a research team at Korea University, it was confirmed that Violeds sterilized (inactivated) the Delta variant (SARS-CoV-2: B.1.617.2) 99.3% in one second. Seoul Viosys' bio research team released research data that the air purifying sterilizer with Violeds technology applied could lower the risk of airborne infection by one-thirtieth. In November 2021, Seoul Viosys provided free air purifying sterilizers to 300 small business stores that have been barely managing to earn their living during the COVID-19 pandemic, and no confirmed cases have been found in any of the stores where the air purifying sterilizers are installed according to a survey of the store owners.



In addition, at the CES in January 2022, portable air purifiers (model name: VAC) with Violeds technology applied were installed in conference halls, restaurants, and vehicles, and thanks to this, no single confirmed case occurred among Seoul Viosys' executives and employees.

Violeds is a clean technology that prevents the growth of viruses and bacteria with ultraviolet (UV) LED, which has sterilizing and deodorizing power. Not to mention air purifiers and air conditioners, this technology can also be applied to air conditioning systems of buildings and automobiles, reducing the possibility of infection caused by airborne droplets and keeping the indoor environment pleasant by circulating internal air.

"Given the results of this Omicron test, we expect that COVID-19 variants that have been continuously emerging, such as Deltacron, can be completely sterilized using Violeds products," a Seoul Viosys official said. "We will continue to apply Violeds technology to various products to create an environment where people can breathe clean and safe air at home as well as restaurants, transportation facilities, and multi-use facilities."

He also added, "Violeds is an innovative sterilization technology that we have developed and started mass-production for the first time in the world, and no one can produce it without permission to use the patents of Seoul Viosys, its affiliate SETi in the US, and NS (Nitride Semiconductor), a strategic partner in Japan." ■

Read more

PLEXIGLAS® Molding Compounds for Zumtobel's Robust, Moisture-proof AMPHIBIA PM Luminaire

Dust swirls through the air, water splashes, cleaning agents are sprayed – luminaires in industrial buildings have to cope with a lot of adverse conditions. They are often exposed to dirt, humidity, extreme temperatures or even chemicals. The materials have to withstand all these impacts, as well as being break and shock-proof. Workplaces are also subject to complex requirements for light quality and illumination.

Zumtobel, a leading international provider of lighting solutions for commercial properties, developed its robust AMPHIBIA moisture-proof luminaire for an extremely wide range of industrial applications. The long LED diffuser luminaire lights up factories, logistics centers, agricultural buildings, parking garages and much more. It is available in three versions, adapted to different areas of use. Zumtobel produces one of these, the AMPHIBIA PM, from PLEXIGLAS® molding compounds, the brand polymethyl methacrylate (PMMA) from Röhm. "Our material meets the high standards needed for industrial lighting and also offers outstanding lighting properties," says Andrea Fruth, Senior Product Manager Lighting, Extrusion, Optics in the Molding Compounds business unit of Röhm GmbH. ■

Read more

Macroblock Releases AEC-Q100-qualified Automotive Lighting ICs

Macroblock announced its new generation LED automotive lighting driver ICs, MBI6659Q and MBI6665Q, are highly praised and appreciated by the customers. The two new products are suitable for the application of intelligent automotive lighting, and both of them have obtained the AEC-Q100 qualification.

The company is positive about the future outlook of the global intelligent automobile market. By launching these two new products, Macroblock has a more complete automotive series product line. Macroblock will continuously focus on the automobile original equipment market and keep developing other new products to assist each brand to maximize business value.

As compared to the ordinary electronic products, automotive electronics have stricter standards for their components. The Automotive Electronics Council (AEC) established AEC-Q100 qualification standard for automotive IC, and the test qualification is rigorous. Macroblock's automotive series products have all passed this certification to make sure that the reliability and stability of ICs meet AEC's requirements.

As an LED driver IC leader, Macroblock expects a very promising future of the automobile industry; especially that electric vehicles and self-driving cars are the recent trending topics in the market. LED now is the mainstream in the field of automotive lighting. Macroblock will work closely with our partners to deploy on the automobile market and will keep designing automotive lighting ICs and automotive display ICs to fulfill customers' needs. Macroblock will cooperate with global automakers to create more modern and fashionable automotive lighting and bring a warmer human-vehicle interactive experience to the car owners. ■

Read more

“Leading by Example and Respect” Dr. Alfred FELDER, CEO Zumtobel Group

Dr. Alfred FELDER
Dr. Alfred Felder joined the Zumtobel Group in November 2012 and was initially responsible for the components business as CEO of Tridonic. In April 2016, he was appointed to the Management Board of the Zumtobel Group as Chief Operating Officer (COO). From February 1, 2018, Felder assumed the position of Spokesman of the Management Board and has held the position of Chief Executive Officer (CEO) since June 2018.

After interviewing many of the leading LED manufacturers, this time we decided to focus on lighting manufacturers. We had the privilege of talking to Dr. Alfred Felder, CEO of the Zumtobel Group, and a TOP representative of the lighting industry. Dr. Felder went over the transformation processes within the lighting sector with us and described the strategic considerations of the Zumtobel Group. The new Light Forum at the Zumtobel headquarters in Dornbirn, Austria was the perfect place for our talk.

LED professional: **First of all, Dr. Felder, I'd like to say what a privilege it is for LED professional to conduct this interview at the new Zumtobel Group Light Forum, here at your headquarters. Before we dive into the topics we're going to talk about today, could we just ask you to give us a bit of background information about yourself? How did you end up becoming the CEO of the Zumtobel Group?**

Dr. Alfred FELDER: Let me start off by welcoming you to the Light Forum. About myself, I received my degree in electrical engineering at the technical university in Vienna. My first industrial experience was with Siemens' corporate research. Later, one of my professors offered to let me work on my PhD at the central labs of Siemens at the end of the 1980's. Afterwards, I joined the Siemens semiconductor group, which later became Infineon. During that time I had the chance to work in different countries, including five years in Japan and a little over three years in the USA. That's where I became acquainted with OLED and OLED technology development for lighting applications. While I was in California I was assigned back to Asia – this time to China – where I had a number of management functions related to LED at Osram. In November 2012, I started within the Zumtobel Group as the CEO of Tridonic, with the aim of transforming the business from conventional lighting components technology to LED. That was a great time, helping to transform the business from 20% LED to 100% within four years! In April 2016 I received an offer to join the Zumtobel Group Board as COO and later, when some changes were made in management, I was offered the position of CEO. Since February 2018 I've been very happy helping lead this company into the future together with a fantastic team.

LED professional: **On the topic of the Zumtobel Group itself: It's a complex structure – an enterprise with a main group and several sub-group companies. Could you explain to our readers how the group, with all its enterprises and different company strategic directions, works?**

Dr. Alfred FELDER: As one of the largest lighting companies, the ambition of the Zumtobel Group is to be a leading supplier of innovative lighting solutions and services – from components over luminaires to services. This is also reflected in our structure. We operate in two major businesses: Tridonic is the components business that develops all components including sensors and sensor technologies for luminaires. The other one is the so-called lighting business that provides complete lighting solutions and services for professional lighting applications, where we operate under the two strong brands of Zumtobel and Thorn.

As we cover the whole value chain from components to lighting solutions, we also operate in different markets and market segments. Our core markets are in Europe both for Tridonic as well as for the lighting brands. As Tridonic also supplies the lighting brands' competitors, it has a completely separated business structure. In all of the countries, where both Tridonic and the lighting brands operate, they work in different offices with different sales people.

To summarize, we have quite a lot of different enterprises in the countries from which we manage our business worldwide.

LED professional: **If we could come back to the lighting business with Zumtobel and Thorn: What is the difference in the strategic directions of these two brands?**

Dr. Alfred FELDER: If we look at the two brands, we see that Zumtobel plays a key role in the top-tier applications and is mainly an indoor brand with direct interfaces to key customers, architects, stakeholders and light planners. Thorn has both an outdoor and an indoor branch. They are represented in the mid-tier segment in the indoor branch and in the outdoor branch in the mid- to high-tier segment, including urban architecture illumination.

LED professional: **Do both Zumtobel and Thorn operate in the residential segment?**

Dr. Alfred FELDER: We operate in the high-end residential segment as we, with all our brands, can offer a complete lighting solution and portfolio to our customers. But the broad residential segment is currently not in the scope of the Zumtobel Group.

LED professional: Are the controls provided by Tridonic or is that part of the Zumtobel solution?

Dr. Alfred FELDER: The components of the controls are in Tridonic's portfolio and they are an integral part of the controls system for the lighting brands when it comes to emergency lighting or light management systems. In this area, we have a very close cooperation between the development teams of Tridonic and the lighting brands. Again, in this case the lighting brands are a customer of Tridonic and Tridonic makes tailored solutions for them.

LED professional: You mentioned that the main market in general is in Europe. What about businesses in Asia or North America?

Dr. Alfred FELDER: Here we have to differentiate. Both businesses, the components business as well as the lighting business, have over 80% of their market in Europe. In the lighting division, especially since the acquisition of Thorn, we are more international – we have subsidiaries in Australia, New Zealand, Singapore, Hong Kong and China, with a very selective portfolio for key applications. This helped us to reach a very strong position. In the US we are mainly represented by the Zumtobel brand, bringing the high-end European Zumtobel design to the US architects, who are developing international projects.

LED professional: The next topic is related to the lighting sector in general. The lighting sector has been transforming over the past years, from fluorescent to LED, and the new digital world. Over the past two years we've had the pandemic situation, so, in regards to this complete transformation process, keeping the outside environmental aspects in mind, how is the Zumtobel Group developing and what results can be expected?

Dr. Alfred FELDER: The pandemic had an impact on our whole transformation journey, but it has shown how quickly the digital transformation can be achieved if you are forced to do it.

Our first transformation was initiated a couple of years ago, with the change from conventional to LED lighting now being at almost 100%. We transformed to LED in all aspects: high efficiency, new designs, and innovation on a broad front.

Obviously, Corona impacted our journey as we were challenged by maintaining the focus on our customers, while securing our business. However, I can proudly say that thanks to all our employees who went the extra mile, none of our factories had to be shut down and we were able to deliver our products to our customers despite the negative impact of the pandemic.

LED professional: Have you been able to overcome the chip shortage?

Dr. Alfred FELDER: With last year's shortage of semiconductor ICs and other raw materials, we and many other companies were faced with availability issues and dramatic price increases.

This IC shortage impacts the production of drivers used in our high-end luminaire solutions, e.g., for the brand Zumtobel. But luckily, Tridonic has been able to adapt its product development where possible, which allowed for a change in producers or the distribution of orders among a larger circle of companies.

However, I have to say that the global trend of material shortages for certain components, including supply chain interruptions coming from China, remains challenging also in 2022.

LED professional: In general, the lighting industry and the automotive industry are suffering because of this problem. Is the general solution to say that we just have to wait until production in China and Asia comes back or could a solution be to bring back some production lines to Europe or the US?

Dr. Alfred FELDER: We had already decided prior to the COVID situation to move our luminaire production and part of our driver production from China back to Europe, specifically to our new factory in Serbia, which reduces the dependence on the Asian supply.

I believe that, wherever possible, production in Europe close to our customers offers a fantastic opportunity to reduce supply chain risks. However, for some global products like semiconductor ICs which mainly come from Asia, we will have to rely on a global supply chain. I think that mitigating the risk by using suppliers that are closer to the production sites and to the customers is an advantage and I see our customers' interests moving into a similar direction.

LED professional: When did the production plant in Serbia open?

Dr. Alfred FELDER: It opened in September 2018. Due to Corona the ramp up was slower than planned, but we now have around 700 people working at the plant in Serbia.

LED professional: There are opportunities and threats in the lighting sector: the shortage in the supply chain is one of those threats, and so my question to you is, what are your expectations for the next few years?

Dr. Alfred FELDER: I see two major trends in the lighting industry which the Zumtobel Group will focus on. One is what we stand for – our DNA – which is the quality of light: Providing our customers with the best light for the respective application, combined with the highest efficiency and controls that are available. The second trend is the digitalization of the lighting industry, where services can be applied and value will be added for customers beyond the lighting application itself.

LED professional: On the topic of new services as a new business approach: We have seen several ideas and concepts on the market – do you think the service business is a strong market that will grow? Is it accepted by the project owners and clients?

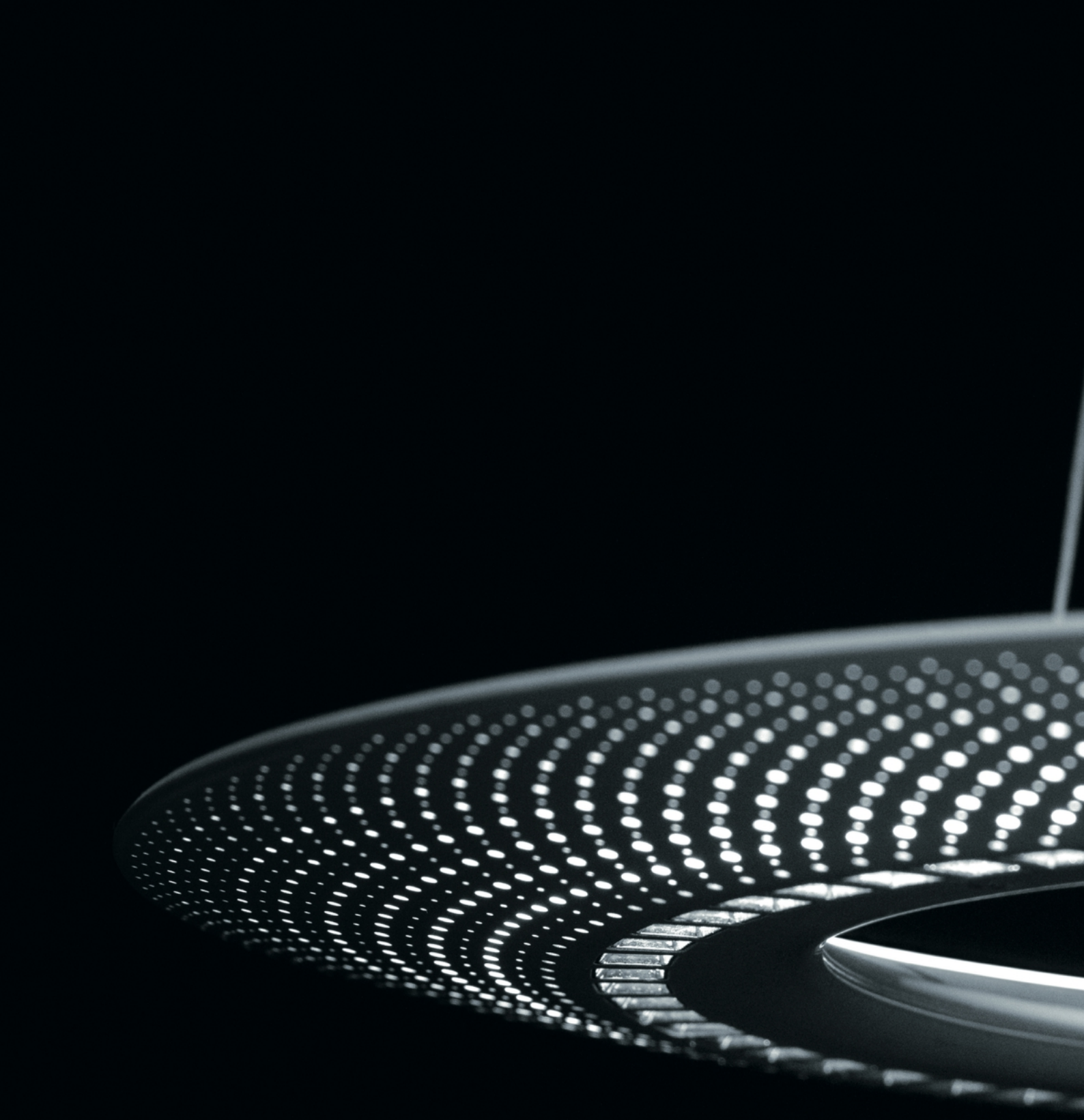
Dr. Alfred FELDER: New services like "indoor navigation services" or "asset tracking services" in warehouses could be realized with the lighting infrastructure as a backbone. These services are small in absolute terms, but they help customers to grow their business. Of course, there is always the question of how well the customer accepts new services and how much added value they provide.

The interview will be continued on page 28.

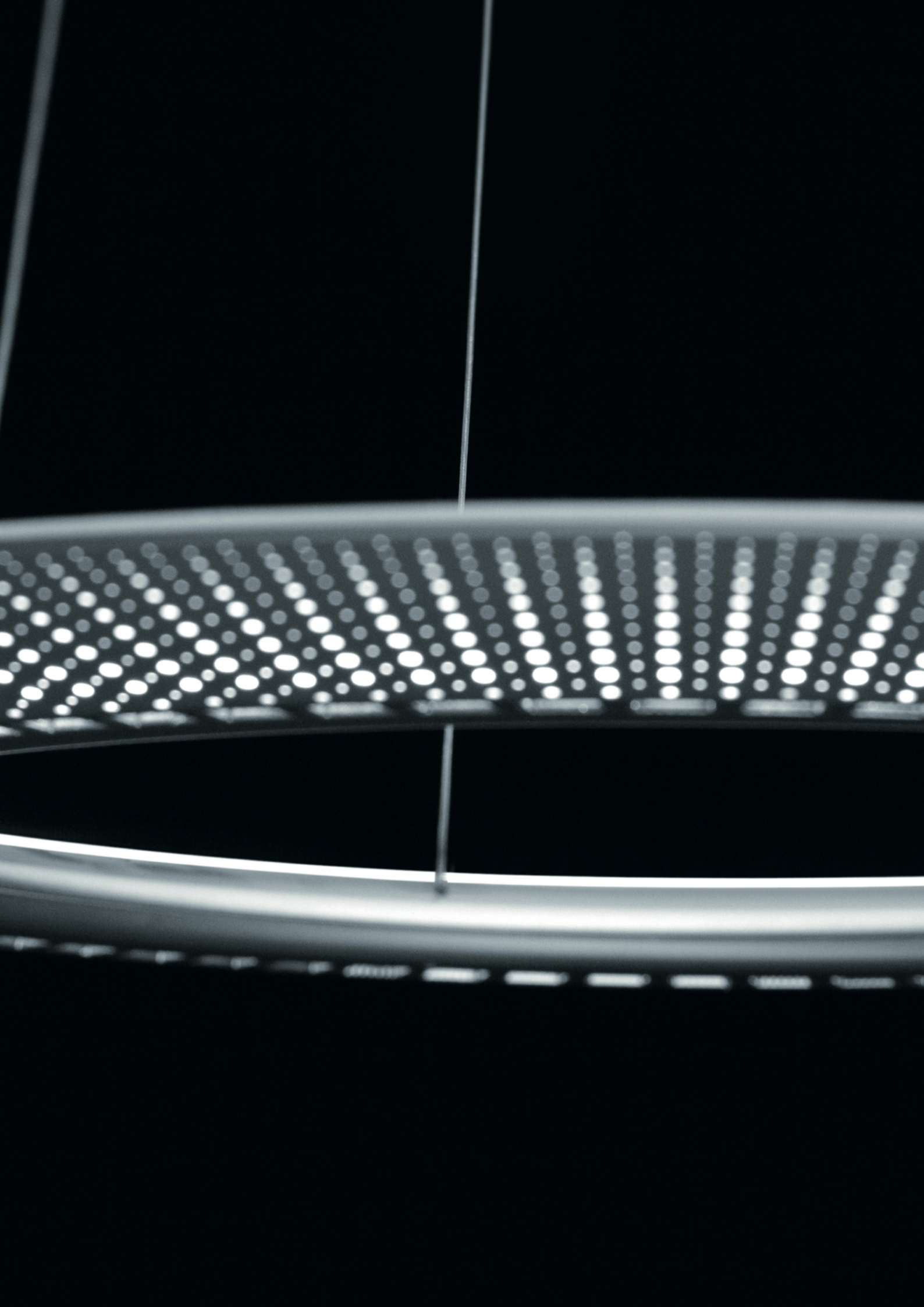
Dr. Alfred FELDER

VIVO II: Aspects of the circular economy were consistently taken into consideration in the design and construction of the VIVO II spotlight series: durable, technically recyclable and reusable parts, maximum energy efficiency, easy maintenance and care as well as minimal, plastic-free packaging reduce the ecological footprint throughout the entire product life cycle. The recycling rate of the materials used amounts to roughly 78%.


ZUMTOBEL



AMBITUS: Where linear lighting systems often represent a visual break in geometrically complex architecture, the round AMBITUS pendant luminaire radiates calm. With the ring luminaire designed by Yorgo Lykouria of RAINLIGHT STUDIO, the light follows a predefined shape and can still change direction. In 2021, this luminaire was awarded the Red Dot Design Award “Best of the Best”.



LED professional: The next topic I'd like to discuss with you is the matter of sustainability. There is this Green Deal approach from the European Union, but we think it's a general need to look for sustainable products. What is the Zumtobel Group's position on this topic, both for the company and its products?

Dr. Alfred FELDER: In my opinion, sustainability is no longer an option. It is our new way of doing business. Our founder, Dr. Walter Zumtobel with his brilliant engineering skills, already combined high-quality light and lighting fixtures with low resource and energy consumption. Therefore, the foundation of the company was already built on these aspects and now we have started to take the Zumtobel Group to the next level.

We, as a company, offer high-efficiency LED solutions which help our customers to reduce their footprint. Last year, we defined our goal to become climate-neutral by 2025 – an ambitious target. As a result of this decision, all of our factories, with the exception of China have switched their electricity to hydropower or renewable energy.

In addition, our aim is to transform from a linear economy to a circular economy. We run prototype development projects where we already apply these rules, like a new freestanding luminaire platform. At the same time, frameworks like ESG are considered in our sustainability activities. I'm proud to say that over the past few years we have been receiving higher and higher rankings, resulting in the "gold status" in the EcoVadis rating last year.

LED professional: Congratulations on those great achievements! You also hand out awards to different projects. Does that go hand in hand with sustainability?

Dr. Alfred FELDER: Absolutely. The Zumtobel Group Award has a long tradition in our company and we decided to revive it again after the challenging business years which the Zumtobel Group had in the past and also after the start of the COVID pandemic. There are two categories: Buildings and Urban. The driving force behind the Award is the significance of sustainable innovation for the built environment which can reduce global energy consumption and boost the quality of life. These can be in developing countries but also European countries. The Award addresses central issues of our time, as has recently been shown with the 2021 prize, for example, the topics of collective housing, water management, affordable homes, disaster protection and energy savings. Criteria like these fit perfectly with our aspirations to really drive sustainability in our company and also with the projects we are entertaining.

LED professional: Is the Zumtobel Group Award given out on an annual basis?

Dr. Alfred FELDER: The last one was a couple of years back now, in 2017. It was always given out in an interval of two to three years because new projects again need time to arise.

LED professional: You mentioned before that innovations are in the DNA of the Zumtobel Group and we believe it is the key to success. Where can innovations happen in the lighting sector and what steps is the Zumtobel Group taking in this regard? Will there be more than the data focused digital concepts – are there other innovation drivers, looking forward to the next one or two years?

Dr. Alfred FELDER: Absolutely. Just to illustrate a little, even in 2021, when there was quite a significant reduction in sales due to the pandemic, we spent almost €65 million in R&D on a Group level. We believe that, even though in terms of efficiency we have reached the point of saturation in LED technology, we still haven't levered all of the opportunities in terms of design and light distribution that LED can offer, due to its miniature appearance. So the trends of miniaturization, energy efficiency and component intelligence create huge potential for innovations. However, digitalization is becoming a new dimension by enriching most of our solutions with new functions. That was also our motivation to open a group application software center in the city of Porto, Portugal, in 2019.

Today we have more than 50 software experts, something you would not naturally expect from a lighting company – but the software content is becoming more prevalent in our product offerings. Advanced light management systems and advanced emergency systems are just two representative examples. Ultimately, we are a lighting company and we offer the best possible light for humans – with our lighting solutions we always put people first.

LED professional: If we look at the automotive trends, where suddenly mobile phone companies are moving into this business, isn't there a danger of a network giant stepping into the lighting business because communication and data services are their business and they see the opportunities offered by lighting?

Dr. Alfred FELDER: It cannot be the aspiration of a lighting company to become an IT giant, but lighting companies are enablers of the IT and data world and are therefore a part of the infrastructure. It's like a melting pot where more and more industries are melting and working together on solutions with communication companies.

LED professional: Are you already partnering with anyone?

Dr. Alfred FELDER: Yes, for example, we're partnering with Kapsch Business Com in Austria. In our cooperation we are jointly looking for lighting and IT service solutions for supermarkets.

LED professional: Can you give us an idea of any new products you are bringing to the market?

Dr. Alfred FELDER: Our focus for 2022 remains on offering highly innovative lighting solutions to our customers. We are also working on the extension of existing products that have been very well received on the market but will have a new design and new features.

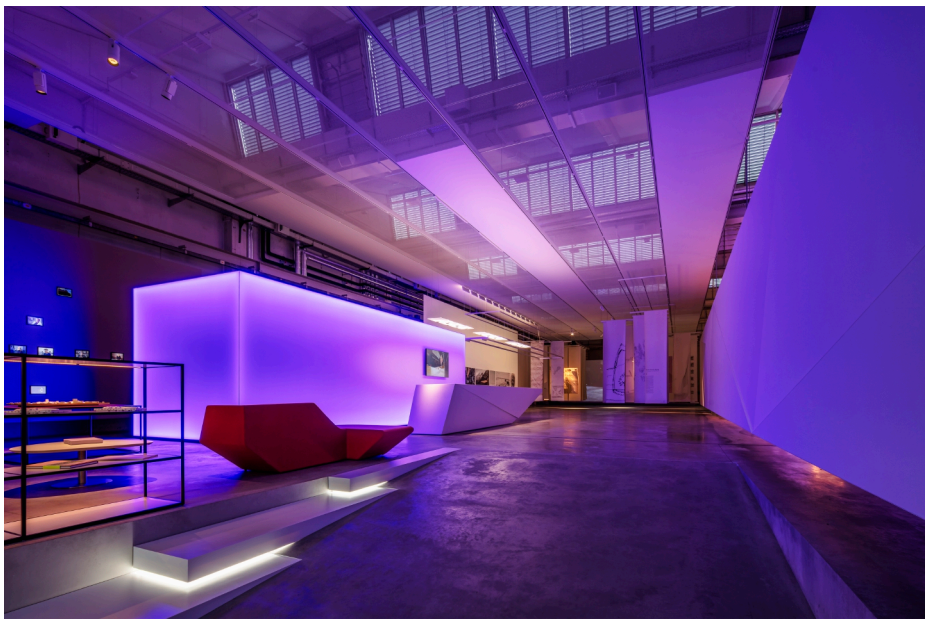
LED professional: You made the decision not to exhibit anymore at Light & Building in Frankfurt – the world's largest lighting fair – but rather to showcase here, in the new Light Forum. What about once the pandemic is over and the trade shows start happening again? Will you be showcasing your products at other fairs?

Dr. Alfred FELDER: I personally believe that showcasing products to our customers is also transforming, it is not an analogous thing any longer. It becomes a combination of presenting a physical product to touch and feel, but also using

digital methods to showcase products to the clients, especially the younger generations.

When we built this Light Forum here at our headquarters in Dornbirn, our aim was to combine the digital and the analogous setup in one place, giving the customer the opportunity to see our solution on-site or from anywhere. A permanent showcase is also in line with our sustainability strategy as all the products are fixed installations, renewed with new technologies.

Also, we are able to showcase the entire innovation portfolio that we have in a much larger space and combined with digital media we are able to virtually visit our customers and bring our solutions to them. I personally believe that this is also the transformation that fairs are going through. Currently, the classic fairs are still set in the analogous world, but I am sure that the transformation will take place there as well. It's a bit of a different concept that we've worked out, together with the Light Forum and the "go to market" concept. But I have to admit – Light & Building is a brilliant place and a fantastic fair. It's a huge opportunity to discover innovations.



Entrance area of the Zumtobel Group Light Forum.

Zumtobel Group is headquartered in Dornbirn, Austria.

LED professional: **How big is the Light Forum, here in Dornbirn?**

Dr. Alfred FELDER: We have 4,000 square meters here. It's a flexible exhibition space, which allows us to keep our Light Forum updated with our latest lighting solutions and products.

LED professional: **Before we wrap up we just wanted to ask you about the financial figures that were published for the past half year. In the first half of the business year 2021/22 you have showed a 10% increase in revenue, a 52% increase in EBIT and a net profit increase of 72%. Is your forecast for the next half year or year just as positive?**

Dr. Alfred FELDER: I'm proud to say that all the hard work that our teams have done over the past couple of years has enabled us to grow substantially. In spite of the raw material challenges we are facing at the moment, I'm confident that we will continue these growth paths we had. As you may know, we had a Capital Markets Day meeting in October 2021 and we believe that we are able to grow in 2022. I'm confident that we will reach the goals we have set for ourselves and have published in our guidance to the market. Our goal is to grow by 4% to 5% every year until the business year 2024/25.

LED professional: **Dr. Felder, it has been a pleasure talking with you. We would like to thank you very much for taking the time. We are convinced that your insights are very relevant for the lighting domain and our readers.**

Dr. Alfred FELDER: It was my pleasure. Thank you. ■

LpS Digital: Lighting Conference & Exhibition 2022

LpS Digital is the unique and first digital lighting conference and exhibition available to viewers 24 hours a day, 7 days a week. LpS Digital presents current, high-quality content about lighting technologies, design and applications, and acquaints the viewers with the latest trends in product developments and applications.

Experience the Future of Light

Like the LED professional Symposium +Expo and Trends in Lighting Forum &Show that took place at the Festspielhaus in Bregenz/Austria every year since September, 2011, LpS Digital is meant to approach and support the complete value chain in the global lighting industry. When it comes to Technological Design, LpS Digital's goal is to provide Corporate Managment, Technical Management, R&D and Production/QM within the global lighting manufacturing industry with top notch technical knowhow, primarily on a component level. In terms of Lighting Design, LpS Digital will show best practice for Architects, Lighting Consultants, Electrical Consultants, Lighting Designers, Lighting OEMs, IT/IoT System Integrators and students. The editors focus on Human Centric Lighting, Connected Lighting, Smart Controls, Internet of Things, Light as a Service and much more.

Unique Global Reach in the Lighting Sector

VIRTUAL CONFERENCE
The authors of contributions accepted by the program management will be invited to give a presentation and, if appropriate, to write a qualified article. Each presentation will be announced to the industry and/or design channel contacts and followers immediately after publication.

VIRTUAL EXHIBITION
Virtual exhibitors have the possibility to present their products and/or services. The maximum length of the presentation is 20 minutes. Each product/service video is announced to the industry and/or design channel contacts and followers immediately after publication.

Lighting Industry & Technology Channel

With the Industry/Technology channel, over 30,000 contacts in the lighting sector are targeted and addressed. The opt-in databases are highly selective, highly qualified and address key persons in the respective channel.

- Magazine: 30,000
- Newsletter: 27,000
- Online: 30,000/month
- Twitter: 22,000
- LinkedIn: 11,700

Lighting Design Channel

With the Design channel, over 30,000 contacts in the lighting sector are targeted and addressed.

- Magazine: 30,000
- Newsletter: 15,000
- Online: 5,000/month
- LinkedIn: 4,600

Benefits for Conference Authors

- Global, highly-qualified target group
- Knowledge transfer at a high level
- Ideal platform for expanding the network

Benefits for Virtual Exhibitors

- Global, highly-qualified target group
- Immediate promotion of innovations and novelties
- Participation in the LpS/TiL Awards
- Highly efficient promotion at no risks

NICHIA

DALI Alliance

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LpS DIGITAL

www.LpS-Digital.global

Wuyuanhe Stadium, China

Lichtvision Design

The new Wuyuanhe Stadium is situated on the southern island of Hainan, China. The building provides seats for more than 41,000 visitors and was developed on an extremely fast project schedule with a construction time of only 15 months. The iconic building was designed to blend into the surrounding architectural, cultural and costal landscape of Hainan. The architectural lighting plays a key role in the building's success, visually enhancing the flow and dynamics as well as the solid structures. Light contributes to the subconscious wayfinding tasks of spectators and allows for communication with the city via a low-resolution media component.

As the very first major sports venue on the island of Hainan, the new Wuyuanhe River Stadium is a mile-stone building project for an ambitious large-scaled sports and culture infrastructure development in the Hainan region. With seating capacity for more than 41,000 spectators and a Gross Floor Area (GFA) of approximately 90 300 m^2, the stadium had a construction time of only 15 months.

Given the importance of this new landmark-like building, close attention was paid to the collaboration between the design and engineering teams, despite the tight project schedules. One key role of the architectural success was the integration of lighting to underline and enhance GMP's architectural aesthetics.

In context to the surrounding urban and coastal landscape, this large-scaled sports venue was carefully integrated, architecturally. The flowing design is in harmony and balance with the urban and natural surroundings. For lighting, that means a neat and subtle integration of monochromatic light considering the impact on architecture, nature and the urban context. A careful enhancement of architectural features, takes into consideration, the wayfinding and visual needs for orientation of large spectator crowds approaching the building, mainly by foot.

The building is situated in an open landscaped area positioned on a platform that is elevated from the ground with diagonally arranged ramps leading the visitors towards the stadium. Those layers build up to shape to its final majestic appearance when reaching the top by foot.

This key arrival experience is staged by the careful consideration of seamless lighting fixture integration into the landscape and continued into the architecture, providing a subconscious wayfinding element. Linear lighting elements within the landscape are merged along the podium and continued on the façade of the stadium. Uniformity and contrast ratios of the carefully integrated linear and graze lighting illuminates the louver façade, lighting downwards and upwards from a brighter central luminous ring of light. The central ring of light forms an inclined centre of gravity dividing the façade and the roof. This ring of dynamically addressable light can react to what is happening within the stadium, creating a very low-resolution media component that communicates with the city.

Behind this luminous band, a circular viewing platform runs around the top of the grandstand. Light fixtures are carefully integrated in a way to minimize glare and light pollution, allowing a panoramic view over city and ocean for the citizens and guests of Hainan.

Scope of Work: Exterior Lighting
Start & Completion: 2013 & 2018
Location: Haikou, China
GFA: 90 300 m^2

Client: Greenland Group
Project Lead: Lichtvision Design; Clemens Seipelt
Architect/Designer: gmp Architects
Photographer: Schran Images

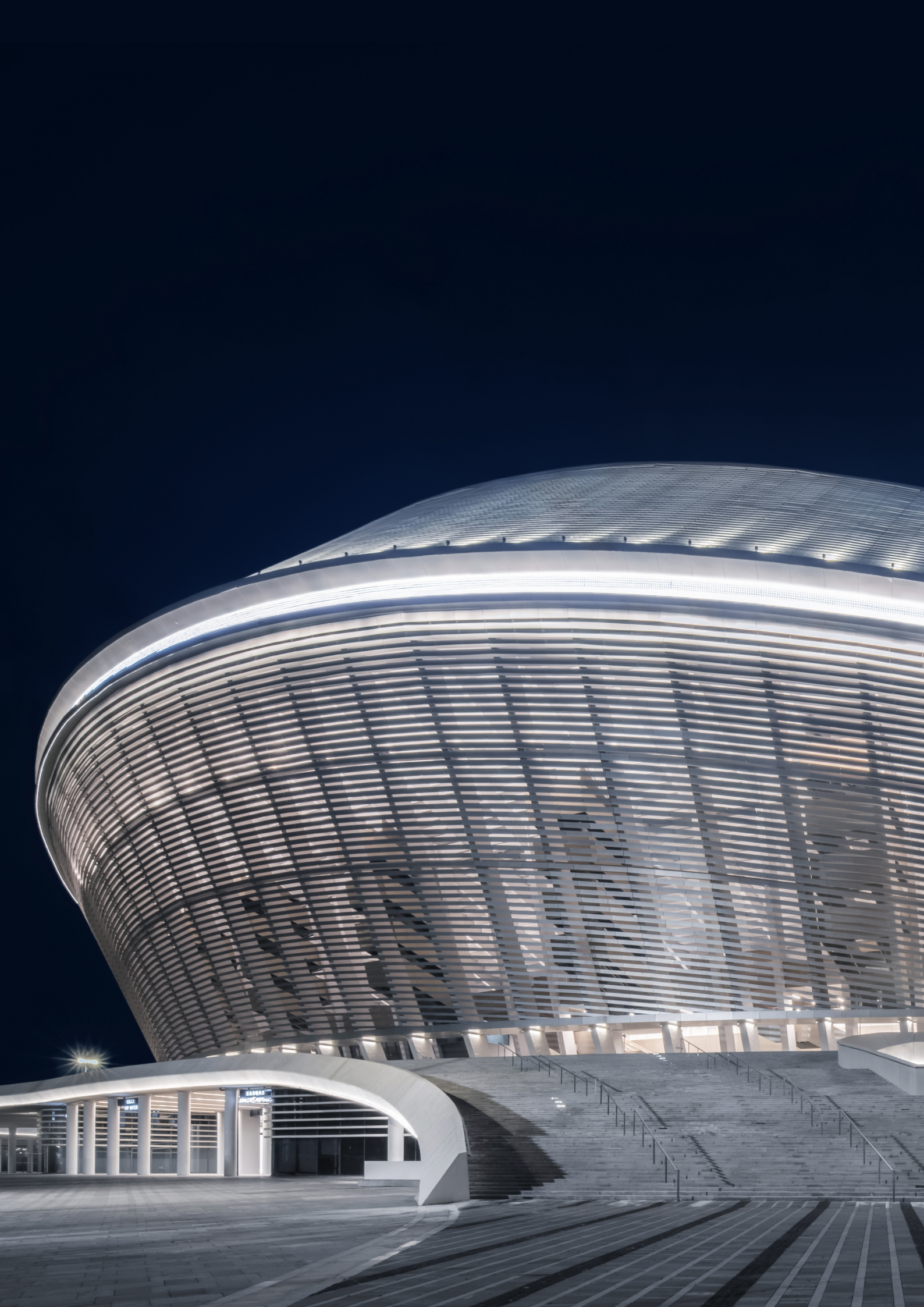
Links:
https://www.lichtvision.com/en/projects/exterior-lighting/wuyuanhe-stadiumhaikou-china.html
https://www.gmp.de/de/projekte/3241/haikou-wuyuan-river-sports-park

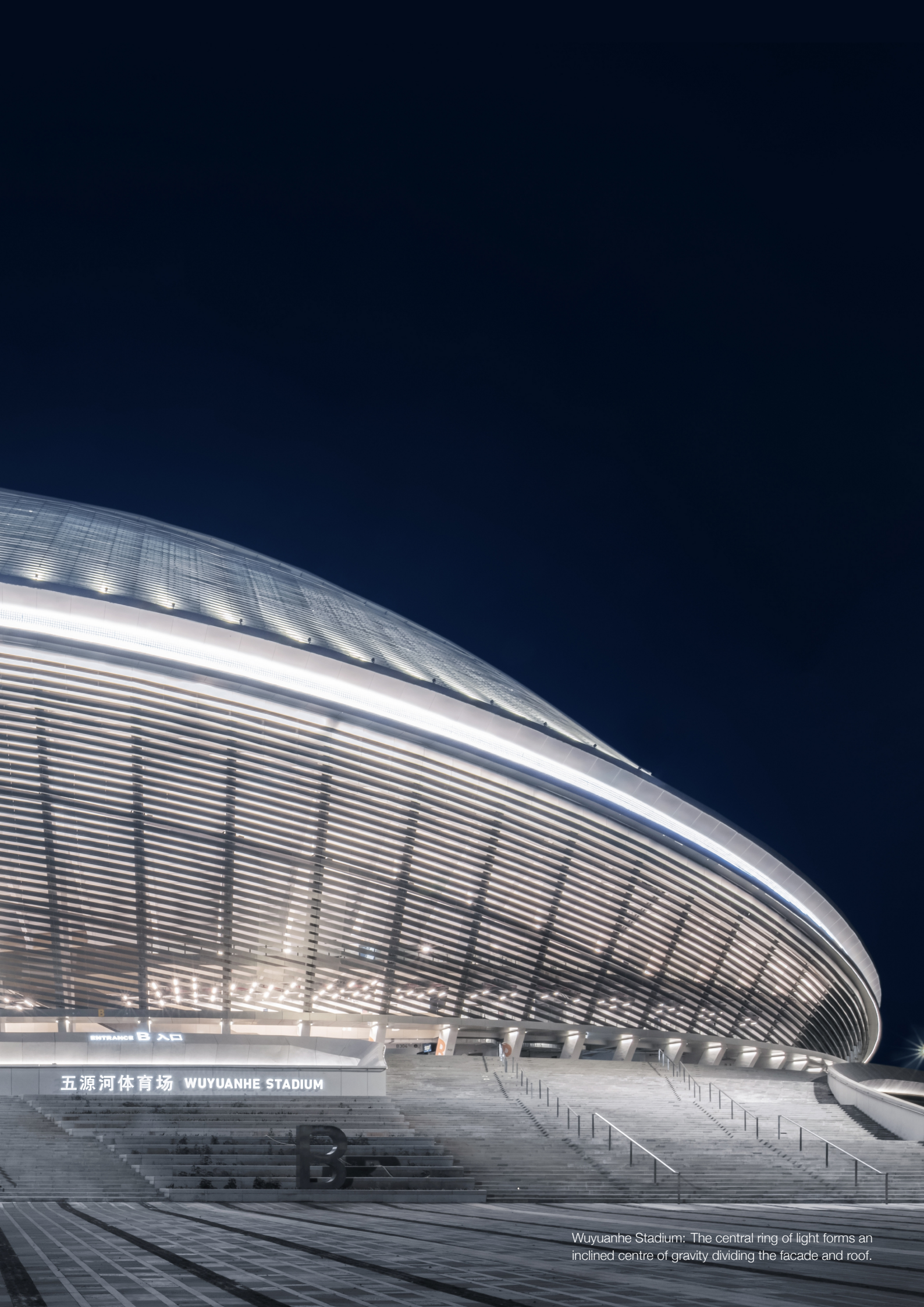
http://www.lichtvision.com

LICHTVISION DESIGN

LICHTVISION DESIGN received the “German Lighting Design Award 2021” in the category International Project for the Wuyuanhe Stadium.

Wuyuanhe Stadium: One key role to the architectural success was the integration of lighting to underline and enhance gmp's architectural aesthetics.





Wuyuanhe Stadium: The central ring of light forms an inclined centre of gravity dividing the facade and roof.

Wuyuanhe Stadium: Behind the luminous band, a circular viewing platform runs around the top of the grandstand.

DALI Lighting Awards 2021

DALI Alliance, www.dali-alliance.org

The DALI Lighting Awards 2021, presented by the DALI Alliance, were created to recognize the best use of DALI lighting control applications and solutions in a broad selection of categories. This year, the Awards attracted a wealth of excellent DALI-based projects from all around the globe. Submissions ranged from small homes and care facilities to giant transport infrastructure projects; from state-of-the-art office facilities to museums, hotels and universities; from new-build projects to refurbishments; from soccer stadiums to high schools and hospitals.

The eight categories for project submissions were:

- Commercial / Professional
- Entertainment & Architectural
- Healthcare & Education
- Industrial
- Infrastructure
- Residential
- Retail & Hospitality
- Outdoor

The winning projects were announced in January 2022, and further details can be found here:

Winning Projects

Judging criteria
The panel of lighting experts (see www.dali-alliance.org/awards2021/judges.html) judged the projects according to several key criteria, namely:

- the aesthetic appearance and lighting design effects enabled by DALI,
- the technical use of DALI features, and
- the specific benefits delivered by using DALI.

Judging panel

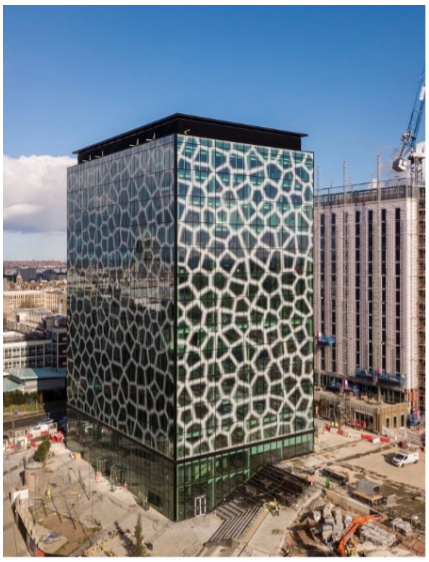
- Chen Zhongli
  Chief Electrical Engineer, Shanghai Architectural Design & Research Institute
- Markus Helle
  Editor-in-Chief, Highlight magazine
- Mark Lien
  Industry Relations Manager, Illuminating Engineering Society (IES)
- Jeff Shaw
  Associate Director Lighting, Arup
- Tad Trylski
  Lighting Designer & Member of IALD
- Karen van Creveld
  Society of Light and Lighting (SLL)
- Scott Wade
  Technical & Certification Manager, DALI Alliance
- Matt Waring
  Editor, arc magazine

For more information, please contact:
Tim Whitaker, Marketing Communications Manager, mailto:Marcom@dali-alliance.org

Category: Commercial / Professional

Winner: HELVAR

The Spine (Royal College of Physicians), Liverpool, UK



The Royal College of Physicians' (RCP) new home in Liverpool, UK, occupies 70,000 square feet across seven floors in The Spine, which is the UK's first building designed to achieve the prestigious WELL Platinum standard for wellbeing – of which light is an important element.

An intelligent, fully addressable DALI lighting control system from Helvar was used to ensure the quality of light and improve the user experience, including defined light levels for the biophilia aspect of the project. The DALI system is distributed from two risers on each floor and connected via an Ethernet network. DALI was chosen as it was specification compliant, with a simple

topography, and cost-efficient. The system provides a one-stop solution for complex control requirements.

A range of button panels, multi-sensors, occupancy sensors and Digidim mini input units were installed using a networked system. The Helvar Cloud Gateway sends data from a lighting system to a cloud platform, where authorised users can access it through a REST API or a web browser interface.

High levels of IP integration were required in the conference spaces to allow the Helvar DALI control system to work alongside audio-visual systems. Helvar Insights has also been installed, allowing the RCP to make decisions backed up by reliable data gathered from their existing lighting control devices and sensors – and thus to improve the wellbeing of users and the efficiency of their building, and help achieve sustainability targets. Judges described The Spine as "a beautifully designed building that seamlessly combines artificial and natural lighting to create a bright and welcoming environment. The additional focus on biophilia should be commended. It's so important for workspaces to have a more considered approach that is tailored towards the wellbeing of its users, and the introduction of plant life is an ideal way to do this."

https://helvar.com

Highly Commended: INTELLIGENT ENVIRONMENTS

Colliers Head Office, HSBC Tower, Auckland, New Zealand

The Colliers Head Office refurbishment within the HSBC Tower included the installation of a DALI-2 control system, which provided versatility, ease of integration, and monitoring and reporting capabilities. The precise dimming and color-changing capabilities of the DALI system were integral in allowing the design objectives of the space to be met. Also, the ability to support the DALI-2 control system remotely allows a swift response to any maintenance issues. Judges recognized the flexibility afforded by the DALI system, which allowed the cabling to be installed with functionality programmed later.

https://www.intelligentenv...co.nz

Highly Commended: SIGNIFY

Huada Semiconductor Headquarters, Shanghai, China

The Huada Semiconductor headquarters project was notable for its use of tunable white lighting control, promoting well-being and productivity of occupants, as well as extensive use of light and occupancy sensing. Judges recognized the flexibility of spatial use that DALI affords in this project. The control system allows a luminaire's light output to be controlled according to the distance from the office windows, which provides a more comfortable and energy-efficient lighting scheme.

https://www.signify.com

Category: Entertainment & Architectural

Winner: DELMATIC

Expo 2020 Pavilions, Dubai, UAE

DALI technology was selected for the Sustainability Pavilion and the Mobility Pavilion at Expo 2020 Dubai to provide accurate, energy-efficient digital dimming and real-time management and monitoring of the lighting network. A key challenge was to deliver an energy-efficient lighting-control system to meet the diverse scene-setting requirements of the various spaces within the pavilions, while also contributing to the Expo's goal to build a lasting legacy of sustainable infrastructure.

DALI presented a flexible, scalable, site-wide solution to meet the diverse lighting-control needs of the Expo, with versatility of lighting layouts and scenes, and the opportunity to adapt to meet the requirements of future tenants. Following the Expo, the pavilions will be repurposed into a science centre and office spaces. Overall, the system controls and monitors around 50,000 DALI lamps, with 770 DALI sensors, as well as switches and control units. DALI Buswire modules provide configurable flexibility through graphical addressing of each luminaire. In other areas, DALI broadcast avoids the need for on-site addressing of DALI ballasts, which speeds installation and reduces commissioning time.

The dynamic and robust DALI lighting control system played a significant role in meeting the Expo's sustainability targets and supporting the Sustainability Pavilion's LEED Platinum rating – the highest accreditation for sustainable architecture – and the Mobility Pavilion's LEED Gold rating.

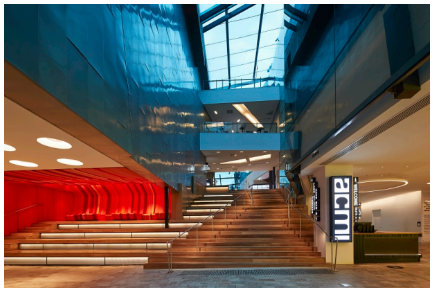
Sophisticated DALI and DMX lighting scenes and scenarios are managed and configured through Delmatic's graphical user interface, without accessing equipment or needing wiring changes. The interface monitors and displays the operational status of every DALI lamp and driver, flags failures in real time, and generates relamping plans. The judges described this as a stand-out architectural lighting project on a very large scale, with strong use of DALI technical capabilities combined with many notable creative and design features. They were impressed by the efforts to design with future-proofing and reconfigurability in mind, all enabled by DALI.

https://www.delmatic.com

Highly Commended: SCHULER SHOOK

ACMI Renewal, Melbourne, Australia

This renovation project – Highly Commended by the judges for its outstanding lighting design – updated the lighting scheme in the common areas, including retail areas, atriums, foyers, studios, and event spaces, within the Australian Centre for the Moving Image in Melbourne.



The DALI lighting control system was designed to enhance the visitor experience and provides smooth transitions and easy programming of the lighting presets, with flexibility for the venue to customize special events. Integration of the lighting with the architecture was carefully devised and coordinated with the wider design team. Judges praised the clever lighting-design ideas, such as the integration of light fittings within the red fabric-clad "urban lounge" area, as well as the use of DMX alongside DALI.

https://schulershook.com

Highly Commended: DELMATIC

Football World Cup Stadiums 2022, Quatar

Delmatic supplied DALI-based lighting control systems for the Education City Stadium and the Ahmad Bin Ali Stadium, which are venues for the FIFA World Cup Qatar 2022™.

The very extensive DALI systems include 90,000 DALI lamps, 5,000 DALI sensors and 2,300 DALI switches, plus DALI controllers and devices, and a further 10,000 DALI emergency lamps.

DALI enables fully addressable scene-setting control and monitoring of normal, emergency and decorative lighting across the stadium canopies and façades. The DALI systems share sensor data to maximize the operational efficiency and sustainability of lighting and connected services, as well as tracking the stadiums' energy usage.

https://www.delmatic.com

Category: Healthcare and Education

Winner: ZENCONTROL

University of Warwick Faculty of Arts, UK

With sustainability in mind, it was essential that the lighting controls for the Faculty of Arts building at the University of Warwick, UK, were based on an open protocol to ensure longevity and interoperability. A high degree of flexibility was also required so spaces could be rapidly re-configured when required.

Working closely with the architect, the electrical engineers specified a range of feature lighting alongside functional and way-finding solutions based on DALI-2. Lighting enhances the internal environment and ensures the sculptural forms of the atrium and any feature artworks are well illuminated.

As well as praising the project's lighting design and aesthetic appearance, the judges recognized the contribution to the university's ongoing decarbonisation plan. They also commented on the use of dashboards to allow the university to manage its key performance indicators (KPIs).

The project uses zencontrol application controllers linked to the Schneider building management system (BMS) via BACnet, providing a single dashboard for KPI management.

The DALI-2 system, which includes emergency lighting testing and monitoring, provides a level of granularity and flexibility not available from other protocols. DALI data is used for energy-usage monitoring and logging, as well as maintenance and servicing. The data obtained from the DALI-2 system was seen as a key factor in minimizing the university's carbon footprint. DALI was the only protocol that provided a platform based around an international standard for future flexibility and upgrades.

https://zencontrol.com

Highly Commended: HELVAR

Hospital Nova, Jyväskylä, Finland

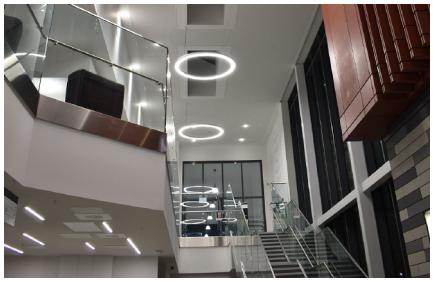
DALI controls all indoor and outdoor lighting at this newly built hospital, one of the largest in Finland, and the project has over 30,000 controlled DALI addresses. The judges recognized that patient and staff wellbeing is central to the building's lighting design.

The DALI system responds to both light-level fluctuations and seasons, and is freely programmable to allow users to tailor the desired lighting scheme. Furthermore, by understanding people's movements and how spaces are used, the lighting can be adjusted to save energy, since the system can detect the most optimal lighting setting based on collected data.

https://helvar.com

Highly Commended: LAING O'ROURKE

Grange University Hospital, Cwmbran, Wales



This large new hospital in Cwmbran, Wales, was equipped with a DALI-2 lighting system and emergency lighting, using interoperable DALI components from multiple suppliers. This resulted in a more resilient building that can be adapted if future requirements change.

As well as this emphasis on resilience and future planning, the judges recognized that off-site pre-assembly of different elements including DALI systems enabled early commissioning and phased handovers. This in turn resulted in early delivery of some sections of the building that were then able to support coronavirus care.

Also, the use of DALI enabled functionality to be adapted to respond to the fast-changing demands of the pandemic – for example, an area was quickly and easily reworked from offices to a doctor's rest facility.

https://www.laingorourke.com

Category: Industrial

Winner: TRILUX

Kühne+Nagel Logistics Hubs, Hamburg, Germany

Transport company Kühne+Nagel implemented a lighting refurbishment for its two logistics hubs in Hamburg, replacing the existing conventional lighting systems with highly efficient, DALI-based, networked LED solutions. The installation was completed without interrupting operations.

One of the sites uses 7.5 km of linear, modular LED lighting combined with sensors, all connected to the cloud via the DALI-based LiveLink light-management system. LED lighting was also installed in the outdoor areas. Judges were particularly impressed by the sophisticated use of data as the basis of predictive maintenance and 'heat mapping' strategies. For predictive maintenance, operational data is collected from each light point in real time, and sent to the cloud via LiveLink. This enables early-stage detection of the need for maintenance, and reduces the risk of expensive downtime.

The 'heat mapping' concept makes use of sensors in the luminaires to determine the paths of people and vehicles in the halls. By identifying hot spots and congestion areas, the facility can be adapted and reconfigured to avoid the risk of accidents, and improve safety for all employees.

The combination of DALI luminaires and controls has reduced the operating costs for lighting and also, therefore, CO2 emissions at both locations. In addition, the lighting systems offer the freedom to easily add innovative IoT applications in the future, with minimal disruption.

https://www.trilux.com

Highly Commended: HELVAR

Oyak-Renault Factory, Turkey

In this car manufacturing plant in Turkey, the transition to LED lighting with a DALI-based, sensor-rich control system was aimed at reducing energy use across this large industrial site.

Judges noted the use of daylight harvesting, time clock use and occupancy sensing to achieve energy savings of approximately 70%.

https://helvar.com

Category: Infrastructure

Winner: DELMATIC

Doha Metro, Qatar

In Qatar, DALI lighting control and monitoring extends across a network of thirty-seven stations on the driverless Doha Metro system. The precise dimming and scene-setting capabilities of DALI enable lighting layouts and scenes to be replicated consistently across the different stations.

Overall, the Metro system uses 133,000 DALI lamps, 500 DALI sensors and 200 DALI switches. IP DALI Broadcast modules provide efficient, addressable control of up to 480 DALI luminaires across twelve channels, without needing to address each fitting individually.

The station architecture takes inspiration from traditional Bedouin tents and reflects Qatar's heritage. The 'vaulted spaces' architecture directs daylight deep into the station's interior, and the DALI systems dynamically adjust the lighting to replicate the effects of daylight in the subterranean areas. DALI sensors adjust lighting levels

according to varying conditions of occupancy and natural light, and the integrated light lines along the station's ceiling and pillars double as wayfinding elements for passengers.

The DALI systems monitor the health and status of the DALI drivers and other devices in real time to enhance the efficiency of the entire lighting installation. The systems also monitor the cumulative run-hour of each DALI lighting channel and generate recommended and proactive relamping schedules to ensure lamps are replaced at the optimum time.

https://www.delmatic.com

Highly Commended: MOSO ELECTRONICS

Guangzhou Metro, China

The West Extension Line 7 of the Guangzhou Metro by MOSO Electronics Corp. was Highly Commended by the judges for its technical merits.

The intelligent DALI lighting system, which contains more than 7,500 DALI LED drivers, is integrated with the KNX building control system. DALI controls the light levels according to passenger flow. The lighting is used to define the public spaces, while also creating a healthier, safer and more comfortable lighting environment.

Judges commented on the energy savings of 30% that were achieved, and the effective use of lighting to guide passengers in the underground areas and on the platforms.

https://www.mosopower.com/en

Category: Residential

Winner: LIGHTING DESIGN INTERNATIONAL

Regent's Crescent, London, UK

Regent's Crescent is a listed building that was redeveloped into 76 luxury contemporary residences with shared amenities, including a business suite, cinema, gym and spa facilities.

The modular, digital, lighting control system, supplied by JUNG, provides precise low-end dimming performance on a range of light sources including constant-current LED downlights, constant-voltage linear LED strips and mains-voltage LED lamps in the decorative lighting.

The DALI lighting control system communicates to the building-wide KNX network via gateways in both the residences and the front-of-house communal areas. The lighting in communal areas features preset lighting scenes which are automatically triggered on an astronomical time clock. A manual override allows adjustment of scenes and dimming levels via a key-operated KNX push-button control plate, located in the reception.

Individually addressable DALI luminaires provide flexible grouping options. DALI supports integration with multiple sensor types including contact switches and IR presence detectors. It has enabled a future proof installation that will allow for later changes or additions without reinstalling cabling.

Judges commented on the very attractive lighting design, and noted the use of DALI for both illumination and emergency lighting, including energy-use monitoring.

https://www.lightingdesignint...com

Highly Commended: MARTIN LIGHTING CONTROLS + INTEGRATION

Karabar Residence, New South Wales, Australia

In a category featuring several high-end, multi-occupancy residences, the judges decided to also recognize a project on a much smaller scale, which seems more like a normal home that most of us could imagine living in. The Judges' Special Mention was awarded to the renovation of a single residence in Karabar, NSW, Australia. DALI was utilized throughout to enable inter-operation between home automation systems, as well as smooth, flicker-free dimming. Intelligent lighting control helps the residents to reach their energy efficiency goals.

From a technical perspective, the judges noted the variety of LED loads, not just downlights but also RGB strips, phase-cut dimmers, and DALI relays to control bathroom extractors and heat lamps. Also noted were the use of sensor-triggered lighting profiles to enhance residents' comfort, wellbeing and security.

https://www.mlci.com.au

Highly Commended: DELMATIC

South Quay Plaza 1, London, UK

South Quay Plaza 1 is one of Europe's tallest residential towers, and the judges recognized the excellent use of DALI, particularly in the shared amenity spaces.

DALI provides accurate, energy-efficient digital dimming and real-time management and monitoring of the entire lighting network, including both illumination and emergency lighting throughout the 68-storey building. DALI sensors maximise energy-efficiency and provide the flexibility to configure and adjust lighting scenes and scenarios.

https://www.delmatic.com

Category: Retail and Hospitality

Winner: INVERSE LIGHTING DESIGN

The Londoner Hotel, London, UK

The Londoner is a new boutique hotel with 16 floors, of which 8 are above and 8 below ground. Over 17,000 DALI luminaires were used to achieve dramatic lighting for the guest-accessible areas, soft lighting for the guest rooms, and functional lighting for the staff areas.

Judges recognized the primacy of lighting design in a unique space with many underground levels, which creates a significant challenge to get the scene-setting correct and achieve a balance between natural and artificial light. The judges were also impressed with the very extensive use of DALI features including color control and white tuning, energy usage reporting, and testing and monitoring of emergency lighting.

A key benefit that DALI provides is the ability to adjust the lumen output of a single luminaire to compensate for lumen depreciation, therefore maintaining a consistent aesthetic. The DALI control system, supplied by Lutron, provides fault reporting, finding and servicing to reduce disruption, as well as energy usage reporting.

Automatic mood setting through the day is achieved without staff intervention by using time-clock events in combination with long fade times. Additionally, white tuning for staff offices mimics daylight and enhances wellbeing and comfort. For the future, DALI provides flexibility to re-zone and adjust the layout with software revisions, without changing the infrastructure.

https://www.inverselighting.co.uk

Highly Commended: MORLIGHTS

Bian, Chicago, IL, USA

Photo: George Lambros Photography

Bian is a wellness, fitness, medical and social space in Chicago, Illinois. Using DALI throughout, the design offers inherent flexibility, enhances the experience of occupants, and offers seamless control of luminaires and multiple lighting scenarios.

The judges commented on the beautiful lighting design enabled by precise DALI control, and in particular the visual continuity and the sophisticated balance of lighting between different spaces with different needs. This creates a truly flexible and comfortable visual environment.

http://www.morlights.com

Category: Outdoor

Winner: SHANGHAI EUCHIPS INDUSTRIAL

Overpass in Xi'an, China

The Outdoor category was won by Chinese manufacturer Shanghai Euchips Co. Ltd. for the overpass lighting scheme in Xi'an, a large city and capital of Shaanxi Province in central China.

A DALI-controlled lighting system, including around 10,000 LED drivers and other components, was installed on the fences and undersides of the bridges.

DALI enables accurate control of the on-off state, brightness and color of the lights according to the flow of traffic at different times, or in response to different seasons and holidays. The energy-efficient lighting scheme creates a colorful lighting atmosphere and a unique night-time scene for the city, while also improving safety for drivers. Judges were impressed by the novel and low-glare lighting scheme to create a more welcoming space in the areas beneath the overpass.

http://www.euchips.com

An Outlook on the Future of LiFi, from the City where the Compact Disc was Born

Prof. Dr. Ir. Jean-Paul LINNARTZ[1,2,email], Research Fellow at Signify and Professor at Eindhoven University of Technology

The radio spectrum is increasingly congested and wireless communication systems are being designed for higher and higher frequencies. To relieve this pressure, communications via light is promoted as a logical step forward. A popular statement [1], is that the visible spectrum of light is a thousand times larger, or even several thousands of times larger than the entire radio spectrum. If that implies that the light spectrum can easily accommodate thousands of times more communication traffic, then we will be relieved of congested connectivity for a very long time.

This outlook, however, points out that some corners have been cut in this reasoning. Nonetheless, steerable LASER beams are a promising and very plausible solution. The CD has learnt that it can become mass-market technology. Jean-Paul Linnartz argues that it is not just a speed race for more bits per second.

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Meanwhile, LEDs are rapidly replacing all other forms of lighting and the light out of LEDs can be modulated. However, this by itself may not mean that with the LEDification of all lighting fixtures, the connectivity congestion is over. A closer look into the proposition shows that any white light source, in particular a white LED, is designed to cover the entire visible light spectrum. In fact, proper lighting quality, say a good color rendering index, requires that the lighting contains all wavelengths of the visible light, even without any modulation. So evidently there is not a necessary one-to-one relation between the bandwidth of the emission spectrum of the light source and the bit rate that a communication system achieves. To complicate matters further, there is a bandwidth of the optical light emission and a bandwidth at which the light can be modulated, i.e., change in amplitude or phase. White LEDs using a phosphor coating on top of a blue LED emit a wide spectrum, but that light cannot be modulated rapidly because the phosphor acts as a low-pass filter that only allows slow variations of the light intensity.

That is, though it can be used for communications, it occupies 1000 times the entire radio spectrum for just one user. That lucky single user is served with bit a rate of somewhere around one hundred megabits per second. As the visible light spectrum ranges from 400–790 THz, thus is about 400 THz wide, the spectrum efficiency is around 0.00001 bit per second per hertz. This is many orders of magnitude worse than can what be achieved via radio communication where typical values of 5 bit/s/Hz are common. Infrared or RGB LEDs can be modulated faster and bit rates above a gigabit per second have been shown, also in commercial LiFi products. LED photonic principles limit modulation speeds and make data rates above a (tens of) gigabit per second less practical. The communications properties of LEDs are becoming better understood [4]. LEDs with higher modulation bandwidths seem to come with lower efficiency which may limit their coverage [5].

From this perspective, the transition towards LASER seems logical: their optical emission spectrum is very thin in the sense that they would not occupy a substantial portion of the infrared light spectrum. For while their intensity can be modulated at a bandwidth that is more than adequate for communications: many gigahertz, it is thus orders of magnitude wider than for LEDs. So, moving from LEDs to LASERS can accelerate LiFi. But bandwidth is not the only factor. Also, the signal strength needs to be adequate. In wireless radio communication, it is commonly known that a certain amount of energy needs to be received to reliably detect a data symbol. So, the required power becomes proportional to the bit rate. If bandwidth is not the limiting factor, then it costs ten times more power to exchange a gigabit per second than to run a link at 100 megabits per second. To keep the power consumption at a reasonably low level, the most efficient approach is to ensure that a sufficiently large portion of the emitted light actually reaches the receiver. Any light emitted in any other direction is just lost and reduces the rate at which the wireless link can operate.

In fact, the power needed to maintain a link is proportional to the size of the area that is covered. Targeting a LASER beam with a spot size with a radius of 3 cm can use 10,000 times less power than an emitter that covers an area with a radius of 3 meters. The advantage of a LASER here is that light comes out as a narrow beam. It has been shown that wireless links with narrow LASER beams carry terabits per seconds.

Figure 1: Signify LiFi unit designed to cover a wide area under the LiFi ceiling access point.

Figure 2: Prof. Jean-Paul Linnartz: "The CD / DVD optical pick-up is great benchmark for the use of steerable lasers in mass market."

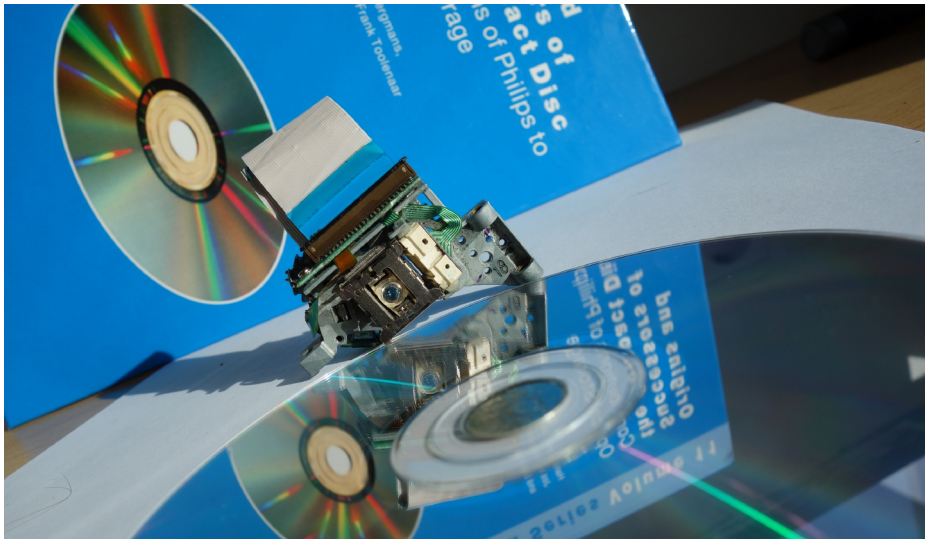

Figure 3: A DVD optical pick-up unit is a compact, cost-effective steerable laser communication system capable of carrying hundreds of Mbit/s. Communication principles were used extensively to design optical recording systems [12,13].

Confining the light into a narrow beam has multiple advantages. It reduces power, allows higher bit rates, it avoids interference to other links, thus cell sizes can become very small **[1,2,3]**, and it makes the link less vulnerable to eavesdropping. However, the beam must actively track client devices if these are mobile. There are ample methods to deflect or to steer the direction of a LASER beam, but the main challenge is to ensure that the beam targets the right position of the client.

Although communication via steerable LASERS is a hot topic of research, few people realize that they already had a steerable LASER beam in their home capable to carry hundreds of megabits per second. It is a component of which hundreds of millions have been produced and was in 75% of all households. In fact, the CD and DVD was pervasive. Although the optical disc technology may be obsolete for listening to music of watching movies, the optics, the tracking control loops have a performance that can be an interesting benchmark for wireless connections. An optical DVD disc spun at 24×, that is, at 24 times the reference speed of 11 Mbps for DVD quality video playback **[12,14]**, reads via a steerable LASER beam bit rates of hundreds of megabits per second. The mechanical strength of the plastic material of the DVD is a main limiting factor.

The mechanisms used for optical discs give valuable insights in where the future of wireless communication can be. There may not be a fundamental reason why a system using a steerable optical beam would be more expensive than a consumer DVD video player that can be produced in mass volume. Interestingly this set the benchmark for modern photonic integration technology to produce solid-state non-moving alternatives to beat the optical pick-up of a disc player in size, cost and performance. The good old CD and DVD technology had more features that may be seen as a reference for photonics technology or the technology of micro-electromechanical systems (MEMS). The steering was effectuated by micromechanics that could follow track deviations up to 130 km/h, still accurately detecting surface features as small a few hundreds of nanometres, that is, with a resolution that in the order of the wavelength of visible light. Such performance is many orders of magnitude beyond the detection of another vehicle or a pedestrian in a LIDAR system for autonomous driving.

Once narrow LASER beams can track a moving target, the communication link can run at formidable speeds. At academic conferences, thought leaders have made

the statements that a LASER beam signalling through the air can carry higher bit rates than a fibre, as the fiber causes dispersion. Only for long haul transmission air turbulence may become a limitation, but these are not seen in normal indoor use. Although the academic world has worked on a speed race to set throughput records, the main challenge remains to get LiFi innovations to the consumer. Office and industry markets may not be in need of getting a bit rate above hundreds of gigabits bits per second.

LASER beams can easily bring the state-of-the-art to a level where four digit megabist per second are easily reached. More than a terabit per second seems to be feasible [6,7] though the main challenges come with the control of the beam direction. One gigabit per second seems to be a psychological threshold for being perceived as up to today's needs. However, that seems to come from the practice in computer systems that compensate a lack of quality or service guarantees via a huge over- provisioning; hoping that a system that is designed for a maximum of 1 gigabit per second can deliver more than 10 megabits per second in 99.9% of the time. Regrettably, as we experience daily in radio systems, that may be an illusion similar to buying a faster car to make your way through a congested city during the morning traffic rush. So, LASERS can increase the bit rate of LiFi systems in two ways: firstly, their bandwidth for modulation is wide and secondly because a narrow beam can ensure that the wireless client device receives enough signal power. These jointly pave the way to link of tens, hundreds of gigabits per second or even more.

Such links have been studied for outdoor urban communication networks [9,10] between buildings or street poles, where fog, aerosols, and pole sway can deteriorate the reception under certain weather conditions. Yet, in short-range indoor office or industry applications, the main challenge is how to steer the beam. CD, DVD and blu-ray technology showed that lenses driven by tiny motors can be highly reliable and can be very cost effective [12]. A challenge is to find the direction towards the mobile client device and vice versa. Only if the two beams, forward and return, meet each other, can a link be established. That would require a four-dimensional search: Not only the forward beam from the ceiling needs to scan in x-y direction, but also the upward beam from the client needs to scan.

There are many principles to actuate the direction of a beam [7,11]. Yet, a main challenge is to maintain the right direction even for a client device in motion. Preferably a feedback control loop a bidirectional link automatically finds, adapts and tracks the beam direction. Here, we learn from compact disc principles that an optical system with a semi-transparent mirror can reduce this search complexity to a manageable dimensionality. The outgoing LASER beam passes through the mirror straight-on and is then adaptively deflected by a mechanical steering actuator towards its target. The main element is that the incoming return channel follows exactly the same path, but in reverse direction. So, it first hits the steering mechanism, then falls on the semi-transparent mirror, perfectly aligned with the direction of the outgoing beam, where it is reflected onto a receiving photo diode. This photodiode, particularly if it is devised as a quad cell, can measure minute deviations of the incoming beam direction. These deviations are used to control steering actuator to optimize the incoming beam. Implicitly it then also aligns the outgoing beam, and keeps the bi-directional link aligned.

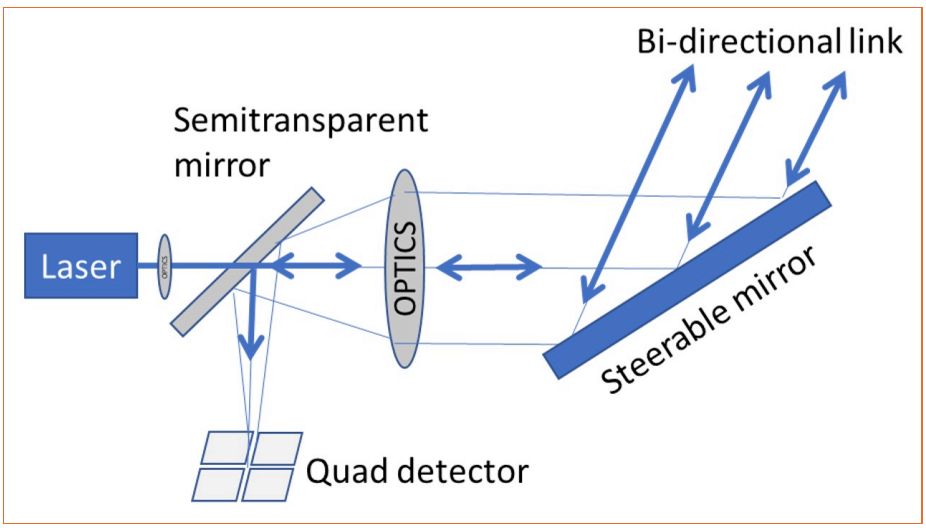

Figure 4: CD-inspired communication system with steerable laser [6].

It is fair to expect that a revitalization of concepts conceived for optical discs can further enhance LiFi speeds. Steerable LASERS sound futuristic, but essentially it is technology of the eighties that already found its way into our houses and was carrying the equivalent of 48 simultaneous video streams. Nowadays, photonic technology has the promise to miniaturize it further. ■

Theoretical Backgrounds

The throughput, the number of bit per second, that a communication system can achieve depends on the bandwidth B_w and on the signal-to-noise ratio SNR, i.e., on the received power P_R and the noise spectral power density N_0. A commonly used expression is:

$$R = B_w \log_2\left(1 + \frac{P_R}{\Gamma N_0 B_w}\right) \qquad (1)$$

This expression may not capture all aspects of optical intensity modulation and the community of information theory experts would challenge whether it should be used here. Nonetheless, the expression can be derived as the throughout that an appropriate modulation method achieves over an optical link, where the parameter Γ is determined by the tolerated bit error rate [15]. it shows the trends in the improving the modulation bandwidth B_w of the optical emitter from that of LEDs to LASERS. Increasing the signal power only gives a logarithmic increase, while the effect of increasing the bandwidth is much more effective.

In particular, we use such an expression for the end-to-end electrical channel, where B_w is the baseband bandwidth at which the LED or LASER can be modulated. A DC-bias can be accommodated as an efficiency penalty in Γ. For infinite bandwidth, this bit rate R converges to a limit:

$$\lim_{B_w \to \infty} R = \frac{P_R}{\ln 2 N_0 \Gamma} \qquad (2)$$

Thus, to reach very large bit rates, it is not sufficient to have a large bandwidth. It is also essential to receive enough signal power. A certain amount of energy per bit is needed to distinguish the signal from noise. To some extent that resembles the notion of requiring a certain minimum number of photons per bit, as we know from optical fibers, although very different error and noise mechanisms apply for LiFi systems.

LEDs have a broad emission even without any modulation. LASERS emit a narrow optical wavelength spectrum, but modulation may widen it to accommodate rapid variations in amplitude. To reach multiple users in the same room, the directionality of the LASER beam may already provide enough signal separation to avoid a need for using multiple wavelengths.

	LEDS	LASERS
Wavelenth Emission Bandwidth	Very wide	Narrow
Modulation Bandwidth	Tens or hundreds of MHz	Many GHz
Bit Rates in Typical Systems	Typically, hundreds of Mbit/s up a few Gbit/s	Tens or hundreds of Gbit/s

Jean-Paul LINNARTZ, Prof. Dr. Ir.
Jean-Paul Linnartz is a Research Fellow at Signify and a Professor at Eindhoven University of Technology in the Netherlands. His research addresses intelligent lighting systems and optical wireless communication (LiFi). Previously, with TU Delft and the University of California at Berkeley, he worked on wireless radio communication (he introduced MC-CDMA). As principal scientist and later as senior director at Philips Research, he worked on electronic watermarking and on anonymous biometrics. His work is cited over 12,000 times (GS) and led to more than 75 granted patents, some of which are the basis for three ventures. He is a Fellow of the IEEE for leadership in security with noisy data and these ideas secure more than 300 Million IoT devices.

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The Invisible Light Revolution

Paul BLANC, Sales Director at Bolb

This article provides an overview of the most important parameters to consider when discussing UVC LEDs as well as background on the main disinfection applications of this technology. It is not intended as a scientific review of UVC LEDs. If you are looking for detailed technical information, then webinars, articles, and white papers from experts such as Mike Krames (Arkesso LLC.), or Ling Zhou and Jianping Zhang (Bolb Inc.) [1], or articles previously published in LED professional Review or on the LED professional website (https://www.led-professional.com/) are a good place to start.

"The COVID pandemic has awakened the world to the need for safe, effective, on-demand, point-of-use germicidal/virucidal solutions that do not involve poisonous chemicals that also cause logistical burdens. Bolb's UVC-LEDs as well as reference designs are tested and certified and demonstrate technology's scalability for air disinfection from large rooms to automotive cabins."

JERRY ZHANG, CTO BOLB

If you are a reader of LpR, there is a good chance that you witnessed the rise of visible light LEDs in the early 2000s. And if not, when was the last time you did not use LEDs in your lighting projects? Who would have imagined that this comparatively expensive and inefficient electronic component would replace proven, efficient, and cheaper conventional light sources? LEDs are now predominant in many applications: from TV backlighting, street lighting, and automotive lighting to entertainment and stadium lighting, commercial and residential lighting, to horticulture – the list is long. 20 years later, new developments in UVC LEDs are now showing very promising results. Yet conventional light sources like mercury lamps are still far ahead in terms of performance. Do you have a strong feeling of "déjà-vu"? This time though, the situation is different.

The LEDification of the visible lighting market has put LEDs in the spotlight. More importantly, the global pandemic over the last two years has shown the urgent need for innovative and environmentally friendly technologies that can make the world a safer and healthier place. Thanks to their compact dimensions, UVC LEDs are now paving the way for new designs. These LEDs offer optimal beam control thanks to optics and reflectors that improve how radiated energy is focused. They do not contain mercury or generate ozone. They start instantly and do not have a warm-up phase, making them ideal for applications with high switching cycles. And finally, UVC LEDs are not made of glass. This makes them more resistant to impact and vibrations, eliminating the risk of mercury leakage that can occur when conventional lamps break.

The Main Parameters When Discussing UVC LEDs

What are the most important criteria when starting a UVC project? Specific requirements will vary depending on the application, but there are some general parameters that always apply.

The first parameter is wavelength. UV light is in the 100–380 nm range of the spectrum. The main types of UV light are UVA (320–400 nm), UVB (280–320 nm), and UVC (200–280 nm). The UVC region is the most important for disinfection as it offers the highest ultraviolet germicidal effect. Mercury lamps have a peak wavelength at 254 nm – that's it. LEDs, on the other hand, can be produced with specific wavelengths, for example 275 nm, or 265 nm. LEDs in the 260–270 nm range offer the highest rate of disinfection. Germicidal effectiveness in individual cases will vary, however, depending on the target medium, surface, and microorganisms.

The next parameter is the Wall Plug Efficiency (WPE) of the light source, also known as Power Conversion Efficiency (PCE). The WPE or PCE is the ratio between the optical power and the electrical power of the emitter. Currently, UVC LEDs typically deliver 260–280 nm with efficiencies ranging from ~ 1% to ~ 10%.

Optical output is another essential factor. It is not quantified in lumen like conventional LEDs but in milliwatts or watts. Manufacturers will normally specify the output at the typical driving current and forward voltage. To increase the optical output of an LED, you can simply increase the driving current.

LEDs can also be easily collimated using optics or reflectors. However, not every material is compatible with UVC light. For example, standard glass can block UVC rays and standard optics degrade when they are exposed to UVC light. That's why optics made of quartz glass or silicone are recommended.

The next point to consider is lifetime. The lifetime of LEDs can be at least 50% shorter than that of standard linear light sources. This strongly depends on the conditions in which the LEDs are used.

- LEDs are driven at the typical current, and if the driving current is reduced or increased, the lifetime will increase or decrease. The following formula can be used to calculate the lifetime based on the driving current: the lifetime is ex-

tended or shortened by the inverse of the current ratio to the power of 1.5.
- Temperature also has an important influence on lifetime and optical output. Exceeding the ambient, solder, or junction temperature recommended by the manufacturer will have a negative impact on the lifetime of an LED. UVC LEDs must be properly cooled to avoid accelerated optical power and loss of lifetime. The use of an appropriate combination of cooling solutions, for example metal core PCBs, thermal pastes, heat sinks, or heat pipes and fans, is prerequisite, particularly in applications where significant optical power is required and where the LED density is high.

Exposure to UVC light is also an important aspect. UVC light can be harmful to living organisms and can damage DNA and RNA. Depending on the irradiance and on a person's skin type, for example, exposure lasting just a few hours can already irritate the skin and eyes, with long-term exposure increasing the risk of cancer. It is therefore essential that users are not exposed to UVC light for long periods of time. The fact that UVC light cannot be seen (or in some cases only as a dim purple light) makes it even more important to ensure that UVC-based systems are safe for the people who use them.

So how can you make sure that UVC systems are safe? Here are some recommendations:

- Install LEDs in an enclosure to avoid leakage of light.
- If LEDs are not placed in an enclosure, users of UVC light technology must wear appropriate personal protection equipment.
- Use smart solutions such as sensors, control timers, and connectivity to limit exposure.
- Place appropriate warnings on the packaging and device.
- Educate and train users.

No matter what wavelength of UVC radiation is used, the safety of the LED system is paramount.

Last but not least, it is essential to look at the UVC dose that is required. The dose depends on the type of microorganism that you want to target (several studies include UVC radiation tables), and on the type of application. Is the target medium a surface, an object, or a fluid? What are the characteristics? What is the distance to the target? How quickly should disinfection be completed?

UVC Disinfection Applications

Water Disinfection

There are two main areas where UVC light can be used to disinfect water: at Point of Use (PoU) and at Point of Entry (PoE). Compared to chemical options, UVC disinfection does not alter the taste, temperature, or pH of water.

PoU was one of the first applications for UVC LEDs. Thanks to the compact dimensions of LEDs, companies can develop single LED disinfection systems for water faucets, fountains, and water bottles where conventional light sources cannot be used. Moreover, most of these systems only run for a few hours a day at most, which is ideal given the current limitations on the lifetime of UVC LEDs. These kinds of solutions can be found in laboratories that produce ultra-pure water, in homes, and in mobile water disinfection systems. PoU systems that use LEDs also help to reduce the use of plastic bottles and improve access to safe drinking water.

Figure 2: Water faucet (PoU) disinfection.

PoE is a much more demanding application, primarily due to the high flow of water and use around the clock. Nevertheless, early adopter companies have already begun installing high-flow water disinfection reactors. These systems can be found for example in municipal water treatment plants, swimming pools, fish farming, ballast water treatment systems on ships, and in many industrial applications. The main motivation here is to avoid the use of mercury and replace fragile glass arches with robust solid state semiconductors. And as the lifetime of these reactors can be up to 20 years, intelligent retrofit solutions can be developed in the meantime to easily upgrade the system with the latest generation of UVC LEDs during recurring maintenance.

An example of water faucet (PoU) disinfection is shown in **Figure 2**. The device is mounted directly at the outlet of the water faucet. It is equipped with one LED with 100 mW (typical) optical power. Water flow rates of 1.5 to 5 L/min were tested with this device, achieving a kill rate against E. coli > of 99.999%.

Air Disinfection

As airborne virions play a dominant role in the rapid spread of the COVID-19 virus and all its mutations, air disinfection using UVC light has a significant impact in preventing transmission. New legislation is already encouraging schools to install air disinfection systems in classrooms. Organizations are using this technology to make offices a safe place for their employees. And public transportation operators are looking at new ways to offer a safer travelling ex-

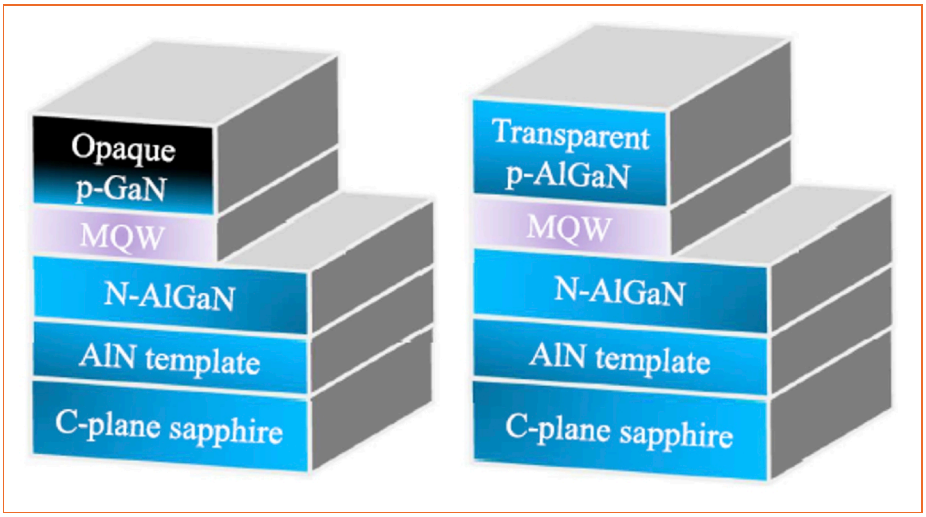

Figure 1: The difficulty for UV-C LEDs is the requirement of a high UVC transparency and an efficient hole injector layer: The traditional design is based on a non-transparent p-layer with a poor $\eta_{ext} < 6\%$ (left). The Bolb epi consists of a transparent p-layer and an efficient hole injector resulting in a higher efficiency of η_{ext}14% now, and η_{ext}75% in the near future (right).

perience to commuters. Air disinfection devices already come in many forms, for example mobile units, air troffers, air ducts, and upper air disinfection solutions. With UVC LEDs, new, innovative solutions for clean and healthy air are possible, from retrofitting of existing systems to development of completely new applications.

Figure 3: Testing of a 3,000 LPM air disinfector at the Guang Zhou Institute of Microbiology, achieving a 99.96% single pass kill rate against aerosolized staph aureus.

The "single pass kill rate", in other words the amount or percentage of virus that will be killed in one pass through a disinfection device has always been considered a key parameter. With LEDs, increasing the air flow rate of a device makes it even more efficient. And this can be done quickly and cost-effectively. LED systems have been developed that can disinfect an air flow of 10,000 liters per minute and achieve a 99.96% kill rate in a single pass against aerosolized Staphylococcus aureus. This is with just one 25-LED module with 2.5 W of optical power.

Surface Disinfection

Surface disinfection is a simple way to disinfect objects and surfaces that need to be kept free of viruses, bacteria, or mold. This can be useful in hospitals, for medical equipment, in forensics, and where objects are regularly touched by different persons, for example door handles, handrails, ATMs, restaurant menus, etc. At the same time, system designers must take care here to ensure safety because this is where users face the highest risk of exposure to UVC radiation. **Figure 4** shows a disinfection chamber for masks with a four-LED module (0.4 W of optical power) that achieves a 99.9996% kill rate against SARS-CoV-2.

Figure 4: Disinfection chamber for masks.

Food Disinfection

Although it is essentially a combination of water and surface disinfection, food disinfection is worth mentioning separately, as food loss due to bacteria or fungus can be crucial. In addition, food poisoning is a well-known risk for end users, as we hear increasingly so about recalled salad, vegetables and meat after treatment with unsafe and contaminated water in the process.

From seeds, to plants, to fruit and vegetables, as well as in livestock breeding, UVC LEDs can be used in many applications. They can also be put to good use in disinfecting farms, greenhouses, vertical farms, food processing factories, and kitchens, as well as in food transport, storage, and retail.

Not only do they help to prevent food waste, UVC LEDs can also significantly reduce the use of pesticides, chemicals, and antibiotics in the farming industry.

"We are proud and glad at the same time that our UVC LEDs are the critical building blocks for such timely applications to provide clean and safe air for healthcare workers, patients, operators of restaurants, retail stores, office buildings, automotive and public transportation."

DR. LING ZHOU, CEO OF BOLB

Summary

The COVID-19 pandemic is demanding urgently for new, innovative solutions to make the world a safer and healthier place. UVC LEDs may need further innovation before they can fully replace conventional UVC light sources, however, they are already on the right road to achieving a success story similar to that of visible LEDs. Not only are they environmentally friendly, UVC LEDs also enable new designs thanks to their compact dimensions. The lessons learned from the last two decades and recent technical breakthroughs in the field of UVC LEDs show that they have the potential to surpass the performance of mercury lamps in the next five to ten years. Some high WPE UVC LEDs from existing suppliers enable already today a more efficient disinfection in air purifiers due to their significant higher surface brightness (etendue). What's more, as the evolution of UVC LEDs continues, new applications are set to emerge too. It's time to join the invisible light revolution! ■

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Bolb, Inc. was founded in 2014 and is based in Livermore, California. Bolb, Inc. has developed and patented breakthrough UVC LED technologies to enable 'never before possible' disinfection systems for air, water, surfaces, and food to scale on a global basis to benefit human health and increase productivity in key verticals with the objective to preserve valuable resources.

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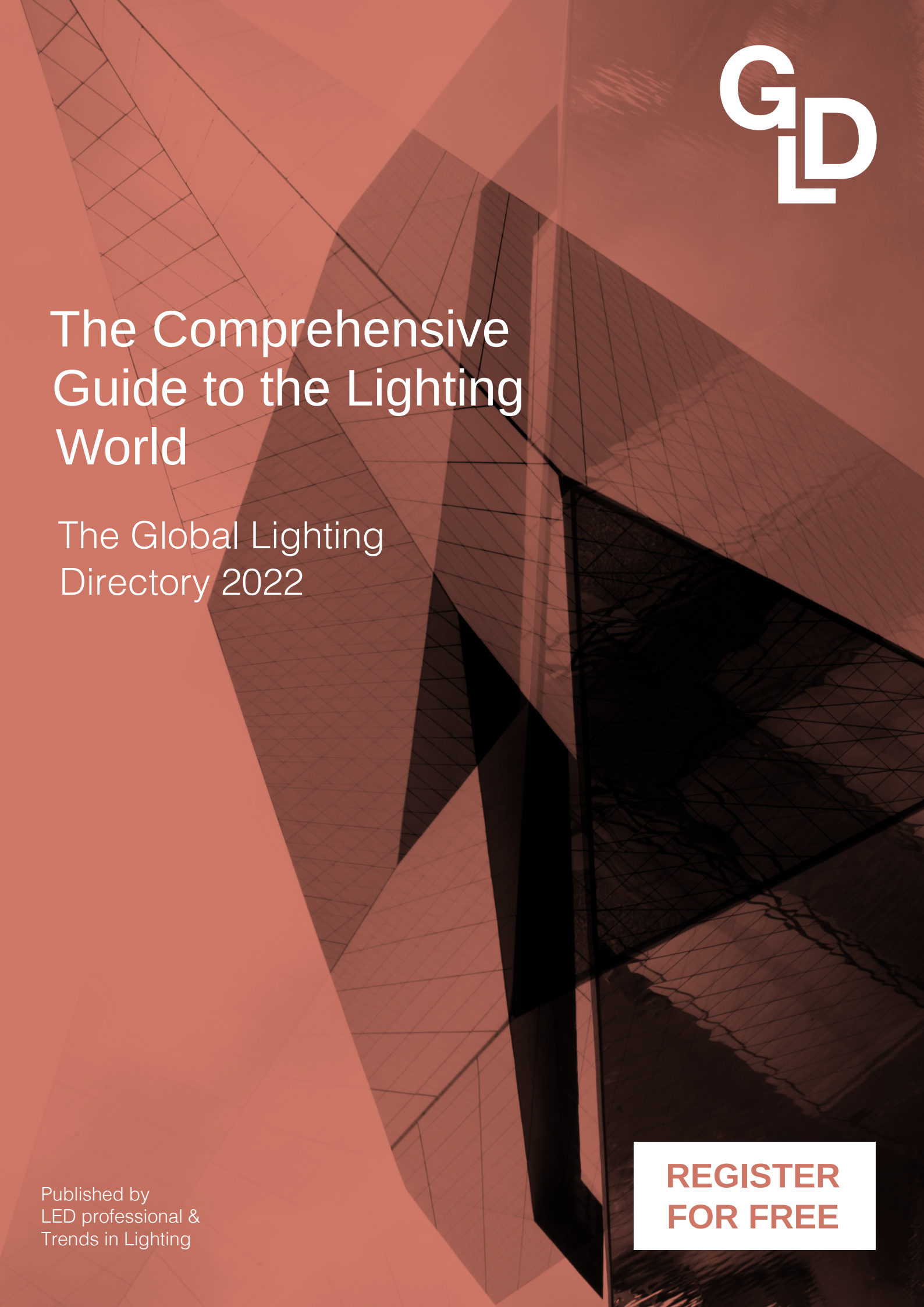
[1] https://bolb.co/



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Durability Enhancement of Formable Reflectors for UV–Sterilization

Tobias TITZ, Dr., Project Manager R&D, Alanod

Surface and material sterilization by using UV light as an intensive source to neutralize many different bacteria and viruses has become more and more visible to the public over the past few years. In many applications, three dimensional parts are disinfected by using UV light sources, such as 254 nm and 365 nm LEDs lamps, in combination with reflector material to fully illuminate all surfaces of the parts. The reflector material, based on formable aluminum sheets, efficiently reflects and directs the UV photons to all exposed surfaces. This article explains the need for efficiency and longevity for reflectors in UV sterilization solutions and the process of durability enhancement for reflector performance.

This world is currently undergoing drastic changes due to the coronavirus pandemic. Also, technological advances are being realized more and more quickly, to keep up with the huge daily challenges being faced across the globe. UV light applications, for a long time mainly known only in the field of sun tanning, radiation curing of inks and lacquers or medical applications, are now becoming popular in the field of disinfection. UV sterilization is in fact one of the most effective, reliable and environmentally friendly ways to disinfect air, water, surfaces and three-dimensional objects without using aggressive, non-healthy chemicals or high temperatures.

However, the effectiveness of disinfection solutions depends on a very high degree of dissemination as well as on efficiency and durability. If UV sterilization equipment manufacturers are to stay ahead of the game, then it is important that they create solutions that are both cost-effective and optimized for different applications.

UV disinfection requires light sources which are highly effective at wavelengths between 250 nm and 380 nm. This is because UV-C radiation, which is emitted between 250 nm and 280 nm, shows strong germicidial effects within these ranges. Microorganisms such as viruses, bacteria, yeasts and fungi are rendered harmless in seconds by suitable UV radiation. The mechanism is, that UV photons are absorbed by chemical bonds within the DNA/RNA and destroy their DNA/RNA structure permanently. As a result, replication of the microorganism is not possible any more. Furthermore, microorganisms cannot develop resistance to UV radiation.

Today's wide availability of UV LEDs allows designers to take advantage of the full range of possibilities for UV sterilization solutions. The high power efficiency of LED's, in combination with their fast on/off switching capabilities, the ozone-free nature of UV light generation for wavelengths greater than 240 nm and the beam shaping potential of reflectors (**Figure 1**) allows for many optimized designs to be developed. However, the lining of the disinfection chambers is crucial for their overall efficiency, because not every UV photon directly hits the desired target. With cost efficient UV light reflectors enormous possibilities are offered to increase the overall efficiency of disinfection of surfaces and three-dimensional objects.

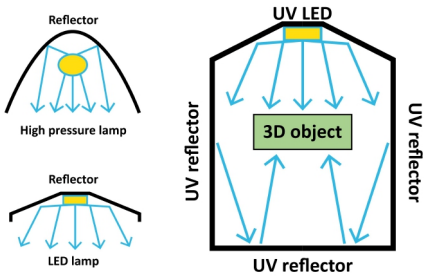

Figure 1: Beam shaping with reflector (left) and UV reflectors for chamber walls (right).

Traditional UV mercury lamps emit light in all room directions and therefore need reflectors for beam shaping to direct the light to the objects. The advantage of LED's is that they have a highly directional light output. However, all the UV light that misses the targeted object in a disinfection chamber (**Figure 2**) should be efficiently reflected by the chamber walls, to further disinfect the item's opposite side and increase the total disinfection efficiency for all surface areas of the three-dimensional objects.

Metal reflectors are the best material for use to increase the lifetime of chamber walls. This is because the most cost sensitive polymer surfaces are not stable against intensive UV light, due to their high UV light absorption in connection with the breaking of chemical bonds within the polymer molecules.

When using a metallic reflector, aluminum sheet has many advantages. As a construction element it creates both a reflector and chamber wall. It is also lightweight, cost-effective, easy to form and fully recyclable. The most important fact is, that aluminum has the highest reflectance values for UV wavelength for all metals. Its reflectance is, for example, up to 4 times higher than that of polished stainless steel.

However, aluminum surfaces without any protective coating are very scratch sensitive and can corrode easily. This makes the mechanical cleaning of these uncoated surfaces impossible, and another approach is needed to expand the lifetime of the material.

For over 25 years, Alanod [1] has been dedicated to producing large area coatings for aluminum strip for lighting reflectors (these are the visible light reflectors used for office, industrial, solar and LED applications) on coil-to-coil coatings lines (**Figure 3**). The process has been fine-tuned over the years to deliver high quality levels and cost competitive production costs, compared to batch coaters.

Alanod's newly designed MIRO® UV products offer several benefits for UV light reflectors. During the first production stage, the aluminum substrate is anodized to

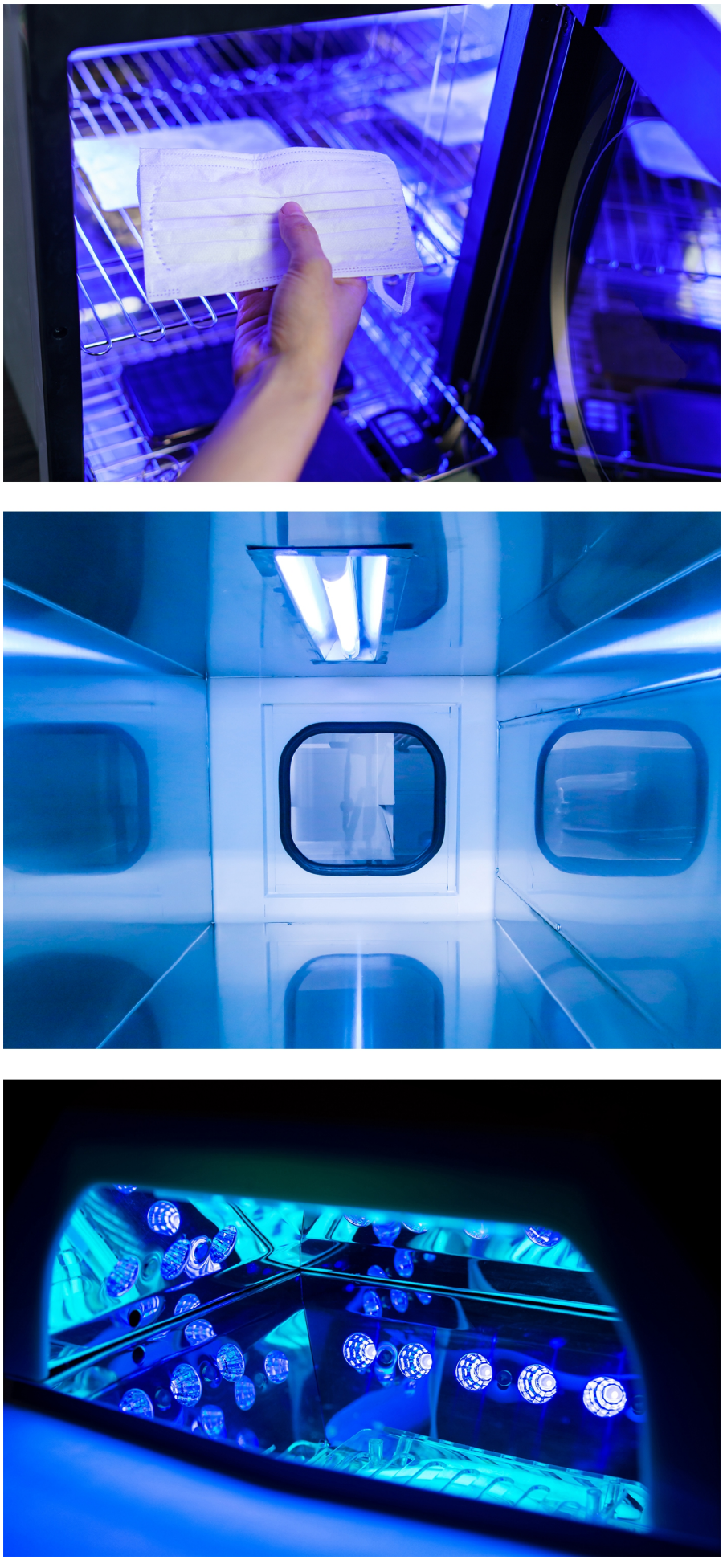

Figure 2: Examples of a range of UV disinfection chambers.

increase its surface hardness and subsequent scratch resistance. The process also delivers corrosion protection. This anodized aluminum is then coated with a high purity aluminum layer to ensure it is a highly effective UV reflective material and an additional dielectric silicon oxide layer is also added. This layer protects the high purity aluminum, and it is included as part of an interference coating system for UV light scattering, to maximize the reflectivity of specific wavelength ranges.

By finetuning the thickness of the dielectric layer, the maximum reflectance of 90% can be adjusted for either the UV-C or for the UV-A/B wavelength range (**Figure 4**). An additional advantage is that it also means that UV reflectance is maximized for all angles of incidence.

The disinfection efficiency of a sterilization chamber is maximized by using the correct combination of light sources and reflector. It is fundamental to choose the material with highest reflectivity if multiple reflections occur inside the chamber. This is to maximize the potential of UV photons hitting the flat or three-dimensional object which is being disinfected.

Durability

As disinfection of surfaces is an important topic due to the coronavirus pandemic, many new manufacturers are entering the market with different UV light sources (LED types and number of LEDs) and chamber designs for their disinfection applications. But they must overcome the same challenge: the durability of the UV reflector material. This is because the stability of the reflectance properties is directly connected with the lifetime of the complete device.

For a manufacturer of flat reflector material, it is not possible to predict the lifetime in all the individual designs of customer products, due to the bending, forming or stamping they might undergo. However, it is possible to understand reflectance change and the failure mechanism of reflector materials through intensive lab tests. At Alanod development material has been exposed to intensive UV radiation at elevated temperatures. Degradation was identified by a visible colour change of the surface and the reflectance loss was confirmed by measurement with an UV-VIS photo spectrometer from Perkin Elmer (**Figure 5**). The loss in reflectance was more than 10% and it was concluded that this would continue to increase if the test time were extended.

Further analysis of layer thicknesses and composition showed that the silicon oxide layer was unchanged. However, the high purity aluminum of the reflective layer was partially oxidized and had formed an intermix layer of oxidized aluminum at the interface to the silicon dioxide layer. This intermix layer was absorbing parts of the UV light, which explained the loss in reflectance. It also contributed to the light scattering of the interference layer system, and the interference condition for maximum reflectance at specific wavelengths no longer existed.

This sample analysis showed that the degradation of the reflector material was influenced by a mixture of light intensity, the wavelength of the light source, exposure time, the temperature of the reflector and the gas atmosphere with humidity and oxidizing or reducing elements or compounds (e.g. O^-, OH^-, H_2S, etc.). It also raised an important question: how were the examined development samples originally produced and how did this impact the protective properties of the silicon oxide layer?

The deposition of the SiO_2 layer was done by high-rate electron beam evaporation. This involved the melting and evaporation of SiO_2 in a vacuum and by condensation of the molecules on the surface of the sample. Due to this condensation process, the structure of the layers showed some columnar growth, with a porous structure. Along with these defects or columnar boundaries, water, oxygen or other oxidizing media had diffused to the aluminum/SiO_2 interface and formed a thin intermix layer at the aluminum interface. If the sample were to be exposed to further UV radiation, the oxidation process would continue into the depth of the aluminum reflective layer, so that parts of the aluminum would be further transformed into an intermix layer, mainly formed as aluminum oxide.

This transformation process, which would continue from the interface into the aluminum layer, would depend on the intensity and energy of the UV light and the temperature of the reflector. Diffusion processes and chemical reactions correlate with temperature, so that acceleration of the material aging increases if temperature of the sample reflector material is increased. With this in mind, by increasing the sample temperature in lab tests, the ageing of layers can be accelerated.

Extending Durability

The protective properties of the SiO_2 layer have a strong influence on the durability of the aluminum's reflectance properties. More precisely, the porosity, or defect structure, of the protective coating correlates with corrosion resistance.

Based on this consideration, the protective SiO_2 layer should therefore be a very dense or defect-free coating, to stop or slow down the ageing reaction kinetics. This is possible by introducing an alternative coating method. For stationary lab coaters, different deposition methods exist. However, for industrial large area roll-to-

Figure 3: Roll-to-roll coating line with in-vacuum deposited large area coatings for high quality and cost-efficient metal reflectors.

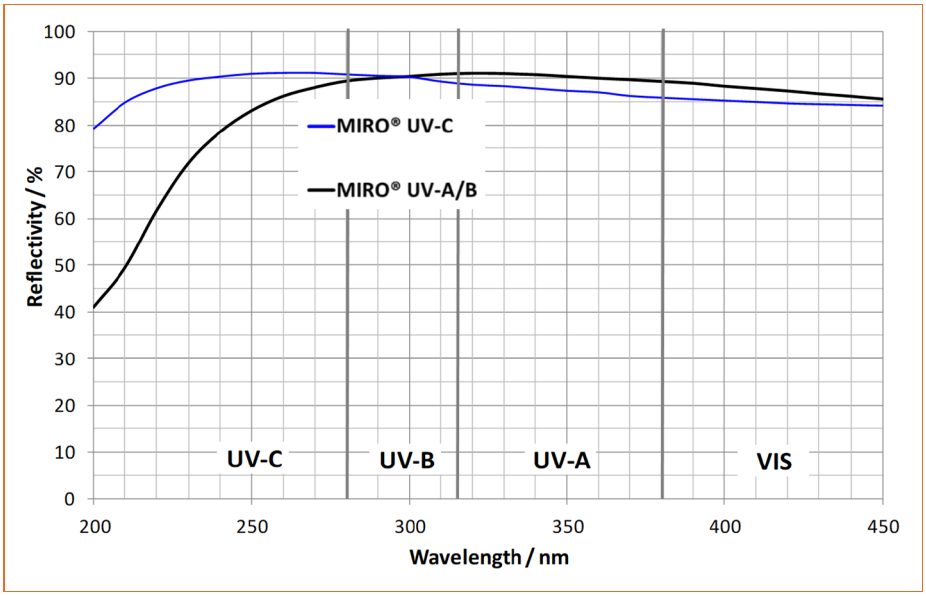

Figure 4: Reflectivity of MIRO® UV products optimized for different wavelength regions.

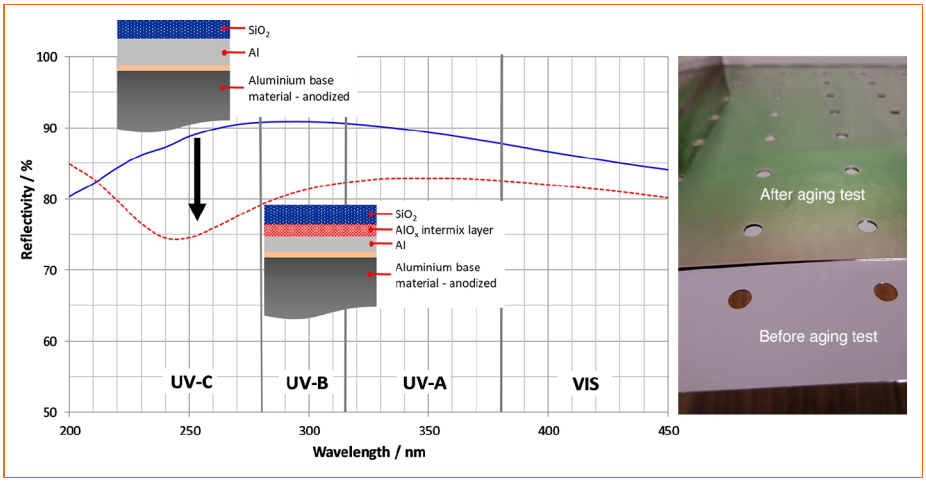

Figure 5: Reflectance measurement of degraded samples (left) and photography of visible colour change of degraded samples after test (right).

roll coating lines, the benefits of high rate, ecologically friendly and low cost limits the selection. With plasma enhanced chemical vapour deposition (PE-CVD), it is possible to deposit very dense SiO_2 coatings but still have high deposition rates for cost-effective production of the reflector material. The ecological use of very little chemistry as a precursor (a few g/m^2), in combination with the aluminum in the layer, as well as the substrate, provides a reflector that is fully recyclable. This is because it consists of > 99.5% aluminum and silicon. In addition, only very little concentrations of water, oxygen and carbon dioxide are produced during the coating process.

Following detailed testing and development, Alanod's MIRO® UV-C and MIRO® UV-A/B have been produced by using PE-CVD for the dense SiO_2 layer. They have displayed superior performance in all comparison tests with those aluminum sheets that have electron beam evaporated SiO_2 coatings. In fact, tests based on constant temperatures, constant humidity and humidity condensation were without change in the reflectance for at least 1000 hours.

As we have seen, the ageing of samples can be accelerated by using elevated temperatures over-and-above typical application-specific operating temperatures. In high intensity UV radiation tests (**Figure 6**) the MIRO® UV-C sample underwent an additional heating stage to raise its temperature up to 150 °C, which is typically 70–100 °C higher than operation temperatures of the reflecting chamber walls. The UV-A/B intensity, measured at the sample surface, was >60 mW/cm^2 and >6 mW/cm^2 for UV-C intensity. After 3000 hours test time, the reflectance change in the UV-A/B or UV-C range was below 1% (**Figure 7**). Based on the elevated test temperature of 150 °C and therefore assuming an acceleration factor of 10, the lifetime of the reflector material could be extrapolated to more than 30 thousand hours before significant changes in reflectance are expected. Prediction of lifetime can be different however in alternative set-ups, due to the unlimited freedom of design configurations and environmental atmosphere differences already mentioned.

In a world with many new applications in the field of surface and 3D object disinfection and increasing LED lifetimes, highly reflective, longer lasting metallic UV reflectors based on aluminum are the first choice for manufacturers wanting to develop cost-effective products. New markets, as well as new coating technologies, go hand in hand when looking to leverage the synergies of cost and maximum performance.

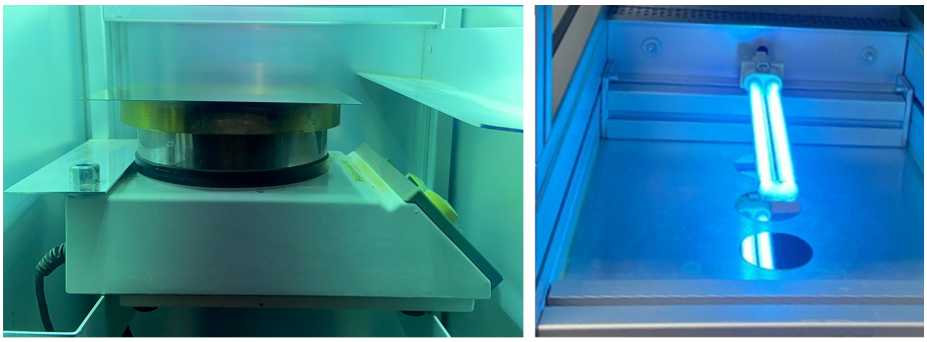

Figure 6: Test set-up for intense UV-A/B radiation (left) with sample heater and intense UV-C radiation (right).

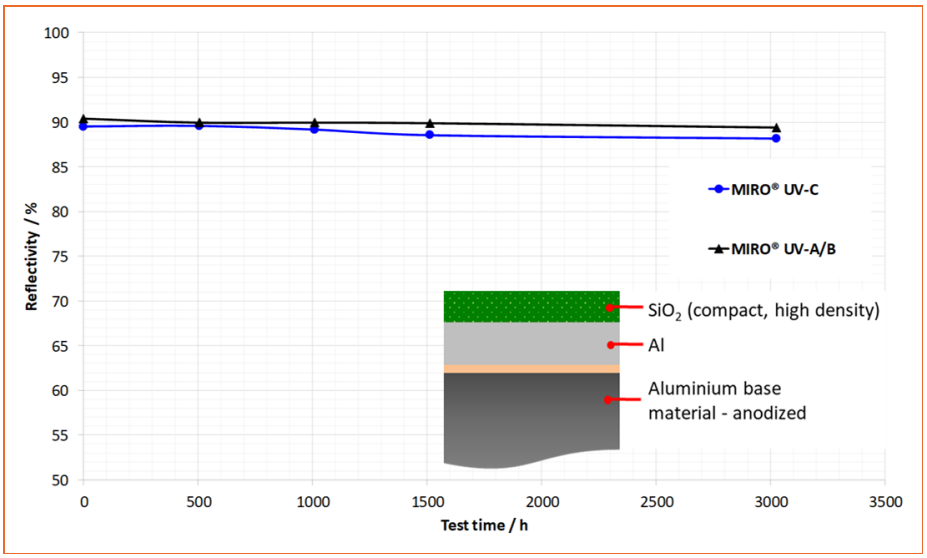

Figure 7: No change of UV reflectivity after up to 3000 hrs test time for intense UV radiation at 150 °C sample temperature.

Author: Tobias TITZ, Dr.
Dr. Tobias Titz has been working in the area of R&D at Alanod for more than 14 years, being responsible for the area of lighting, electronics and solar applications with a strong focus on material science, optics, coatings (PVD, lacquer, anodizing), corrosion protection and simulation for different applications. He studied physics at the technical university in Munich, Germany, and received his Ph.D. for "Corrosion resistance and formability of ultra-thin plasma polymer films on galvanised steel" at the Max-Planck-Institut for Iron Research in Düsseldorf, Germany.

About ALANOD:
Alanod is a specialist in the creation of functional and decorative surface coatings on various strip metals, such as aluminum, copper, steel and stainless steel. The company combines various coil-to-coil technologies: from anodizing to PVD coating to individually developed lacquer systems, offering a full range of process technologies from one single source.

Alanod produces on a large industrial scale for a wide variety of sectors. Their high-quality products, which are produced in Ennepetal, Germany, are used internationally in the lighting, solar, automotive and electronics industries. In addition, the company provides surfaces for facades, ceilings, furniture laminates and household appliances.

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[1] https://alanod.com

Presence Sensors for Warehouse Lighting Control – Radar vs PIR

Victor VERBOVSKY, CEO of Intelar

Nowadays, warehouses are the most income-generating and high-growth segment of the commercial real estate market. We have a lot of experience in lighting system automation of various-purpose buildings and can say that warehouses are economically, the most effective automation objects.

Sometimes it is difficult to believe that the installation of presence sensors can result in 70–80 % energy savings of warehouse lighting, but this is easy to calculate. For instance, in a 24 hour warehouse with a forklift that comes into a particular warehouse aisle every seven minutes and operates there for one minute, only uses the lighting in this aisle for three hours a day (12.5%). It could be either turned off or its power could have an automatic 12-to-14-fold decrease by applying a dimming function, during the other 21 hours.

If you just replace gas discharge lamps with LED lamps to upgrade the warehouse lighting you will get a significant economic impact that will be scaled down due to the raising of electricity tariffs. Permanent operation of lamps causes degradation of LEDs due to the heat, and in several years their flux decreases by 30 percent and more, and, therefore, one should be ready to replace the lamps.

Using the principle of "Light on demand" both reduces energy consumption dramatically and increases lifetime of lamps, since in the case of moderate traffic intensity in an aisle, LED arrays of the lamps will not heat up to high temperatures and, therefore, no distinct degradation will occur.

Warehouse Application Features of Passive Infra-Red Presence Sensors (PIR Sensors)

Regardless of the wide use of PIR sensors in warehouse lighting control systems, many experts, including this author, think that these sensors are ill-suited for solving the problem [1]. Why?

1. One of the chief disadvantages of PIR sensors lies in the exact motion detection principle – the sensors do not respond to motion as it is but to a temperature difference between a moving object and the environment. Therefore, if an electric forklift is cold and the operator's compartment is covered with polycarbonate or the operator wears warm work clothes, PIR sensors often miss such motion.
2. The second disadvantage is directly related to the first one. If your warehouse is located in a warm or hot region, in summer, when the air inside the warehouse heats up to 30 °C and above, the sensors stop detecting motion because the required temperature difference between a human being and the background is not there. In this case, one should take into consideration when calculating project payback that the lighting will be on permanently for two or three months during the summer in the facility.
3. During installation of PIR sensors, one should also keep in mind that false operation will occur if warm or cold air flows from air conditioning systems are in their sensitivity area.
4. PIR sensors are good in detecting a person moving across their beams but perform poorly when trying to detect a person moving along the beams, i.e. in the direction of motion towards or from a sensor. Unfortunately, this is the way a person moves in a warehouse aisle! In this case, it is plausible to assume a reduction of the sensitivity zone specified in an ad or in a datasheet, by at least 30%! Some manufacturers of PIR sensors give this information in their product datasheets.
5. PIR sensors are optical sensors. In freezing warehouses, their focusing lenses become covered with frost and the sensors stop detecting movement
6. Since PIR sensors are beam sensors, if they are installed high up, they can only detect motion in certain points of their sensitivity zone and the distance between these points can be several meters, creating many "dead zones".
7. PIR sensors can only fully operate if installed at up to 12 m, while today VNA

warehouses which can be up to 22 m high are becoming more popular. Such warehouses provide the maximum efficiency of the warehouse inner space. This is especially true for places where real estate is expensive.

Many readers may ask why PIR sensors are still being installed in warehouses if they have so many disadvantages. It's because there is no alternative. More specifically, there was no alternative. An alternative that is available now will be discussed later in this article.

What do PIR-Sensor Manufacturers and Installers Recommend to Eliminate the Above Disadvantages?

Recently, to reduce the cost of the automation system, designers and installers have proposed a scheme with two PIR sensors in each warehouse aisle, regardless of its length – at both ends.

How does this system work and how profitable is it for the owner of the warehouse?

One of the sensors detects the entry of the loader into the aisle. Due to the large shutdown delay of about 10 minutes set by the installer, the lighting system in the aisle is ensured while the loader is outside the sensitivity zone of the PIR sensors. For example, it works in the center of the aisle. After completing all the operations, the loader leaves the aisle, causing one of the PIR sensors to re-activate. Thus, the 10-minute timer for turning off the lighting starts again.

In other words, there is nobody in the aisle but the lighting is still on for the next 10 minutes. Now, when the delay time of the PIR sensors is about to end and the lighting must turn off, another forklift comes in the aisle and the cycle repeats. In the warehouses with intense traffic, such as in **Figure 1**, the lighting in such an aisle will hardly ever be off! It means that the customer spent his money on automation in vain!

What about the Radar Sensors?

The principle of operation of a K2150 sensor is based on radiation into the surrounding area of the electromagnetic field and recording its changes caused by the reflection of objects moving in the sensor sensitivity zone. The radiation power is only 100 mW, so the sensor has no harmful effects on humans.

The parameters of the radar sensitivity area for the warehouse are ideal for use in places of shelving storage of goods – the beam angle is 160 degrees in one plane and 12 degrees in the other [2].

Particular features of the radar sensor (based on the experience of more than 40 projects implemented by our startup):

- Sensor installation height – 3 to 30 meters. The sensor will also work at a height of 40 m, but its sensitivity zone will be reduced a little;
- No dead zones;
- Fail-safe operation in any climatic conditions – chilled and frozen warehouses, warehouses with special storage temperature/moisture conditions such as banana ripening coolers, vegetable and fruit storage chambers, etc.;
- One radar sensor controls an inter-rack aisle up to 85 m long (detection of humans) and up to 115 m long (detection of vehicles);
- If installed on a wall, the radar sensor detects the presence of a human at a distance of up to 80 m within the area of up to 3000 m^2 (parking areas, industrial and municipal buildings and areas, Smart City projects).

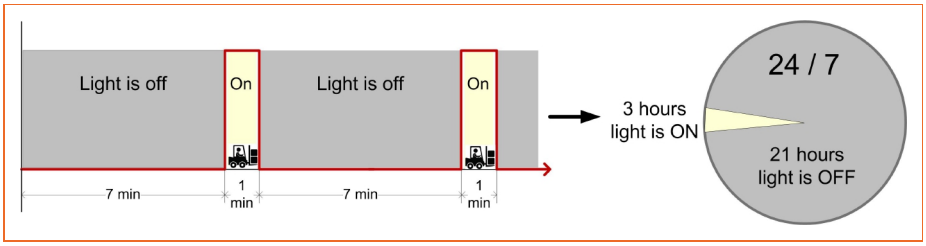

Figure 1: Effects of traffic intensity in a warehouse on efficiency of the lighting system automation (actual traffic measurement results in a warehouse of a large dairy company).

Figure 2: Sensitivity areas of PIR sensors in the beginning and in the end of the warehouse aisle (highlighted in red) and a sensitivity area of a radar sensor (highlighted in green).

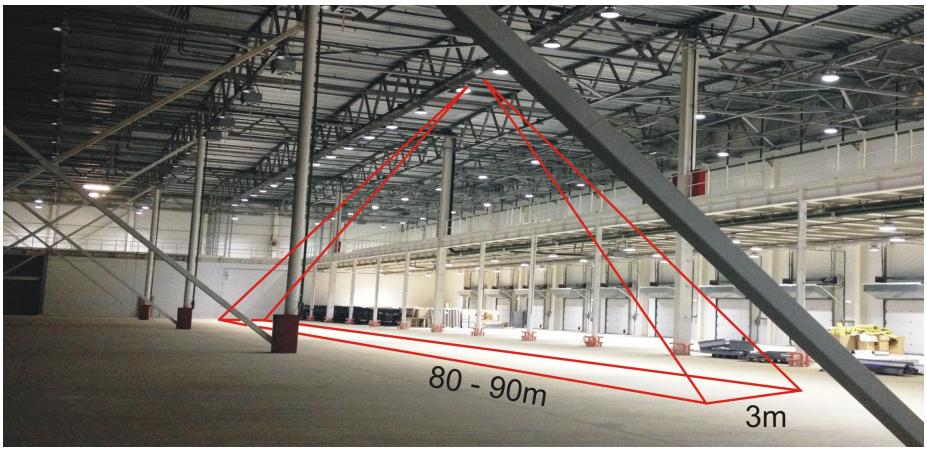

Figure 3: The sensitivity area of the radar installed on the ceiling of the warehouse at a height from 10 m to 22 m.

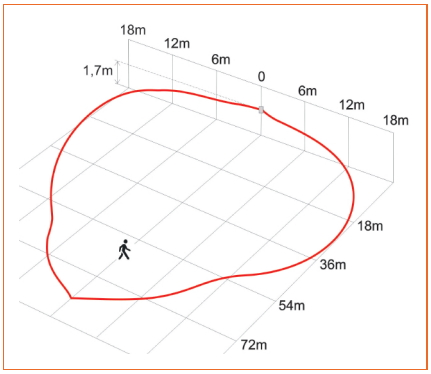

Figure 4: A sensitivity zone of the radar sensor when vertically installed on a wall.

High-bay PIR vs Radar

Let us compare two warehouse solutions – special-purpose high-bay PIR sensors by the best global brands and a K2150 Radar sensor

One Radar Sensor Instead of Four PIR Sensors

Experts might object that the radar sensor turns on lighting in the entire aisle at once, and the PIR sensor only in half or even in on quarter of the aisle, so PIR sensors save more energy. Unfortunately, that is not the case. In order for the staff to be able to work comfortably and not have the light suddenly turn off when a person is in a PIR sensor dead zone, i.e between the beams, a long turn-off delay of the lighting is set for 5 to 10 minutes. As we have already shown, this results in a waste of energy. It is enough to set turn-off delay for only 30 to 60 seconds for a radar sensor, as it has a very high sensitivity. For example, it can detect the motion of a person's hand at a distance of 50 m.

Example – lighting control in a Moscow warehouse of a large international beverage company. One radar sensor was installed in each aisle of the warehouse with a length of 65 m at a height of 15 m. The shutdown delay was only one minute. As a result, electricity consumption decreased by 2.8 times – from 286 000 kWh to 101 000 kWh. Each radar sensor saved 10 800 kWh of electricity per year. The investment paid off in 18 months at a tariff of 0.03 EUR/kWh. Imagine what the payback period could be if this warehouse was located, for example, in Germany, where 1 kWh costs 0.17 EUR for large wholesale consumers [3].

Cable Length and Installation Costs

The use of radar sensors makes it possible to reduce investments to lighting control installation several times. The installation work at a 12-meter height is quite expensive and requires the use of special-purpose equipment. As a rule, the client also requires the possibility of forcibly switching on the lighting through the bypass of motion sensors and does not want to spend money on a digital control system. This requires installation of additional cable and increases the investment.

Here is an example from a large pharmaceutical wholesaler's actual tender which offers PIR sensors by a well-known European manufacturer and radar sensors. Thirty warehouse aisles, each 84 m long, require lighting control. The installer of PIR sensors offered to install 120 sensors and lay 17 km of cables. The installer of radar sensor offered 30 sensors and 3 km of cables. This pharmaceutical company has never used PIR sensors in its facilities [4,5].

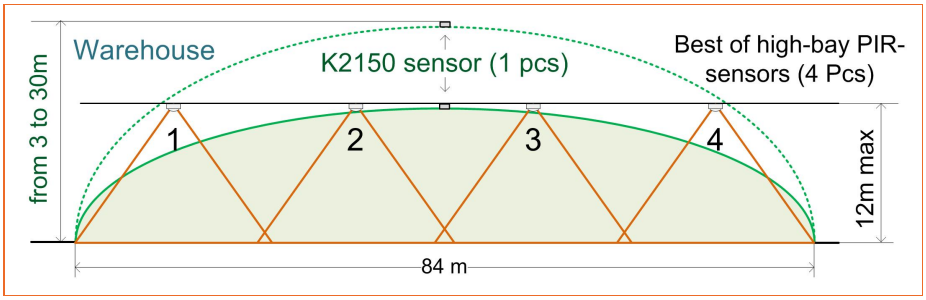

Figure 5: One radar sensor replaces 4 high-bay sensors by the world's best manufacturers.

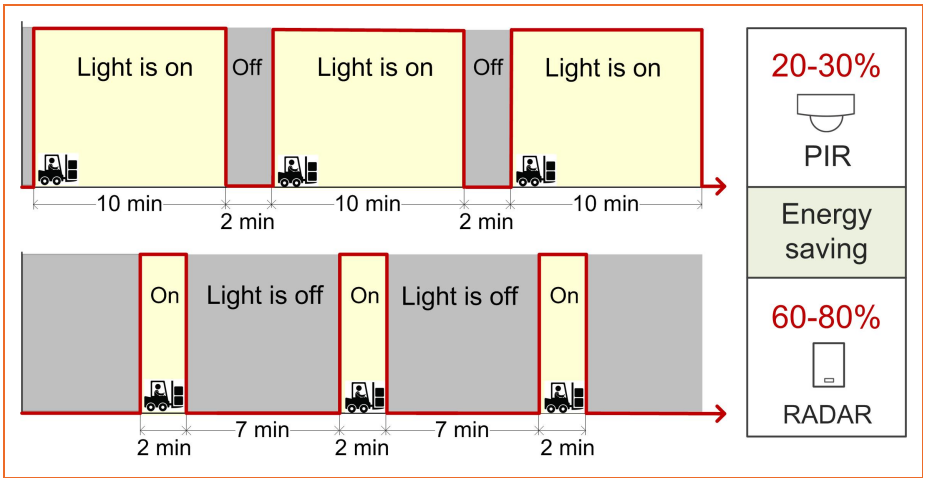

Figure 6: Effects of the turnoff delay time on sensor efficiency.

Characteristics	PIR Sensors	K2150 Radar
Maximum installation height in the warehouses [m]	12	30+
Length of the sensitivity zone in the warehouse aisle [m]	20	85
Sensitivity zone [m^2]	120–400	3000
Relay output and smooth light dimming output in one sensor	No	Yes
Can be mounted on the wall and on the ceiling	No, only on the ceiling	Yes
Can be integrated with security alarm systems, IP-cameras, BMS, Automated Process Control Systems	No	Yes
Operating temperature	–10 – +65 °C	–30 – +65 °C
Can operate in cold storages –30 °C	No	Yes
Can run directly from solar cells 12 V DC, without converters	No	Yes
Enclosure protection	IP54, IP65	IP65, IP67
The payback period, in years	2–5	1

Table 1: Parameter comparison between PIR Sensors and K2150 Radar.

Automation Efficiency and Payback Period

As experience of the radar sensor use has shown, the payback period of an investment is usually about one year, and the best result ever achieved is 6.5 months. One sensor has been proven to save 10 000 kWh per year. If LED lamps were installed in the warehouse, radar sensors could reduce energy consumption by a further 2.5 to 4 times.

Unfortunately, PIR sensors can provide no such values of efficiency. Installation of two PIR sensors at the beginning and the end of the aisle (**Figure 2**) is a very common configuration. It is also recommended by experts of well-known European manufacturers of lighting control systems. Their point is that 25% saving is a very good value for the European market. But the consumer should decide for themselves: is it feasible to agree to a savings of 25% if you can get 60–80 % savings at a lower cost?

Where Else can Radar Sensors be Used?

The radar sensors are ideal for the following lighting control systems:

- Car parking lots – one sensor per 3000 m^2 of the parking area;
- street lighting – smooth control of lighting power for presence of vehicles and pedestrians at a distance of up to 100 m (the sensor has no optical lens, thus it requires no regular cleaning);
- solar powered lighting of streets and cycle lanes – direct connection with power supply without converters;
- railway platforms;
- pedestrian subways, metro – a sensor can be hidden behind any radiotransparent surface, for instance it can be installed in an advertising light box;
- various industrial and municipal buildings and areas. ■

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Mr. Verbovsky is a graduate electrical engineer. He is an expert in the automation of building engineering systems and has been running his own technology business for 31 years. For more than 15 years, his company's clients have been large oil corporations such as BP, Occidental Petroleum, and others. His company implemented the first Smart Building project in 2003. His current project, Intelar startup, is a resident of the Skolkovo Innovation Center in Moscow. This startup was awarded the Golden Mercury Medal from the Chamber of Commerce and Industry of Russia and is one of the TOP 12 Smart Building / Smart Construction Innovators 2021 (Munich, Germany). The K2150 radar sensor developed by the company is labeled as a world efficient solution from Solarimpulse Foundation, Switzerland.

Keeping EMI from LED Drivers Under Control

Frederik DOSTAL, SME Team Leader at Analog Devices

Nearly all lighting applications today use LEDs. In a relatively short amount of time, they have become established as the preferred choice of illumination. However, in most applications, an LED cannot fulfill its function by itself. The LEDs must be operated with a suitable power supply. Such a driver circuit should naturally be as efficient as possible to reduce energy consumption, which is why switch-mode power supplies are primarily used for this purpose. For all power supplies, regardless of the type, electromagnetic compatibility should be considered. This is especially true in the case of LED lights. Various standards for measurement, evaluation, and documentation of the interference generated by LED lights have become established over time.

Uncontrolled electromagnetic interference can have serious consequences. Just recently I had a firsthand experience with one of them. An old E27 incandescent light bulb on my electric garage door opener burned out. After I replaced it with a modern LED light bulb, the light worked again. However, I could no longer open the garage door with the remote control. Thus, the radiated emissions from the LED light must have caused interference in the radio electronics of the garage door. The emissions generated by a switch-mode power supply are partly conducted and partly radiated emissions. Electromagnetic emissions from an LED driver thus can be transferred via the power supply lines as well as magnetically or capacitively coupled into adjacent circuit segments. These emissions are not usually destructive, but they can lead to improper functioning of adjacent circuit components.

Thus, it makes sense to minimize the generated emissions, but what requirements must be met in this regard? All electrical and electronic products in the European Union require CE marking. The CE mark proves that a product complies with EU rules on safety, health, and environmental protection. As a result, transport of such compliant devices within the European Economic Area is permitted. In other parts of the world, there are other important requirements pertaining to radiated emissions. Examples include UL, CSA, and others.

There are numerous standards specifically related to the safety of and emissions from LED lights. A major one is CISPR 11. CISPR stands for International Special Committee on Radio Interference. There are many other rules and regulations, including ISO, IEC, FCC, CENELEC, SAE, and more, that are based on the CISPR standards.

Conducted emissions can be reduced predictably with the appropriate measures using additional supply line filters. These filters are designed to address common-mode or differential-mode noise. The frequency range that usually plays a role here is below 30 MHz. However, developing these filters is not all that simple. A filter is usually optimized for a particular frequency range. In other frequency ranges, parasitic effects and the resulting changes in behavior of the components used can cause problems. For example, a filter may reduce the emissions generated by a switch-mode power supply at 100 kHz very well. However, power supplies usually generate emissions in a wide frequency range, especially above 10 MHz. Here, the filter optimized for 100 kHz could even increase the emissions through parasitic effects and resonances.

The radiated emissions cannot be predictably reduced in this way. Here, the energy content of parasitic inductances and capacitances from the PCB traces, as well as passive circuit components, plays a decisive role. The frequency range usually lies above 30 MHz up to an upper limit that is laid down in the respective standards. Reducing these radiated emissions is very difficult. It requires a great deal of experience and background knowledge. Especially in the driving of LED lights, the level of radiated emissions can be extremely high. Usually a chain of LEDs is driven. This series circuit often requires a large amount of space on the board. Thus, the geometrical arrangement has the properties of an antenna and generated emissions are radiated particularly effectively. Shielding electrical circuits is complex, expensive, and, in the case of LEDs, not even possible in part because the desired light could not pass through a sheet metal shield. Thus, the solution lies in generating only a small amount of radiated emissions.

When designing LED bulbs with a power supply, be aware of the following possibilities regarding electromagnetic compatibility:

- Adding filters at all inputs and outputs of the power supply without really understanding the concrete emissions. This

usually results in high costs for over-dimensioned components and higher manufacturing costs.
- Reusing a proven filter concept without adapting the filter each time. Here, too, higher component costs may arise, and the filter design may be less than optimal.
- Commissioning an expert to provide the filter design. For this, the external expert must also be available at the right time. This also results in additional costs.
- Selecting switching regulator ICs that are already designed for minimal emissions and optimal EMC behavior. In this case, either minimal or no filtering is needed.

Most LED drivers are boost (step-up) converters. **Figure 1** shows a schematic circuit diagram of this type of converter. Boost converters usually have lower conducted emissions on the input side. The input currents are nonpulsating (blue current loop). On the output side, however, there are very high emissions because here pulsed currents flow through the flyback diode (red current loop). During the on-time – that is, when the switch connected to ground is on – the inductor is charged and there is no flow of current through the flyback diode. The total energy to supply the load in this time section comes from the output capacitor.

In **Figure 1**, the current flow during the on-time is shown in blue and the current flow during the off-time is shown in green. All paths in which the current flow changes over a very short time, or the switching transition time, are shown in red in **Figure 1**. These paths change their state from current flow to no current flow in just a few nanoseconds. They are the critical paths and must be designed to be as small and compact as possible in order to reduce the radiated emissions.

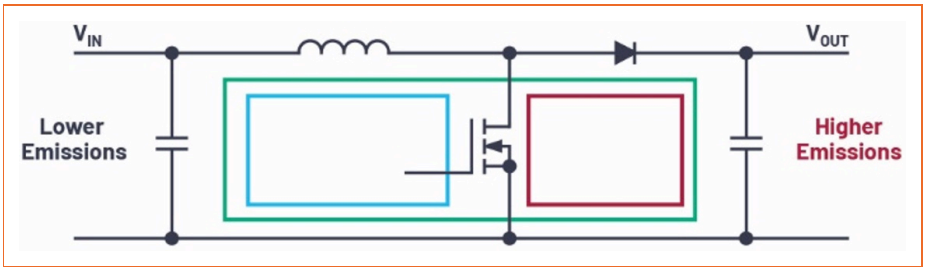

Figure 1: Circuit diagram of a boost converter, a very common topology for LED drivers.

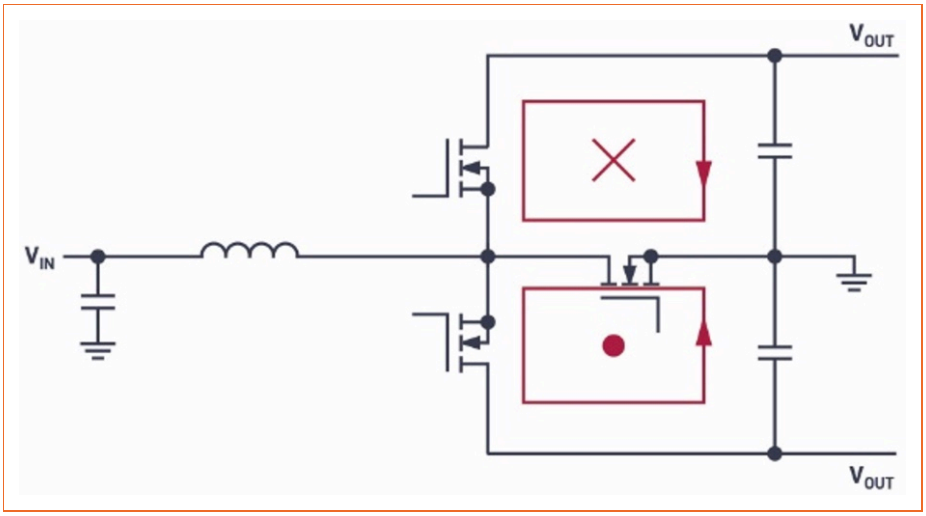

Figure 2: Silent Switcher concept applied to a boost converter with magnetic fields that cancel each other out.

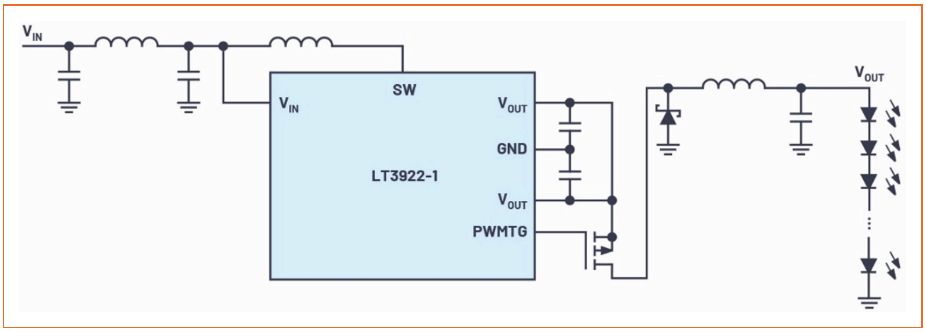

Figure 3: Example circuit for a Silent Switcher LED driver optimized for minimal emissions and the best EMC behavior.

Switching regulator ICs that generate much lower radiated emissions as a result of innovations have recently become available. The critical paths are laid out so symmetrically that the generated magnetic fields largely cancel each other out due to different directions of current flow.

Figure 2 shows the symmetrical arrangement of this topology. The magnetic field generated in the top red loop is the same magnitude as the field in the bottom red loop, but points in the opposite direction. This yields the effect of field cancellation. At Analog Devices, this technology is marketed under the name Silent Switcher. In addition to this innovation, there is a strong reduction in the parasitic inductance in all critical line segments, resulting in a considerable reduction in the radiated fields. The Silent Switcher topology utilizes a proprietary layout of the power transistors to achieve this magnetic cancellation effect. The length of the path between the power transistors and the output capacitors for the boost converter (the hot loop) determines the inductance involved with this magnetic field. In Silent Switcher 2 technology, the length of this path is greatly reduced. This is accomplished through the so-called flip chip technology. Here, the silicon in the switching regulator IC is connected to the IC housing not with bond wires, but rather with copper pillars. These pillars have a much lower inductance. Thus, for the same current switching speed, there is a much lower voltage offset and, through this, a lower radiated emissions level. It is hence very possible to achieve a considerable reduction in EMI by using optimized LED driver ICs. In some cases, it is even possible to stay within certain EMI limits without using EMI filters.

A practical circuit with very low radiated emissions is shown in **Figure 3**. Here, the LT3922-1 **[1]** is operated in a boost circuit. A chain of 10 LEDs with 333 mA is driven with an input voltage of 8 V to 27 V. For this constellation, switching is done at a switching frequency of 2 MHz and the generated emissions are minimal.

In **Figure 4**, the average radiated emissions from the circuit in **Figure 3** are shown.

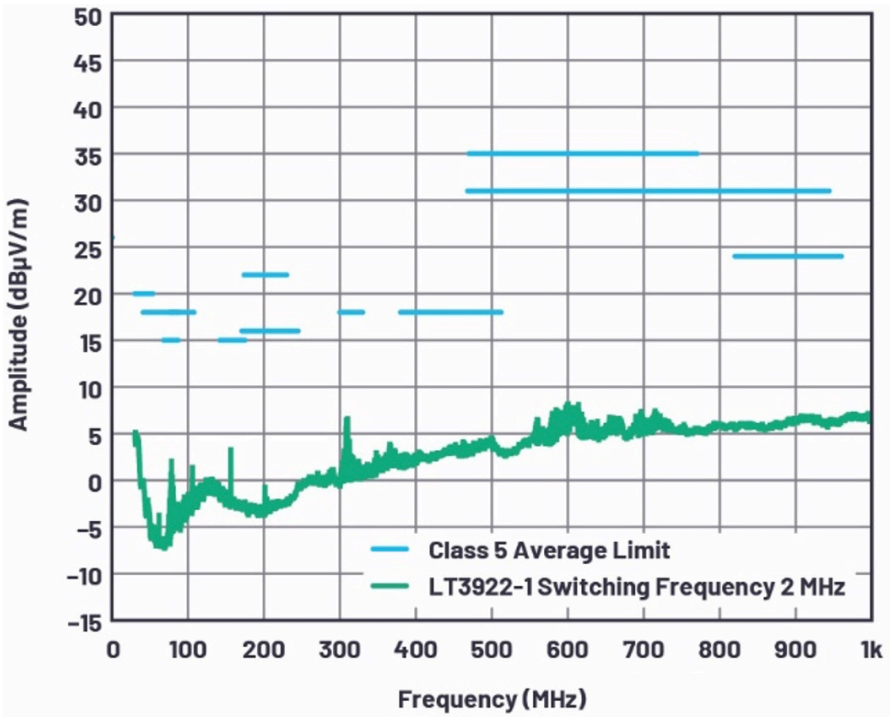

Figure 4: Average radiated EMI (CISPR 25) from the LT3922-1 in Figure 3.

The red lines show the respective limits from the CISPR 25 specification. As can be seen, this specification is easily met (undershot).

An LED driver such as the LT3922-1, which is designed for low emissions, frequently also offers the option of activating a spread spectrum frequency modulation (SSFM) function. This may not reduce the real emissions generated, but it spreads the emissions over a wider frequency range. Through this, better results can be obtained in the measurements for individual EMC standards. The LT3922-1 offers this function between the respectively set switching frequency and 125% of this value. Spread spectrum can also have a very significant effect in the VHV and UHV bands, reducing the emission of any given frequency below the level that would affect radio communication.

As is the case for every switching regulator, for LED drivers the design of the board layout is very critical. Modern innovations such as the Silent Switcher and Silent Switcher 2 technologies help to dramatically improve EMC behavior, but it is still important to avoid any mistakes with the printed circuit board layout. Proper placement of critical components that conduct rapidly switched currents is especially decisive for minimizing radiated emissions. As little parasitic inductance as possible should be included in these paths. The current loops should also be designed as compactly as possible. To aid in the successful consideration of these aspects, detailed documents such as the LT3922-1 data sheet offer valuable and clear information.

Some of today's modern LED drivers are specialized in minimizing electromagnetic emissions. For this, they use some key innovations in the field of switching regulators, including the Silent Switcher and Silent Switcher 2 technologies from Analog Devices. When designing with these ICs, the effort required to comply with EMI limits is relatively low. ■

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Frederik Dostal studied microelectronics at the University of Erlangen in Germany. Starting work in the power management business in 2001, he has been active in various applications positions including four years in Phoenix, Arizona, where he worked on switch-mode power supplies. He joined Analog Devices in 2009 and works as a SME Team Leader at Analog Devices in Munich. He can be reached at mailto:frederik.dostal@analog.com.

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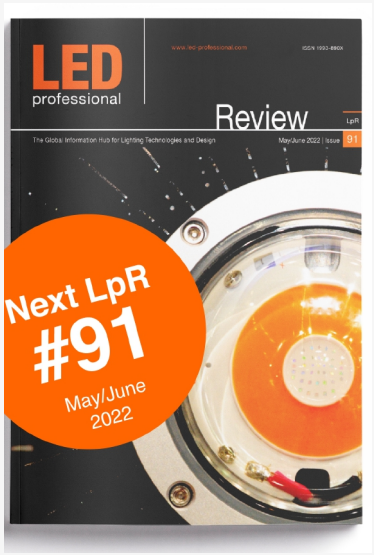

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PRINT PUBLICATION
MAY 31, 2022

ENQUIRIES | LpR 91

editors@led-professional.com,
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Imprint

LED professional Review (LpR)
ISSN 1993-890X

Publishing Company

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