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ISSN 1993-890X

LED professional Review

LpR

The leading worldwide authority for LED & OLED lighting technology information

May/June 2014 | Issue 43

Tech-Talks BREGENZ: Martina Paul

Light + Building 2014: Post-Show Report

White LED Color Design

Smart Lighting Report

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IYL 2015 Incentives

The International Year of Light and Light-based Technologies 2015 (IYL 2015) was brought about by UNESCO together with a consortium of scientific committees and various interest groups. It is a global initiative with the goal of paying tribute to light as a key figure in research and application and promoting sustainable developments. With the help of light based technologies, solutions to global challenges in energy, education, agriculture and health can be found. With the Tech-Talks BREGENZ, the LED professional Scientific Award and intensive international co-operations, LED professional is setting the course for the IYL 2015.

The Tech-Talks BREGENZ are a series of four to six talks per year with international, distinguished experts from the lighting branch. The goal of this initiative is to provide the global SSL purchasers of LED and OLED materials, components, systems and services, orientation and help in the areas of technology developments and trends. The series started in March with Martina Paul, the General Secretary of the International Commission on Illumination (CIE) on the topic of international standardization. You can read the interview in this issue.

The LED professional Scientific Award will be presented for the first time at the LED professional Symposium +Expo in Bregenz in acknowledgement of the IYL 2015. To promote global lighting research, an international jury of experts will honor the best scientific paper in the areas of LED and OLED light sources. The LpS event takes place from September 30th to October 2nd, 2014 in Bregenz, Austria. Visitors can expect a diversified program with top class presentations, Tech-Panels, workshops, exhibition and numerous networking possibilities. Over 100 exhibitors and more than 1,300 visitors are expected.

In order to supply the SSL industry with up-to-date information from the areas of LED and OLED lighting, a deep scientific and application oriented exchange is essential. In order to guarantee this exchange, LED professional has reinforced its co-operations with international organizations such as the International Solid State Lighting Association (ISA) from China, the European Photonics Industry Consortium (EPIC) from Belgium and the European umbrella organization of the lighting industry, LightingEurope, from Germany.

With these incentives for the IYL 2015 the whole LED professional team will work on bringing you the latest stories, innovations, inventions, technologies and backgrounds.

Yours Sincerely,

Siegfried Luger

Event Organizer - LpS 2014
Publisher - LED professional

Content

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Musa Unmehopa

Musa Unmehopa is the Secretary General of the Zhaga Consortium, a global lighting-industry organization that is enabling interchangeable LED light engines. Musa has been involved in international standardization across several industries for almost 20 years, serving in various chair positions and directorships. He is on the Board of Directors of the ZigBee Alliance (intelligent control for connected lighting) and the EMerge Alliance (standardizing low-voltage DC power distribution). Musa received an MSc degree from the University of Twente, as well as MBA degrees from TiasNimbas Business School in the Netherlands and Bradford University School of Management in the UK.

THE INDUSTRY ASKS - ZHAGA DELIVERS

Every industry in transition needs to successfully overcome a number of challenges as it pursues growth and profitability for all its stakeholders. Four years ago, the Zhaga Consortium was founded when a number of leading companies in the lighting industry identified a challenge as a result of a rapidly developing LED market, i.e. the proliferation of form factors for LED light sources. Since its conception in 2010, Zhaga has addressed this industry challenge by developing 8 Books, which specify the mechanical, thermal, photometric, electrical and control interfaces between LED light engines (LLEs) and LED luminaires. These Books address both indoor as well as outdoor applications, and cover socketable and non-socketable LED modules, with an integrated or separate electronic control gear (or driver). At the Light + Building show in Frankfurt in early April, Zhaga modules were ubiquitous across the trade show floor. Despite the accomplishment of the current Books and the successful introduction of over 160 certified products on the market, Zhaga cannot rest on its laurels. Zhaga must continue to respond to the evolving needs of the industry.

At its recent member meeting in Amsterdam, Zhaga started the development of three new Books. The new Books are designated numbers 9, 10 and 11. Zhaga Book 9 will define the interfaces of an LLE which consists of a non-socketable LED module with a ring-shaped light-emitting surface (LES) and a separate LED driver. Book 9 will cover small, mid-power LED modules which could enable LED luminaire products for use in consumer lighting applications, such as small spotlights, track lighting and other compact luminaires.

Book 10 and Book 11 will both describe LLEs that consist of a circular, non-socketable LED module with a separate LED driver. The modules have a circular LES and are suitable for spotlight-type applications. Both Book 10 and Book 11 are similar to Book 3, which is already published and is one of the most widely-adopted Zhaga Books in the industry with the most commercially-available certified products. Compared to Book 3, the new Book 10 will describe larger, higher-output LED modules with a larger diameter, while the modules in Book 11 will have a smaller diameter and smaller thickness.

Furthermore, Zhaga has decided that it will aim to enable LED modules and drivers that are independently interchangeable, by defining the electrical interface between the module and the driver. Today, for LED light engines having a separate driver, it may not be possible to interchange LED modules from different suppliers without also using a different driver, or vice versa. However, Zhaga identified clear signals from the industry that there is now a growing market need for LED modules and LED drivers that are independently interchangeable (i.e. you can interchange one without necessarily interchanging the other). This initiative will take the industry one step closer to full interchangeability at the component level.

As well as continuing to look at new proposals from members, Zhaga has also initiated a project to evaluate the use of LED light engines across a wide range of lighting applications. The goal is to identify opportunities and set priorities for the development of new specifications that will provide most benefit to the LED lighting industry. Zhaga welcomes requirements and feedback from a wide range of interested companies and organizations, both inside and outside Zhaga.

These are exciting times of change which pose a number of challenges that need to be addressed head on. I invite you to join Zhaga on its mission to accelerate the adoption of LED lighting solutions in the marketplace, through standardization of LED light engine interfaces. Sign up as a Zhaga member and help shape our industry! ■

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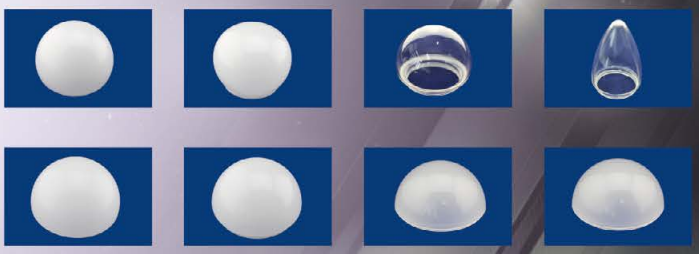

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Philips Lumileds - Most Affordable & Efficient Array LEDs

Today Philips Lumileds delivers the most affordable chip-on-board (CoB) arrays for PAR38 equivalent lamps, which achieve 10% or greater efficacy than competing solutions. Also ideal for spotlights, LUXEON CoB 1202 has a typical efficacy of 115 lm/W, and it varies from 95-130 lm/W depending on color temperature and CRI of the array.

Philips Lumileds' LUXEON CoB 1202 arrays for PAR38 equivalent lamps and spotlights deliver the industry's highest efficacy at lowest cost

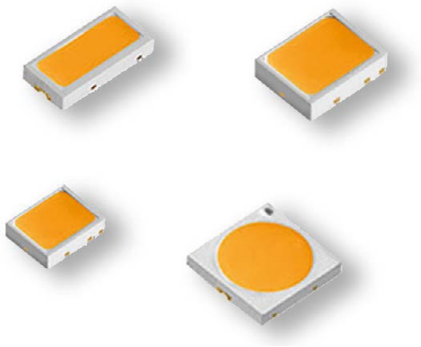
"The high efficacy, combined with our lineup of compatible reflectors and drivers, enables the most affordable PAR38 and spotlight designs to date," said Eric Senders, Product Line Director, Philips Lumileds.

The LUXEON CoB 1202 completes the portfolio for PAR lamps. Together with the 1203, these 9 mm Light-Emitting Surface (LES) versions will be the best in price/performance for directional retrofit lamps. Due to the LUXEON CoB 1202's mechanical and optical compatibility with the LUXEON CoB 1203, you are able to use the same ecosystem to create a high efficient and most cost effective solution.

The performance range of the LUXEON CoB 1202 arrays is 95-130 lm/W and over a CCT range of 2700-5700 K at CRI of 70, 80 or >90. Typical output for warm white (3000 K, 80 CRI) is 800 lm when driven at 200 mA. The warm white arrays can be driven at up to 400 mA to achieve a flux of 1500 lumens. The high CRI (>90) versions deliver an R9 of >80 for demanding applications such as retail downlights and spotlights. ■

Luminus Launched Mid Power LED Product Line

Luminus Devices Inc. announced the mass production of their new XNOVA line of mid power LEDs developed for the general lighting market for replacement lamps and luminaires.



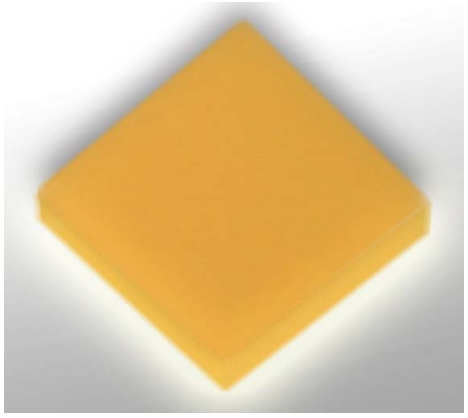
Luminus Devices' new XNOVA mid power LEDs were on display at Light + Building 2014

XNOVA mid power LEDs are targeted at high growth lighting applications ranging from linear T8 lamps to diffused panel lighting and replacement lamps and luminaires. The new product line consists of 2016, 3014, 3020 and 3030 platforms, with nominal input powers ranging from 0.18 W to 0.93 W and corresponding flux output from 22 to 107 lm.

XNOVA mid power LEDs achieve 130+ lumens per watt (LPW) at nominal test conditions, and 170+ LPW at lower input power. The products span the ANSI color gamut from 2700 K - 6500 K with standard minimum CRI of 70 and 80. In addition, Luminus is offering each mid power platform in a high CRI configuration of 90+ for applications that require the highest color quality for demanding illumination applications. ■

Lextar Debuts White Chip LED

Lextar Electronics Corp., a vertically integrated LED company, announced packaging-free "White Chip" to demonstrate its new achievement in LED technology. This new White Chip LED was demonstrated at "Light + Building Frankfurt 2014" by various LED lamps, including a 50-watt halogen equivalent GU10 LED spot lamp, point-light candle lamps, and omni-directional LED tubes featuring ultra-high efficiency.



Lextar's new White Chip technology involves a substrate-free flip chip and phosphor molding process

Lextar's new White Chip technology involves a substrate-free flip chip and phosphor molding process, and can be fabricated by current SMT equipment; all these features can simplify the manufacturing process significantly. Lextar's White Chip is a chip scale die without the packaging process. It features high lumen densities, high lumen output, wide beam angle. It can be packaged closer and therefore simplify optical lens design. Lextar's White Chip can be applied to lighting products, especially small sized lamps such as spot or candle lamps. It can also be applied to backlighting, helping reduce the thickness of direct-lit backlight modules.

To demonstrate Lextar's synergy of vertical integration, Lextar brought various lighting applications with its White Chips implemented to Light + Building 2014. When used in a GU10 spot lamp, this White Chip can achieve high lumen output and high lumen intensity; reaching up to 2500 cd at 25 degrees with high CRI 90 performance, making it a perfect replacement for a 50-watt halogen lamp. The White Chip point-light candle lamp has identical glowing effects to starlight and creates an exquisite indoor setting. Moreover, the light tube equipped with White Chip and COG (Chip on Glass) technology, on the other hand, allows for a 360-degree illumination, reaching an ultra-high efficiency of 200 lumens per watt.

Since LED companies have been eager to attempt simplified manufacturing processes at reduced costs during the past few years, flip chip and packaging-free LED products are getting more popular. The Company expects to move this newly launched White Chip onto the market during Q2 of this year. ■

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LL01CT-AYTxxR35-P

Reflector: LL01CT-AYTxxR35-P
DxH(mm) 75 x 45
FWHM 15° 24° 38°
Connector: LL30A00SUNB2-M2
LED: Citizen CLL020

LL01CR-AYMxxR35-P

Reflector: LL01CR-AYMxxR35-P
DxH(mm) 90 x 50
FWHM 15° 24° 38°
Connector: LL38A00SUUB2-M2
LED: CREE CXA 2520/ 2530

Reflector: LL01CR-BGCxxR49-M2
+ Lens DxH(mm) 75 x 45
FWHM 15° 24° 38°
LED: Cree 1816/ 1830

Reflector: LL01CR-BIYxxR49-M2
+ Lens DxH(mm) 100 x 57
FWHM 13° 24°
LED: Cree 1816/ 1830

Reflector: LL01CT-BKY15R49-M2
+ Lens DxH(mm) 93 x 35
FWHM 15°
LED: Citizen CLL032

Reflector: LL01CT-BKY36R49-M2
+ Lens DxH(mm) 93 x 35
FWHM 36°
LED: Citizen CLL032

Reflector: LL01CT-BKY75R49-M2
+ Lens DxH(mm) 93 x 35
FWHM 75°
LED: Citizen CLL032

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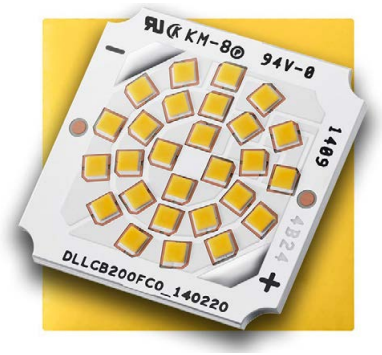
Samsung Introduces Flip Chip LED Package and Module

Samsung Electronics Co., Ltd., a world leader in advanced component solutions, introduced a new lineup of flip chip LED packages and modules offering enhanced design flexibility and a high degree of reliability. The new offerings, for use in leading-edge LED lighting such as LED bulbs, MR/PAR and downlights, will be available in the market during the second quarter 2014.



Samsung presents Flip Chip on Module (FCOM) for cost efficient high efficacy lighting solutions

Samsung's new flip chip (FC) LED package and flip chip on module (FCOM) solutions feature highly efficient and versatile LED structures, created by flipping over blue LED chips and adhering phosphor film to each of them. Samsung's FC package technology can produce LED packages down to a chip-scale size without any mold, enabling more compact lighting fixture designs.

Samsung's new FC and FCOM series can be driven at a current higher than that of conventional LED components, and have low thermal resistance. The low thermal resistance improves the reliability of the FC and FCOM solutions, resulting in higher flux, and a decrease in the number of packages needed, plus a reduction in the size of the circuit board.

Also, by attaching a cell film, each package gains uniform thickness and lower color deviation. As a result, the FC and FCOM solutions provide a high level of color consistency and ensure the chromaticity control of MacAdam 3-step ellipses.

The new FC and FCOM LED solutions include a middle power LED package (LM131A), a high power LED package (LH141A) and an LED downlight module.

Flip chip mid power LED package (LM131A) and high power LED package (LH141A):
Samsung's LM131A and LH141A flip chip packages feature exceptionally compact form factors of 1.22x1.22 mm and 1.4x1.4 mm, respectively. By excluding a plastic mold, the two packages can function at a high current level in a highly reliable manner, even after long hours of use. These advantages make them ideal for use in LED lighting applications requiring a small form factor with high light output, including LED bulbs and spotlight products such as MRs and PARs.

Flip chip on module (FCOM) for LED downlight fixtures:
Samsung's new FCOM downlight products are distinguished by their high light output. Compared to a chip-on-board (COB) engine, which has a fixed wattage, the new FCOM permits simple adjustments in the number of FC LED packages to make the module compatible with a variety of electrical drivers of different wattages, in allowing greater design flexibility.

To create a downlight with 1000 lm output and 100 lm/W efficacy, Samsung FCOMs require a 1.7x1.7 cm circuit. Such a small form factor makes these FCOMs well-suited for size-sensitive LED lighting applications, which include LED bulbs, MR/PAR spotlights, downlights and even cove lighting.

Samsung's FCOMs can support MacAdam 2-step depending on customer needs, thanks to the superb color consistency of the chips and a rating of at least 80 on the color rendering index (CRI). The new Samsung FCOMs also offer a range of correlated color temperature (CCT) – from 2700 to 5000 K. ■

Luxeon 3535 2D Mid Power LED Update Boosts Performance

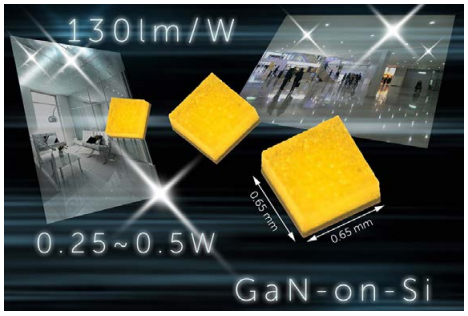
The Luxeon 3535 2D has increased its typical flux output by 10%, delivering optimized performance in combination with the quality of light needed for distributed light source applications. Specifically, for Luxeon 3535 2D 2700 K 90 CRI parts, typical flux levels have increased from 55 lm to 61 lm. Simultaneously, typical voltage has been lowered - resulting in an efficacy increase of more than 10%. This increase in performance will drive the adoption of LED lighting for consumer bulbs.

Philips Lumileds improved the performance of the 2700 K / CRI 90 versions of their popular Luxeon 3535 2D

This is in line with Philips Lumileds targeted improvements in flux and efficacy for 90 CRI warm white LEDs. Developed to address the rapidly growing market for high color rendering light sources, this boost in performance of 90 CRI warm white emitters mimics the color quality of traditional incandescent bulbs. Increasingly, customers seeking retrofit lamp solutions are specifying a minimum of 90 CRI. For example, the California Energy Commission is requiring minimum 90 CRI and 50 R9 for light fixtures installed in California. ■

Toshiba Shrinks Package Size of White LEDs

Toshiba Electronics Europe (TEE) has launched a new series of ultra-small chip scale package white LEDs for lighting applications that can reduce the mounting area by 90% compared to conventional 3.0 x 1.4 mm package products. The new TL1WK series LEDs have been designed as light sources for general lighting, including straight tube lights, light bulbs and ceiling lights.



Toshiba's GaN-on-Si based new LEDs for general lighting applications reduce mounting area by 90%

The new products utilize gallium nitride-on-silicon (GaN-on-Si) process technology and a new process technology that fabricates the elements of a packaged LED on an 8-inch silicon wafer. The LEDs are the industry's smallest in sub-watt class (0.25 to 0.5 W) white LEDs, with a package size of just 0.65 x 0.65 mm, but they achieve a luminous efficacy of 130 lm/W and superior heat dissipation. Forward current is up to a max. of 180 mA.

The new white LEDs make it possible to achieve a narrow beam in small-size lighting equipment and can contribute to innovation in lighting design. The first device has a color temperature of 5000 K and a color rendering index Ra of 80, other color temperature variations including 4000 K, 3000 K and 2700 K are also under development. ■

LUXEON 3020 Crosses the 1 klm/$ Threshold

The launch of the reliable and cost effective LUXEON 3020 emitter will drive a variety of long-awaited commercial LED lighting fixtures into the mass market, including lamps and troffers. The LUXEON 3020 is Philips Lumileds' most affordable mid-power LED, delivering over 1,000 lumens per dollar. This product will inspire the market with the next generation of high quality, efficient and attractively priced LED lamps.

Philips Lumileds' LUXEON 3020 is a hot color targeted leading lm/$ 3V LED in QFN package

Main Features:

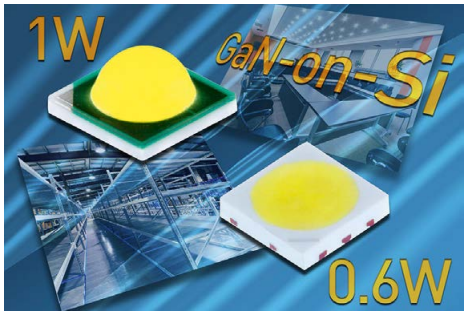
- 155 lm/W (60 mA, 6500 K 80 CRI) and 145 lm/W (60 mA, 3000 K, 80 CRI)
- >1000 lm/$ EMC QFN package enable affordable and reliable designs
- Hot targeting at 85°C ensure ANSI CCT compliance at operating condition
- Micro 1/9th micro binning enable 3, 4, and 5 SDCM designs

The LUXEON 3020 features hot color targeting and a 1/9th micro color binning structure. Philips Lumileds hot color targeting ensures the color temperature remains within ANSI specifications at operating conditions. With the new binning option, customers have the ability to select portions of the bin structure that are within the ANSI 5-step MacAdam Ellipse or 3-step MacAdam Ellipse regions, achieving the color point needed for a particular application.

For designers of lamps, troffers, TLEDs, high bay and low bay luminaires, the LUXEON 3020 produces 90 lm at 6500 K and 80 CRI when driven at the maximum drive current of 240 mA. The LUXEON 3020 also features the use of epoxy molding compound (EMC) along with QFN packaging technology to deliver superior reliability and thermal properties. Typical efficacy of the LUXEON 3020 is 135 lm/W at 6500 K at a CRI of 80 and a drive current of 120 mA. LM-80 data is available for the LUXEON 3020 emitter. ■

Toshiba Launches 0.6 & 1 W White LEDs for Lighting

Toshiba Electronics Europe (TEE) has announced the launch of two new series of white LEDs, the 3.5 x 3.5 mm lens package 1 W type TL1L2 series, and the 3.0 x 3.0 mm flat package 0.6 W type TL3GB series. Both have been developed as light sources for general lighting applications (including light bulbs, base lights, down lights and ceiling lights), street lights and floodlights.



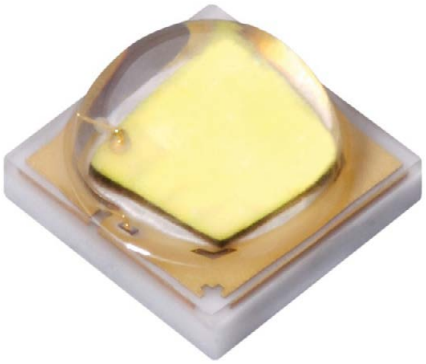
Toshiba's latest 1 W & 0.6 W white LEDs are utilizing gallium nitride-on-silicon (GaN-on-Si) process technology

Utilizing gallium nitride-on-silicon (GaN-on-Si) process technology, the new white LEDs realize low forward voltage (VF) and can contribute to lower power consumption and cost reductions in lighting applications.

Forward voltages realized are 2.85 V at 350 mA (TL1L2-Series) and 5.76 V at 100 mA (TL3GB-Series). Luminous efficacy for the TL1L2-Series is 135 lm/W (5000 K, Ra70) at 1 W operation (If=350 mA); for the TL3GB-Series it is 118 lm/W (5000 K, Ra80) at 0.6 W operation (If=100 mA). Color variation of six color temperatures is 2700 K to 6500 K. ■

LG Innotek's New High Power LED Improves Efficacy

LG Innotek announces the release of a new high power LED technology, with a 30% lumen efficacy improvement over its previous products. The proprietary "next-gen" vertical chip technology boasts up to 167 lm/W, now positioned as one of the world's best performing High Power LED's. This represents a 30% improvement in performance compared to previous high power products.



LG Innotek's "next-gen" vertical chip technology-based new high power LED shows up to 167 lm/W efficacy which equals a 30% improvement

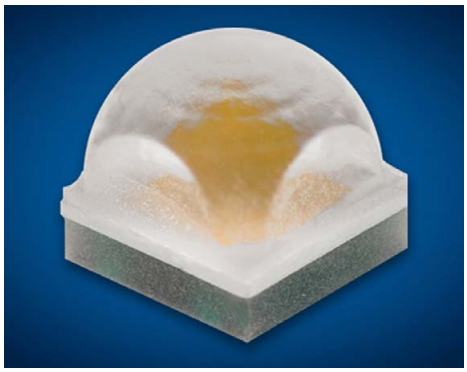
LG Innotek's "next-gen" vertical chip technology is suitable for high temperature environments, such as 85°C or above, where the performance degrades less than 5%, while typical LEDs show greater light output degradation.

LG Innotek's high power LEDs are optimal for outdoor/indoor applications such as street lights and commercial High Bay lighting. The high efficiency of the LED package allows for design optimization, making the OEM's light fixture more market competitive and differentiated. LG Innotek also plans to release higher CRI (Color Rendering Index) products (90 or higher) to serve the more demanding commercial lighting market.

In addition, LG Innotek ensured high reliability because of the improvement in the heat dissipation capability with LED epitaxial growth technology and packaging technology. So it has a life expectancy of more than 50,000 hours. LM-80 (The U.S Environmental Protection Agency's (EPA) LED Lighting reliability ratings) certification was completed and officially recognized package's reliability.

Cree's New Discrete HD LED Offers Highest Performance

Cree, Inc. introduces the XLamp® XB-H LED, the brightest discrete in Cree's high-density (HD) class of LEDs, delivering a breakthrough combination of lumen output and efficacy in a small package. The XB-H LED brings the lighting-class performance of the XP-G2 LED into a package that is 50 percent smaller. Delivering more than 500 lumens at 1.5 A, 25°C in a 2.45 mm^2 package, the Cree® XB-H LED can enable luminaires that use the same size footprint XB-D LED to triple their light output at the same efficacy.



Cree's new XB-H LED can enable luminaires that use the same size footprint XB-D LED to triple their light output at the same efficacy

The XB-H joins the XQ-E in the family of HD class discrete LEDs that offer the industry's highest optical control factor (OCF), a measurement of how LED size and performance benefit directional lighting applications. High OCF LEDs enable lighting manufacturers to improve the performance of any lighting design, create smaller and less expensive systems, and develop new lighting solutions that were previously not possible.

Utilizing Cree's proven and highly reliable ceramic package technology, the new XB-H LED delivers long L70 lifetimes at both high temperature and current. In addition, the XB-H offers compatibility with most optics designed for the Cree XP family of LEDs, allowing lighting manufacturers to leverage the optics of existing lighting designs and improve time to market.

Lighting manufacturers seeking ENERGY STAR® qualification can take advantage of the XB-H LED's successor status to the XP-G2 LED - meaning that ENERGY STAR qualification can be achieved using just 3,000 hours of LM-80 data, instead of the normal 6,000 hours.

The XLamp XB-H LED is available in color temperatures ranging from 2700 K to 8300 K and CRI options of 70, 80, 85 and 90. Binned at 700mA, 85°C, the XB-H LED delivers up to 499 lumens at 5 W, 85°C. Product samples are available now and production quantities are available with standard lead times.

Acrich MJT 2525 Offers Unmatched Lumen Density

Seoul Semiconductor, a global leader in LED technology, released a new generation of LEDs, Acrich MJT 2525 series, with industry leading performance and lumen density in the mid-power class. The new mid-power product family of the 2525 series offers a compact symmetrical package with dimensions of 2.5x2.5 mm and wide beam angles making these LEDs ideal for applications that require uniform illumination.

SSC's new Acrich MJT 2525 series is a mid-power package with leading performance and lumen density

At the heart of this new package is the state-of-the-art chip technology from Seoul Semiconductor and also optimized light extraction from the package resulting in high luminous efficacies.

MJT 2525 Data:

- CCT [K]: 2600-3700
- CRI [Ra]: 80
- Size [mm]: 2.5x2.5
- Forward Current [mA]: Typical = 40; Max. = 60
- Luminous Flux [lm]: @ 40mA = 95; @ 60mA = 129
- Viewing Angle [deg]: 130°

The Acrich MJT 2525 series is a compact high voltage mid-power package with a typical forward voltage of 22V. At 3000 Kelvin (K) and a CRI of 80 it achieves a brightness of 95 lumens (lm) and an efficacy of 105 lumens per watt (lm/W) at an operating current of 40 milliamps (mA) at 25°C. With a lumen density of 15lm/mm2 this midpower package is best in class and has a lumen density five times that of any other midpower package making it ideal for space constrained lighting applications. The wide viewing angle on these LEDs also helps implement the omni-directionality in replacement lamp designs.

The high voltage Acrich MJT 2525 series incorporates the Acrich-Multi-Junction Technology with multiple junctions on a single monolithic chip eliminating the usage of multiple wire bonds between several dies to create the high voltage architecture. This construction vastly improves the reliability of the LED package since it reduces the potential number of failure modes associated with wire bonds within the LED package. This high voltage architecture also enables the use of simpler, more cost-efficient drivers, compared to conventional LEDs. The improved efficiency of the driver electronics also results in less heat generated and fewer electronic components used in the driver design allowing more space for thermal management within the luminaire.

Seoul Semiconductor's new 2525 Series' unparalleled lumen density in the mid-power class of LEDs, not only reduces the total system costs for designers but also enables new possibilities in lighting design.

The MJT 2525 series has higher cost efficiency than most mid-power packages and has already been adopted worldwide in a number of designs by key customers.

Osram OS Soleriq P 9 with Twice the Light from Half the Surface

For the first time, Osram is offering a chip-on-board LED, the Soleriq P 9, which is suitable for compact powerful spotlights such as the ones used in retail outlets and museums. The latest member of the Osram Soleriq family produces 2000 lumen from a surface with a diameter of only nine millimeters. Compared with the existing Soleriq S 13, that is twice as much light from an area half the size. Just one of the new light emitting diodes is enough to replace a 35 W HID lamp for spotlighting.

Osram Opto's new Soleriq P 9 offers a luminous flux of 2000 lm and a luminous efficacy of 100 lm/W from a light-emitting surface with a diameter of 9 mm

Technical Data:

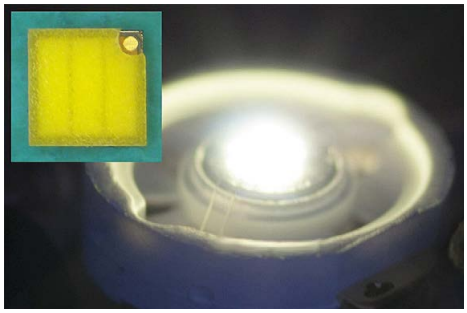
- Package dimensions: 15 mm x 15 mm
- Light-emitting surface: 64 mm^2 or 9 mm diameter
- Beam angle: 120°
- Luminous flux (Tj = 85°C and 3000 K): 2000 lm
- Luminous efficacy (Tj = 85°C and 3000 K): 100 lm/W
- CRI: min. 80 and min. 90
- CCT: 2700 K – 5000 K (CRI 80), 2700 K – 4000 K (CRI 90)

The P 9 has a light emitting surface with a diameter of only 9 mm (64 mm^2) which is around 50 percent smaller than that of the existing Soleriq S 13 versions but at 2000 lm the LED delivers twice as much light with the same efficiency. This high brightness is made possible by the surface-emitting chips used. Even at very high packing densities they can produce high luminous flux with above-average efficiency. The small light-emitting surface means that extremely compact and therefore lightweight optics can be fitted for highly compact spotlights. The spotlights can therefore be less cumbersome and more cost-effective, while still providing the same luminous intensity. The luminous intensity of a 35 W HID lamp, for example, can be matched by just one LED. The Soleriq P 9 has been designed for use in spotlights for directional indoor lighting and in particular for shop and museum lighting.

The new Soleriq is being tested and measured at a temperature of 85°C to simulate the thermal conditions in actual applications as closely as possible. Customers will therefore be able to directly plan the use of the LED in their applications and will not have to carry out time-consuming appraisals based on data sheet values. ■

SemiLEDs ReadyWhite Technology for High CCT Uniformity

SemiLEDs Corporation, a global provider of vertical LED technology solutions, announced sampling and volume availability of the EV-W series of white LED chips, providing LED packagers with a vastly increased range of capabilities while lowering production costs. The new EV-W chips incorporate SemiLEDs' proprietary ReadyWhite™ phosphor technology, which delivers a highly uniform phosphor coating across the emitter surface, greatly increasing color precision and uniformity.



SemiLEDs' high-output, high-consistency unpackaged white chips (inset) support the development of creative new LED packages, especially lower-profile implementations

The availability of high-output, high-consistency unpackaged white chips offers LED packaging and luminaire manufacturers a wide variety of new COB and package options by eliminating the phosphor application from the packaging process. Innovative package-level implementations can include variable-CCT single-package solutions, and greatly simplified RGBW, WWRA, WWWR or WWGR solutions to provide enhanced CRI and higher efficiency red/amber/green augmentation.

EV-W LEDs, based upon SemiLEDs proven EV product line, are available in high-power 40-, 45-, and 53-mil low-profile vertical chips and can deliver up to 140 lumens with efficacies of 130 lm/watt at 350 mA, depending upon the chip bin and chosen packaging approach. Standard CCT & CRI options range from 6500 K & 70 CRI to 2700 K & 80CRI, and include distributions as tight as ¼ of a standard ANSI bin. Additional customization, including specialized phosphor options, is also available.

Historically, manufacturers who assemble LED chips into low profile packages have been faced with a substantial challenge when it comes to uniformity and cost issues. While the industry has developed effective techniques to evenly cover the blue chip in a cavity-based package, current dispensing and spray-coating techniques tend to deliver a domed distribution rather than a flat, uniform coating. While moving to a vertical-metal chip solves the problem of blue leakage that would typically emanate from the sapphire substrate with a dispense-coated or spray-coated horizontal chip, SemiLEDs ReadyWhite technology additionally addresses the equally important issue of uniformity.

The SemiLEDs' EV-W chip series is designed for manufacturability and rugged longevity and is available with an option of gold/tin (AuSn) metallization to support eutectic bonding to further enhance thermal characteristics. The SemiLEDs EV-W series is RoHS compliant with production quantities available now. ■

Philips Lumileds Mid-Power LED - LUXEON 3535 HV

Philips Lumileds launched a mid-power LED, the LUXEON 3535 HV, which allows lighting manufacturers to design in high voltage drivers that are diminutive in size compared to standard drivers, enabling simplified design and lower total cost of the overall lighting solution. The company's high voltage mid-power portfolio is available in industry leading 24 V and 48 V parts.

Philips Lumileds' latest mid-power LEDs, LUXEON 3535 HV, are high voltage 24 V and 48 V products that allow simplified and compact fixture designs

Features:
- High voltage
- Excellent current spreading
- High light output per package
- 1/9th micro color binning

Benefits:
- Lower current, more efficient and cost effective driver
- Leads to better light extraction
- Allows reduction in LED count
- Enables tight color control

Key Applications:
- Downlights
- Indoor Area Lighting: Wall Sconce / Wall Pack
- Lamps

The advantage of designing in high voltage LEDs is that they utilize drivers containing on average less than 20 components, relative to standard LED drivers that can contain up to 50 components. As a result, the total BOM cost can be reduced and the amount of inventory they need to carry to design the driver is minimized.

Applications for the LUXEON 3535 HV include space constrained lamps such as retrofit bulbs, downlights, wall sconces, wall packs, and pendant luminaires. Philips Lumileds is providing LM-80 data for its best-in-class 24 V and 48V LUXEON 3535 HV LEDs. In addition, these LEDs are offered with a 1/9th micro color binning structure with 3- and 5-step color accuracy, offering the customer the benefit of tight color control.

Typical lumen output and efficacy of the LUXEON 3535 HV 48 V at 20 mA is 120 lm and 125 lm/W at a color temperature of 4000 K and CRI of 80. The 24 V LED at 20 mA is 60 lm and 125 lm/W at a color temperature of 4000 K and CRI of 80. ■

Philips Lumileds Debuts LUXEON 3014 and 3030 2D

Philips Lumileds announces two mid power LED emitters with hot color targeting and new 1/9th micro color binning, the LUXEON 3014 and LUXEON 3030 2D. Hot color targeting ensures ANSI compliance at application conditions while micro color binning simplifies color selection. The new 1/9th micro color binning structure enables tighter color control for a given application and designers can easily pair different bins to hit a 3/4/5 SDCM color point.

Philips Lumileds' LUXEON 3014 and LUXEON 3030 2D have the hot color targeting and new 1/9th micro color binning in common

LUXEON 3030 2D:
Philips Lumileds is introducing the industry's first and only mid-power LED with hot color targeting, which ensures performance within ANSI specifications at real-life operating temperatures. The LUXEON 3030 2D is destined to become a workhorse LED for high flux applications such as retrofit bulbs and downlights as well as high bay and low bay luminaires.

Features & Benefits:
- Industry standard package for drop-in replacement for existing 3030 LEDs
- New 1/9th micro color binning
- Hot color targeted to ensure that color is within ANSI bin at typical application conditions
- Leading efficacy of 125 lm/W for warm white and 133 lm/W for cool white at 120 mA and 25°C

The LUXEON 3030 2D release is also being introduced with a new 1/9th micro color binning structure. Customers now have the ability to accurately select 3 or 5-step MacAdam Ellipse for optimal color control.

The LUXEON 3030 2D LED utilizes an epoxy molding compound (EMC) QFN package for exceptional reliability and excellent lumen maintenance. Typical warm white (2700 K) performance is 87 lm at 80 CRI at 120 mA. Cool white efficacy reaches 133 lm/W at 80 CRI and 120 mA. When driven at the maximum drive current of 240 mA, the LUXEON 3030 2D can deliver 160 lm at 6500K and 80 CRI.

The LUXEON 3014:
Philips Lumileds introduces the LUXEON 3014 low-power emitter for linear and omnidirectional lighting applications such as under cabinet lighting, refrigerator display lighting, troffers, TLEDs and retrofit bulbs. Delivered in a rectangular 3.0x1.4x0.7 mm footprint, the LUXEON 3014 will be the industry's first low-power LED offered with the advantages of hot color targeting and a 1/9th micro binning structure.

Features & Benefits:
- Industry standard package for drop-in replacement
- New 1/9th micro color binning of ease of color consistency
- Hot color targeted to ensure better color accuracy
- Rectangular package design increases uniformity

With leading cost effectiveness, the LUXEON 3014 emitter can deliver 10 - 12 lumens of uniform light at 30 mA in neutral white and can be driven as high as 100 mA to reach 33 lm. The LUXEON 3014 is offered in an industry standard QFN package, allowing compatibility with leading manufacturers' 3014 designs. ■

Toshiba Introduced a Transparent OLED and Global Solutions

Toshiba is the only company to provide a full and comprehensive line-up of solutions for building and public infrastructure. Toshiba wants to cover the needs of all 4 key market segments: home, office, retail and outdoor. At Light + Building, visitors were able to discover new and innovative solutions.

Toshiba's transparent OLED panel's unique feature is to emit light from one side only

Transparent OLED:
After the traditional in-organic LED, OLED (Organic LED) has been heralded as the next generation light source because of its unique properties.

Toshiba's latest development in this field has been the creation of a transparent OLED panel, with light emission from one side only. Compared with the conventional transparent OLED panels, which emit light evenly to both sides, this new transparent OLED panel emits most of its light toward a single desired direction, effectively illuminating objects and allowing customers to see through one side of the panel, even when turned on.

The prototype luminaires using the new transparent OLED panels provide comfortable, non-glare lighting when the light is turned on, and fit seamlessly into the atmosphere due to their transparency when turned off. ■

MEGAMAN Expands and Improves Range of MH LED Modules

MEGAMAN®, a leading provider of the latest in LED lamp technology, showcased its full range of Metal Halide replacement products at Light + Building 2014. Used with Zenia® Modena tracklights and Zenia® Carlo and Conxento downlights, MEGAMAN®'s TECOH® modules provide solutions which accentuate merchandising displays and illuminate the environment, without the shortcomings of equivalent metal halide solutions. Now available to replace 20 W, 35 W and 70 W Metal Halide solutions, MEGAMAN®'s TECOH® MHx and RDx LED modules deliver luminous efficacy of up to 125 lumens per watt for high performance light, have instant start and hot re-strike capabilities and offer excellent color consistency.

MEGAMAN®'s improved TECOH modules now cover a broad range of applications, providing up to 125 lm/W

MEGAMAN® TECOH® MHx Gen2
The patented MEGAMAN® TECOH® MHx module provides a unique solution utilizing two axially mounted multichip LED arrays, which when combined with a reflector, deliver a precise directional light source with an extremely even light distribution and minimal glare. With this unique geometry, TECOH® MHx enables powerful accent lighting even with a very narrow beam.

With improved efficacy levels of up to 125 lm/W and the expansion of the range to include even smaller unit sizes, the TECOH® MHx - Gen2, available in 17 W and 24 W versions, offers a viable LED alternative to 20 W and 35 W ceramic metal halide lamps.

MEGAMAN® TECOH RDx
The TECOH® RDx is available in a wide range of lumen packages – from 1300 lm to 5200 lm. Designed in line with Zhaga interface Specification Book 3, all TECOH® RDx modules have the same diameter and height, with the same screw hole placings. Offering linear dimming from 1% - 100% TECOH®

RDx modules are all designed with the same LES (Light Emitting Surface) so you can be assured that every RDx module will fit in the same fixtures or reflectors.

MEGAMAN®'s lower wattage TECOH® RDx modules can operate in three different modes: High Efficiency, Normal and High Output, meaning each unit is flexible enough to work in a multitude of applications – maximizing flexibility, and reducing the need for large stock holdings.

Advancements in MEGAMAN® LED Technology means TECOH® RDx modules have high efficacy levels of up to 126 lm/W, superb color rendering (available with Ra82 and Ra94), and color consistency of < 3 SDCM. ■

LED Engin Introduces LuxiTune 2.0 LED Emitter Module

LED Engin, Inc., a leader in high flux density LED products, demonstrated the generation 2.0 model of its award-winning* tunable white light engine LuxiTune™, designed to replace halogen style dimming and color tuning downlight applications.

LED Engin updated LuxiTune LED Emitter Module to V2.0 with improved color tuning opportunities and connectivity

The next gen version of LuxiTune offers many additional features including a Correlated Color Temperature (CCT) tuning function that enables users to separately adjust the CCT, between 2100 K and 4300 K, and light intensity (flux). Tracking along the same tune curve, the existing halogen style dimming mode allows users to dim from 3000 K to 1800 K. In both modes of operation, the tune curves have been precisely designed to stay a short distance below the black body locus throughout the tuning range, resulting in more vibrant colors. Additionally, LuxiTune 2.0 has newly added DMX control functions, such as switching in between halogen dim and CCT tune modes. In the second quarter 2014, LED Engin plans to further expand the LuxiTune product range with additional DALI control functionality and 700 lm and 2000 lm versions.

LuxiTune delivers warm, soft tones of dimmed light in a compact single emitter while maintaining color quality and consistency within 3 Standard Deviation Color Matching (SDCM) throughout the dimming range. LED Engin's robust multi-channel LuxiGen™ emitter platform in concert with LuxiTune's thermal feedback control eliminates the known effects of varying light output over temperature and time from different color dies, providing exceptional flux and color stability over the life of the product.

Providing high lumen density and Lux-on-Target™ performance, LuxiTune has a luminous flux of 1100 lumens, equivalent to a 60 W halogen lamp. Luminous efficacy is 63 lm/W at temperature including the secondary optic, far higher than that of rival products. At full intensity, Color Rendering Index (CRI) is 90 and LuxiTune maintains a CRI average of 85 as it dims. Class leading in size, compact 45mm diameter optics - available in 24°, 34° and 45° beam angles - support the development of compact lighting fixtures and are far easier to integrate into downlights with beam swivel features.

LED Engin will also showcased Gallery White, the world's most compact emitter for directional lighting boasting an exceptional color rendering index of 98. Designed for high-end applications, including retail outlets, galleries and museums where accurate color representation is vital, Gallery White offers high color fidelity in warm white light (3000 K) and achieves impressive individual R values (R1-R15) to enhance the contrast of retail merchandise, artwork and skin tones. Available in a range of package sizes for different power ratings from 10 W to 80 W, the emitters deliver between 480 and 3,450 lumens output. Additionally, there's a full suite of TIR lenses to choose from with beam angles ranging from 9° to 50°.

LED Engin offers Gallery White emitters in a range of package sizes for different power ratings from 10 W to 80 W, delivering between 450 and 3,200 lumens output. There is a full suite of TIR lenses available offering a beam angle from 9° to 50°. ■

Bridgelux OLM - Advanced IP Rated LED Sub-System

Bridgelux, a leading developer and manufacturer of LED lighting technologies and solutions, unveiled the Bridgelux Outdoor Lighting Module (OLM); a new line of LED sub-systems which integrates optics, environmental protection and the LED source for roadways, parking garages and other outdoor and industrial applications. OLM will allow manufacturers to rapidly expand their product lines while lowering costs.

The OLM Series is Bridgelux's LED replacement for the high pressure sodium lamp that may reduce product development time by three to six months

Outdoor applications, including roadways, parking lots and flood lighting are some of the fastest growing segments in the industry. According to McKinsey & Company, LED based outdoor lighting solutions are expected to grow from six percent of the market ($10 billion USD) to 74 percent by 2020.

The new Bridgelux OLM Series incorporates a number of key technology advancements and features that will help luminaire manufacturers develop a broad range of differentiated outdoor lighting products with lower total costs, faster time to market, and industry leading energy efficacy.

The Bridgelux OLM Series is a reliable and efficient platform that integrates a number of fundamental components for building solid-state luminaires into a single sub-system. OLM reduces product development time by three to six months, eliminating up to $100,000 in R&D expenses. Building solid-state fixtures with OLM can reduce manufacturing time by five to seven days.

When compared to conventional high pressure sodium systems, OLM can reduce the manufacturing cost of outdoor solid state lighting fixtures by 10 to 20 percent, and

reduce maintenance costs while lowering power consumption by up to 65 percent. Further, OLM has been specifically designed to enable lighting manufacturers to reduce the overall bill of material cost of their luminaires and deliver a best-in-class cost to the market.

OLM's slim profile, impact resistant optics, and broad area lighting capabilities make it the ideal platform for outdoor wall pack and flood light applications. Designed to be compliant with key light pattern standards (IESNA, EN13-201, NEMA), the OLM sub-system also has an Ingress Protection (IP) rating of 66; making it an ideal solution for harsh outdoor environments.

"Bridgelux continues to push the envelope in LED and SSL technology innovation, developing products that help light manufacturers and designers solve their biggest manufacturing problems and toughest challenges," said Brad Bullington, Bridgelux's chief executive officer. "We are now introducing the industry's most advanced and sophisticated LED sub-system for outdoor applications."

Bridgelux's proprietary integrated symmetric and asymmetric optics enable lighting manufacturers to design luminaires for targeted applications that spread light in more effective and efficient ways. OLM-based fixtures can also be designed into applications with specific lighting pattern requirements such as glare reduction and dark sky.

Bridgelux is initially launching six OLM subsystems ranging in power from 18 to 40 watts and estimated product lifetimes of 50,000 to 100,000 hours. The new OLM sub-system will be commercially available in June 2014 with pre-orders for this new product being accepted now.

Philips inroduces a Luminous Ceiling Predicted by Isaac Asimov 50 Years Ago

Philips, the global leader in lighting, revealed an innovative luminous panel that can cover a whole ceiling with homogenous white light.

In 1964 the professor of biochemistry, Isaac Asimov, predicted: "By 2014, electroluminescent panels will be in common use, and ceilings and walls will glow softly''

Philips' OneSpace luminous ceiling was predicted by American author and professor of biochemistry Isaac Asimov in a 1964 New York Times article looking at the technology of the future. He wrote that "By 2014, electroluminescent panels will be in common use, and ceilings and walls will glow softly.''

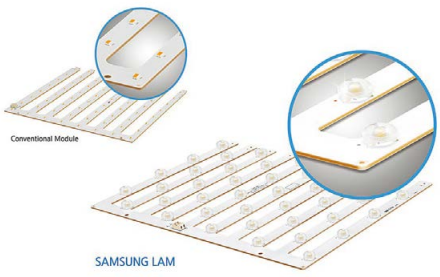
The Philips OneSpace luminous ceiling integrates LED lights with textile to create a white light ceiling surface that hides the source of light completely. The result is a smooth and clutter-free ceiling that emits a uniform and glare-free light. The emitted white light recalls the feeling of natural daylight. It can be dimmed, used as safety lighting and also be connected to building management systems enabling centralized control to switch it on or off for greater energy efficiency.

No additional ceiling is required with Philips' OneSpace luminous ceiling that plays the dual role of ceiling and light. It also meets all building and safety requirements.

Philips' OneSpace luminous ceiling is available in customized sizes up to 10 x 3 meters, providing a maximum freedom of design. It is especially suited for car showrooms, flagship retail stores and public spaces like airports, hotels and conference facilities to create a striking and calm space while also serving as functional lighting.

Samsung Lens-Attached Modules

Samsung Electronics Co., Ltd., a world leader in advanced component solutions and LED component technology, said that it has begun mass producing a value-added line-up of highly efficient lens-attached LED modules (LAMs), for use in office LED lighting applications that include linear and line lighting, cove lighting and troffers.



The new LAM series makes use of technology from Samsung LED packages for flat-TV backlight units (BLUs)

Samsung's LAM series embraces a state-of-the-art concept in LED modules. The LAM solutions are created by attaching lenses on top of the LED packages in each module. The lenses add wide beam angles for their light sources using advanced optic technology, so that each LED package can brighten a space larger than that of conventional packages.

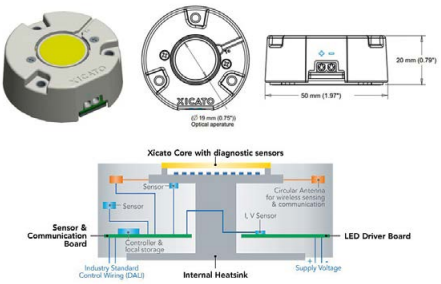
The new LAM series makes use of technology from Samsung LED packages for flat-TV backlight units (BLUs). In 2012, when LEDs became popular in BLUs for LCD TVs, Samsung created LED BLU modules combining lenses with LED packages to increase overall light output.

Using a Samsung LAM solution adds more design flexibility for a wide range of luminaires. Unlike fluorescent and incandescent lamps, conventional LED lighting features individual LED packages, each of which emits light. As a result, depending on the distance between the diffusion plate and the LED modules in the fixture, the spaces between packages on the module can appear as dark spots.
To prevent this, the diffusion plate has to be placed further away from the module, which unfortunately increases the thickness of the fixture.

With the new Samsung LAM series using diffusion-improving optic technology, the diffusion plate can be placed much closer to the module – as close as 35 millimeters, a significantly smaller space than the 80 to 100 millimeters needed for conventional T5/T8 fluorescent tubes.

Xicato® XIM - The Intelligent Approach to the Internet of Lights

Xicato, enablers of the Internet of Lights, introduced its new XIM LED Module, a 100+ lumen per Watt light source that is designed to accommodate an integrated LED driver, on-board dimming capability, self-diagnostics, sensors and connectivity. For the first time, a single intelligent module will enable luminaire manufacturers to simplify the implementation of controls and dimming for end-users and establish a true digitally enabled light platform.



Xicato's intelligent XIM module delivers more than 100 lm/W and has a 5-year color consistency and lumen maintenance warranty

OEMs can offer a more universal and future proof platform that connects to virtually any back end operations and management system via wired and wireless communication platforms. By integrating most sensors - essentially putting the power of a smartphone into the module - XIM enables aesthetically pleasing, architectural grade luminaires, enabling an Internet of Lights.

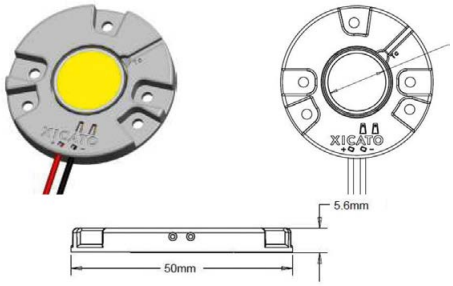
New System Architecture:
Xicato's integrated approach unifies the electronics with the LED system. This future-proof approach removes the variability between drivers in the market. It simplifies the OEM supply chain and fewer devices need to be stocked. Voltages, connectivity and diagnostics will be completely managed within the module. A new 48V DC constant voltage solution enables a thinner track, safe operation and more cost effective designs.

Integrating in the Module:
Xicato has made a smaller, more cost effective version of the company's patented Corrected Cold Phosphor Technology® that delivers all the benefits customers have enjoyed with its first generation of modules and creates space to integrate electronics and sensors. With integration in the light source, luminaires from any manufacturer can work seamlessly together and with virtually any management system.

Xicato® XTM - Zhaga Compatible, Cost Effective LED Module

Xicato, enablers of the Internet of Lights, announced availability of its new XTM module. With more than 100 lumens per Watt at operating temperatures, XTM is a cost effective module that outperforms competitors by as much as 20% in its 1300, 2000 and

3000 lumen packages. The Zhaga compatible mechanical interface enables virtually any luminaire manufacturer to quickly and easily incorporate XTM into existing luminaires and for the first time offer Xicato's renowned light quality and consistency to a broader portion of the professional lighting market without sacrificing system efficiency. Xicato has dramatically reduced the size of its Corrected Cold Phosphor Technology®, the innovation that enables the company to maintain consistent color and quality of light over time by keeping the remote phosphor cool.



Xicato's Zhaga compatible XTM module delivers industry leading quality

XTM LED Module Features:

- Standard, Artist, & Vibrant Series
- 400 lm to 5000 lm
- 100+ lm/Watt
- 2700 K to 4000 K CCT
- No UV Emissions
- Corrected Cold Phosphor Technology®
- Zhaga Compatible

Xicato's ability to provide engineered light that is consistent, reliable and uniform over time is unchanged and the XTM will be available in Xicato's full light quality portfolio: Standard Series™, Artist Series® and Vibrant Series™, eight flux options from 400 lumens to 5000 lumens and a full range of correlated color temperatures from 2700K to 4000K. General sampling of XTM coincided with this year's Light + Building show and production volumes will be available in June for 1300, 2000 and 3000 lumen options with the balance through the 2nd half of the year.

The company will continue to provide customers with comprehensive support, including identification of complementary electronic, optical and thermal components to customers so that customers' efforts are greatly reduced and solutions can be brought to market more quickly and with greater confidence.

Non-Linear Curved and Flexible Light Guides from GLT

Global Lighting Technologies (GLT), the world leader in edge-lit, LED-based light guides, has increased their capabilities to include non-linear curved light extraction technologies, enabling the design of more complex light guides.

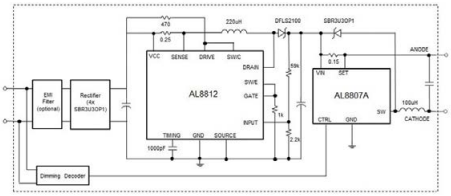
GLT's non-linear curved light extraction technologies enable the design of more complex flexible light guides

These non-linear light guides can be integrated into a variety of products, from overhead lighting and wall sconces to automotive interior/exterior lighting such as dome lights, passenger compartment lighting, and daytime running lights, as well as white goods and consumer electronics devices.

This new product capability was made possible by two developments within the company. The first was the development of a thin film embossing process that allows manufacturing of 0.25 mm or less thick flexible light to be used in applications requiring flexible or mechanically curved products. The second was a change to the manufacturing process of the optical extraction features embedded in the light guides, allowing injection molding while creating the extraction features onto curved surfaces for thicker light guides. These developments allow GLT to custom design the curvature of the light guides for various applications, offering typical sizes from 0.25 mm to 4 mm thick and greater than 24" in diagonal, depending on the application.

Diodes High PF Boost LED Driver for MR16 LED Lamps

Diodes Incorporated, a leading global manufacturer and supplier of high-quality application specific standard products within the broad discrete, logic and analog semiconductor markets, has introduced the AL8812 DC-DC converter. This device, which features boost, buck and voltage-inverting modes, co-packages a 60 V, 3.6 A-rated power N-channel MOSFET with all primary functions required by a DC-DC controller into the compact DFN6040-12 dual exposed-pad package, enabling a reduction in form factor of MR16 LED lamp circuits.



Dimmable MR-16 LED driver system diagram based on Diodes' AL8812 and AL8807A combination

Applications:

- Low Voltage LED Lighting such as MR-16
- General Purpose DC-DC Converter

Features:

- Operation from 3.0 V to 20 V Input
- Integrated 60 V, 3.6 A MOSFET
- Low Standby Current
- Current Limiting
- Output Voltage Adjustable
- Frequency Operation to 100 kHz
- Precision 2% Reference
- Totally Lead-Free & Fully RoHS Compliant
- Halogen and Antimony Free

With a 6 mm x 4 mm footprint and an off-board profile of just 0.6 mm, the AL8812 converter is comprised of a temperature-compensated reference, a comparator, a controlled duty cycle oscillator with an active current limit circuit, a driver and a high-current output switch.

The AL8812 features an input voltage range of 3 V to 20 V and an output voltage that is fully adjustable up to 60 V. This wide operating voltage range makes the device suitable for medium-voltage LEDs and 12VAC lighting applications, as well as dimmable MR16 LED lamps.

Shut-down current is very low at less than 0.01 µA, typical, and its maximum output switch current is 3.6 A. The converter is able to deliver very accurate voltage and current control by incorporating a precision reference with a 2% tolerance.

By combining the AL8812 with its AL8807A constant current step-down converter, Diodes Incorporated has produced a two-stage reference design for dimmable MR16 LED lamps that provides good transformer compatibility and low current ripple at a very reasonable BOM cost. ■

Dialog Semiconductor iW3600 with 1-100% Dimming Range

Dialog Semiconductor introduced its latest single-stage LED driver to address dimming performance, heat and cost in high power, dimmable solid state lighting applications. The new 45 W output iW3600 seamlessly dims from 100% down to 1% of measured light with virtually no dead travel and offers low pop-on current to turn light on at very low dimmer levels (< 5% of light output).

Besides built-in configurable temperature derating for predictable operating life, iW3600 offers a wide 1% to 100% dimming range with a low pop-on current of < 5% of the light output

Key Features:

- Output power: 45W
- Single-stage design for low BOM cost
- Built-in, configurable LED over-temperature protection derating
- Wide dimmer compatibility (TRIAC, digital), automatic detection of dimmer type
- Wide dimming range: 1% to 100%
- Lowest pop-on current < 5% of light output
- Configurable dimming curves compliant to NEMA SSL 6 dimming standard
- Meets global standards, including European Union IEC61000-3-2
- Zhaga hot-plug compliant
- Low TDH < 20% with high PF > 0.92

The iW3600 also uses Dialog's patented, configurable over-temperature protection (OTP) derating to tackle LED bulb lifetime issues caused by excessive heat, while its single-stage, digital design lowers Bill Of Material (BOM) costs for lighting OEMs.

Designed for retrofit bulbs including external, dimmable lighting ballast drivers and A19, PAR and T8 bulb replacements used in existing phase-cut dimmer installations, the iW3600 incorporates Dialog's patented intelligent dimming control to provide compatibility with a wider range of dimmers, including TRIAC, digital and universal dimmers. This technology uses digital analytics to query the dimmer and applies algorithms that automatically adapt to the dimmer type.

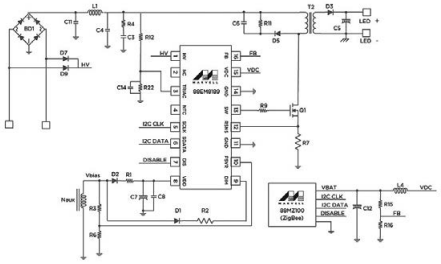
Most power ICs are designed with thermal shutdown, which simply shuts the IC down in high temperature environments. This procedure protects the IC, but not the LED driver circuit, since most control IC shutdown occurs well above safe operating temperatures for electrolytic capacitors.

The iW3600's built-in configurable temperature derating technology monitors the temperature inside the sealed SSL bulb and, in high temperatures, automatically reduces current drive to the LEDs in small, virtually imperceptible increments, then seamlessly restores brightness as temperature falls. This results in cooler operation and helps ensure a predictable and safer operating life.

The iW3600 meets or exceeds global regulations for power quality and efficiency with low total harmonic distortion (THD) < 20%.and high power factor (PF) > 0.92. ■

Marvell's Intelligent LED Controller for Smart Wireless Lights

Marvell announced its new AC/DC LED driver Integrated Circuit (IC), the Marvell® 88EM8189 featuring I2C compatible digital interface integration to connect with a networking microcontroller that runs a lighting control protocol, such as Zigbee, for Smart wireless bulbs, providing premium dimming performance with a full dimming range from 100 percent to 1 percent.



Marvell's new 88EM8189 LED controller offers I2C control, low standby power, compatibility to phase cut dimmers and accelerates the transition of smart lighting

Key Benefits:

- Single-stage fly-back or buck-boost topology
- Integrated digital interface I2C for connection to networking microcontroller to provide digital dimming through ZigBee, Wi-Fi, Bluetooth, PLC and other technologies
- Integrated AC-DC converter for bias power supply to networking microcontroller
- Enables meeting ENERGY STAR power consumption (500mW standby) when light is off
- Backward compatible with phase cut wall dimmers worldwide
- Reduced system BOM cost with two chip lamp solution – 88EM8189 plus connectivity device

Electrical performance:

- >0.95 PF
- Up to 90 percent efficiency
- <20 percent THD

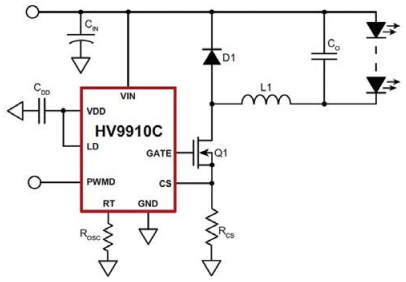
Marvell's 88EM8189 chip integrates a separate high efficiency AC to DC power supply circuit providing standby power dedicated to the networking chip; therefore, lowering the bill-of-materials (BOM) for the electronics and drastically driving down the price point. This implementation enables the lowest standby power consumption by the networking circuit in a Smart wireless bulb while the light is turned off, allowing the system solution to meet today's ENERGY STAR requirements. Built on the same technology as Marvell's industry-leading phase cut LED driver chip the 88EM8187, Smart bulbs using the intelligent 88EM8189 chip are backward compatible with existing phase cut wall dimmers as a system level option. The Marvell 88EM8189 LED driver currently is sampling with global customers.

Marvell's 88EM8189 LED driver IC is part of the Marvell Smart Lighting Platform which includes 88MZ100 ZigBee microcontroller,

88MC200 Wi-Fi microcontroller and a low cost ZigBee-to-Wi-Fi gateway solution. The Platform fully supports industry open protocols in ZigBee Home Automation (ZHA) and ZigBee Light Link (ZLL), and is accessible by mobile devices via Wi-Fi. Marvell built an ecosystem around the platform including original device manufacturers (ODMs) and cloud software partners to offer turn-key solution to end markets. Marvell's open architecture also allows the Smart bulb to be connected to home gateways offered by retailers and service providers.

Supertex Releases HV9910C Universal HB LED Driver

Supertex, a recognized leader in high voltage analog and mixed signal integrated circuits (ICs), released an additional package option for the HV9910C. The Universal High Brightness LED Driver is now available in a lead(Pb)-free/RoHS compliant 8-lead SOIC with heat slug package in addition to the 8L and 16L SOIC packages.



Typical application circuit using the Supertex HV9910C LED driver IC

Features:

- Enhanced drop-in replacement to the HV9910B
- Open loop peak current controller
- Internal 15 to 450 V linear regulator
- Constant frequency or constant off-time operation
- Linear and PWM dimming capability
- Over-temperature protection

Applications:

- DC/DC or AC/DC LED driver applications
- RGB backlighting LED driver
- Back lighting of flat panel displays
- General purpose constant current source
- Signage and decorative LED lighting
- Chargers

The HV9910C is an open loop, current mode, control LED driver IC that can be programmed to operate in either a constant frequency or constant off-time mode. It includes a 15 – 450 V linear regulator which allows it to work from a wide range of input voltages without the need for an external low voltage supply. HV9910C includes a TTL compatible PWM dimming input that can accept an external control signal with a duty ratio of 0 – 100% and a frequency of up to a few kHz. It also includes a 0 – 250 mV linear dimming input which can be used for linear dimming of the LED current. The HV9910C is equipped with built-in thermal shutdown protection.

The HV9910C is ideally suited for buck LED drivers. Since it operates in open loop current mode control, the controller achieves good output current regulation without the need for any loop compensation. Also, being an open loop controller, PWM dimming response is limited only by the rate of rise of the inductor current, enabling a very fast rise and fall times of the LED current. The HV9910C requires only three external components (apart from the power stage) to produce a controlled LED current making it an ideal solution for low cost LED drivers.

Diodes AL8807B Simplifies LED Lighting Design

Diodes Incorporated has introduced a dimmable buck LED driver enabling a reduction in component count and PCB size in 12 V and 24 V LED lighting systems and MR16-type LED lamps. The AL8807B is a hysteretic driver with an integrated power switch and operates at a switching frequency of 1MHz. The output current is set using a single external sense resistor.

Diodes' new AL8807B driver IC simplifies the driver design for 12 V and 24 V lighting systems

Dimming is achieved by applying a fast digital PWM signal to the driver's control input. A low voltage, applied to the same input, turns the output power switch off. Lamp reliability is ensured by the driver's built-in over-temperature, LED open-circuit and short-circuit protection features.

By packaging the driver in a small footprint, low thermal-resistance MSOP-8EP package, a higher power density is achieved, maximizing the permissible LED current over a wider ambient temperature range. The AL8807B delivers an LED drive current up to 1.3 A and operates between -40ºC to +125ºC with an efficiency of 96%.

From voltage sources between 6 V and 36 V, the driver will produce a constant current for a chain of high brightness LEDs. Average LED current accuracy is better than 5%, helping to improve channel-to-channel matching and meeting the requirements of most medium voltage LED lighting products. ■

Dialog's iW3640 for Simple 2-Channel Color Mixing

Dialog Semiconductor introduced its iW3640 solid state lighting LED driver, designed to bring mood-enhancing ambiance to price-sensitive SSL bulbs. The iW3640 2-channel, 25 W SSL LED driver offers a simple, low-cost, dimmable color-mixing solution to achieve warm incandescent-like dimming while eliminating the need for a microcontroller and dedicated power supply. This reduces the bill of materials (BOM) cost for 75 W to 150 W equivalent A19 SSL and PAR bulbs, as well as 20 W to 45 W commercial dimmable external lighting ballasts.

iW3640's simple 2-channel color mixing operation eliminates costs of MCU and power supply, while temperature derating ensures predictable operating life

Key Features:

- 2-channel, sunset dimming SSL LED driver: 25W output power
- Low BOM cost – no external MCU or power supply; PrimAccurate™ control eliminates secondary-side regulator or optical feedback isolator
- NTC-based LED over-temperature protection derating
- High power factor (PF) > 0.95, low total harmonic distortion (THD) < 15%
- Phase-cut dimming with wide dimmer compatibility, automatic detection of dimmer type
- Wide dimming range: 1% to 100%
- Meets global energy standards, including European Union IEC61000-3-2
- NEMA SSL 6 compliant
- Zhaga hot-plug compliant

While typical LED bulbs retain the same harsh white color as they dim, the dual driver output of the iW3640 lets designers use amber LEDs in parallel with the main white LEDs allowing LED bulbs to gain warmth as they dim. Dialog's patented, built-in digital dimming technology detects the dimmer type and phase - automatically adjusting LED color mixing in step with light intensity to provide smooth dimming that closely matches the warmth and ambiance of a traditional dimmable incandescent bulb from bright white down to warm amber, with flicker-free dimming down to 1% of initial brightness. The result is a much more intimate LED lighting experience in residential and commercial settings, where lighting plays an important role in setting the mood.

Dialog's digital dimming technology allows the iW3640 to work with virtually all phase-cut wall dimmers, including leading-edge (R-type or R-L type) and trailing-edge (R-C type) dimmers, as well as digital dimmers.

The iW3640 addresses bulb overheating issues by including an over-temperature protection (OTP) derating function. Additional iW3640 safety features include LED open/short circuit, over-current, current sense resistor short-circuit, and input over-voltage protection.

The iW3640 2-channel, 25 W SSL LED driver offers a simple color-mixing solution to achieve warm incandescent-like dimming that reduces the bill of materials (BOM) cost for 75 W to 150 W equivalent A19 SSL and PAR bulbs, as well as 20 W to 45 W commercial dimmable external lighting ballasts. ■

EnOcean Self-Powered 2.4 GHz Wireless Switch Module

At Light + Building 2014, EnOcean presented the world's first energy harvesting wireless switch module communicating in the 2.4 GHz ISM band. The new module is ideally suited for consumer applications such as the control of LED lighting systems. It complements EnOcean's established battery-less portfolio in the sub 1 GHz frequency band, often selected in building automation and smart home applications. With this portfolio expansion, EnOcean cements its position as the leading worldwide enabler of energy harvesting wireless solutions.

With this new product, EnOcean expands its portfolio of energy harvesting solution with a battery free, wireless switch module on the 2.4 GHz band to meet consumer market requirements

Visitors of Light + Building learned more about EnOcean's battery-less wireless switch module portfolio. For EnOcean, the development of the self-powered 2.4 GHz switch module signifies an entry-point for business acceleration in the consumer space.

The power of motion:
The 2.4 GHz switch module has the same form factor as EnOcean's renowned PTM 210 module in the sub 1 GHz frequency band. Therefore, it fits in any standardized light switch. It is powered by EnOcean's miniature world patented ECO 200 electromechanical energy generator. Converting kinetic energy into electrical energy it works in the same way as a small but powerful dynamo, drawing out and delivering this power to a wireless module.

Worldwide-established technology:
EnOcean sells its self-powered wireless solutions in 37 countries on four continents and has been adopted by more than 150

OEMs worldwide. The EnOcean radio standard ISO/IEC 14543-3-10 is very well established for battery-less wireless solutions in building automation based on a large ecosystem of products. EnOcean's self-powered wireless switch modules are already widely used in the building automation and smart home sectors. Here, they have proven that wireless link is a reliable alternative to traditional wiring in buildings. With its new 2.4 GHz (IEEE 802.15.4) switch module, EnOcean is targeting the specific requirements of worldwide consumer applications. ■

m!Qbe - New Controls Concept for Modern Lighting

The m!Qbe makes it simple to control your light. Its six faces reproduce six lighting functions that can be easily selected by placing the cube on the corresponding face. Predefined favorite lighting situations as well as the manual adjustment of color and intensity are provided by the m!Qbe. It is therefore much more flexible than a traditional light switch but at the same time much easier and faster to use than a smartphone app for lighting control.

The system consists of the m!Qbe, the gateway m!Base and the wireless charging station m!Charger and offers a perfect connection being compatible to the system of Philips hue

New lighting technologies bring reams of options to vary personal lighting at home. An easy and intuitive solution is needed to extend or to replace traditional light switches in order to use all these possibilities in daily life. The team behind the m!Qbe was faced with that very problem when one member's grandma visited them one day. She was amazed at the colorful LED lamps and wanted to take them home – until she got to know the control with a smartphone app. That is why the young startup from the Lighting Technology Institute of KIT in Karlsruhe (Germany) deals with the intuitive control of light. Now, with the m!Qbe a light switch is available that offers both access to all the options of modern lamps and easy usage that is a lot of fun.

The m!Qbe features six functions to control the light. Besides the off-state two faces serve as manual adjustment of light color and intensity. A simple rotation of the cube around its own axis changes these parameters individually. Once the preferred color and brightness are chosen for one lamp, the next lamp can be selected with a short touch on the face or the current situation can be transferred with a long touch to all lamps in the room. The remaining three faces store favorite lighting situations that can be accessed directly by turning the cube to the corresponding face. Thus it is easy to switch on the suitable light for different situations such as reading the newspaper or relaxing on the couch. The m!Qbe is the perfect light switch for everyone who wants to control their lights quickly and simply. In addition, there is always a surprise inside. It never gets boring with the random lighting situations achieved by shaking the m!Qbe.

The 77x77x77mm sized m!Qbe communicates via Bluetooth to a gateway that is connected to the local network. With its open source software it will be possible to connect other devices of daily life in a similar way, for example, the audio system. ■

LumaStream Broadens Trinity™ Line Power Centers

LumaStream, the leader in low-voltage, intelligent, LED lighting systems, announced today that it has expanded its Trinity line of remote power drivers for LED lighting, adding an analog model with as many control zones as power channels to give lighting designers and system integrators ultimate design flexibility. Lighting applications where 0-10V controls are most common, but where only small numbers of LED fixtures are grouped together on one switch, can now have the same variety of lighting configurations as a digital, low-voltage system at the lower analog system price point.

The expansion of the Trinity™ series brings new flexibility to low-voltage LED lighting systems

LED is the fastest growing technology for general lighting in commercial buildings. LumaStream is the only company to offer a holistic approach to low-voltage power distribution for LED lighting. The Trinity 3-in-1 platform combines digital power conversion, constant current drivers, and superior dimming control into one cohesive, intelligent LED power supply. Trinity remote drivers can power and control up to 24 LED luminaires up to 200 ft. away using only thin-gauge speaker wire.

According to the U.S. Department of Energy, onboard drivers are the number one source of failure in LED fixtures. LumaStream eliminates that failure point, combines power and control onto one wire, and provides both analog and digital control protocols.

The new Trinity Analog model is ideally suited for hospitality and medical office applications where standard analog control switches and dimmers are used and where individual rooms or spaces may have only one or two LED fixtures that need to be powered or dimmed at once. Both markets, hospitality and healthcare, are experiencing growth in 2014, leading in new construction numbers.

A first project to benefit from the new Trinity Analog power supply is the St. Petersburg College midtown campus. Opening later this year, the new facility will incorporate LumaStream low-voltage power distribution and LED fixtures. Each administrative office will have the familiar toggle switches and slide dimmers for light control, but groups of several offices will be able to be powered from a single Trinity remote power supply. The energy efficiency and infrastructure savings are significant, while the system is easy to install, configure, and commission. This saves the college upfront investment and shrinks the ongoing operating expense. ■

EM converterLED - Emergency Light for Standard LED Modules

With the EM converterLED product range, Tridonic provides simple implemented emergency light functionality with local battery supply for standard LED modules. The emergency light drivers feature reliable 3-pole technology with compatibility to most LED control units in the market. Thanks to power control, the maximum output for specified rated operating duration is always achieved in emergency light operation.

Tridonic's EM converters are available in three versions, Basic, Selftest and DALI, offering different function and duration test functionality

The product family consists of the versions EM converterLED BASIC, EM converterLED SELFTEST and EM converterLED PRO DALI.

EM converterLED Types:

- EM converterLED BASIC features fundamental emergency light functions with an appealing price-performance ratio. The function test and duration test are carried out manually, whereby the function test must be implemented once monthly and the duration test once each year.
- EM converterLED SELFTEST features self-test functions for the emergency lighting installation. An indicator LED positioned noticeably on the luminaire housing displays the test results. Integrated, automatic test routines in the emergency light unit are implemented in compliance with international standards for emergency light operation.
- EM converterLED PRO DALI represents the high-end solution in the portfolio of emergency light drivers. Tests can be individually set via DALI x/e touchPANEL or other DALI-compatible components for each device. The test results are either displayed with an indicator LED on the luminaire housing or documented centrally, e.g. on the DALI x/e touchPANEL.

Classification according to SELV classes:
All three versions are additionally subdivided according to SELV classes. Luminaire design is particularly simple up to a maximum of 60 V forward voltage (EM converterLED 50 V – 10 to 50 V forward voltage), as no supplementary measures are needed for protection against accidental contact. Typical applications are spots for example, operated with higher current but with forward voltage below 50 V.

SELV applications to a maximum of 120 V forward voltage (EM converter LED 90 V – 50 to 90 V forward voltage) cannot be touched and are suitable for luminaires requiring higher forward voltage. Typical applications are single LED modules switched in series with a nominal consumption of 20 to 50 W.

The non-SELV versions have been designed for maximum output voltages of 200 V (EM converterLED 200 V for 50 to 200 V forward voltage). These are typically assembled in linear and planar luminaires and also ensure homogeneous light distribution with emergency lighting.

The emergency light drivers are compatible with standard dimmable and non-dimmable constant current converters on the market, and thanks to integrated power control always ensure maximum output for the specified rated operating duration (1 – 3 hours). The emergency light driver identifies the forward voltage of connected LED modules and regulates the LED current to the maximum possible value with which connected batteries achieve the specified service life. The power control function also enables many different combinations of LED converters and modules. ■

SL Power's Smallest Conduction Cooled 130 W Power Supply

SL Power Electronics, an industry leader in the design and manufacture of rugged, highly reliable power supplies, announces its LB130 series single output power supply. The LB130 is the first conduction cooled LED power supply to deliver 130 W at 90% efficiency in such a small size. It is ideal for high intensity entertainment applications such as stage lighting and theatre control systems due to the ability to operate efficiently in extreme temperature conditions and tight spaces.

SL Industries' new 130 W LB130 Series AC/DC power supply offers high power density, high efficiency and a wide temperature operating range

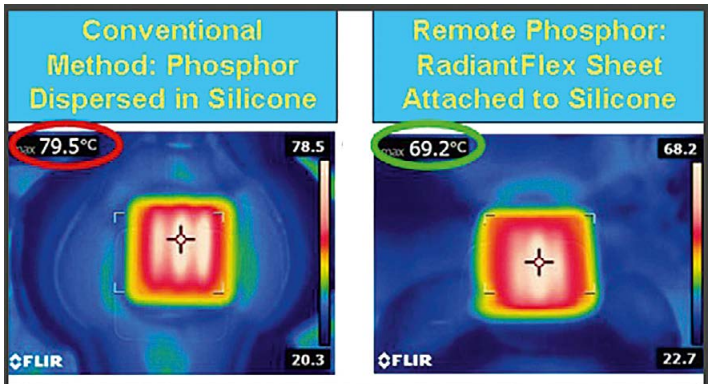
The LB130 is designed to operate from -40°C to 70°C providing optimum thermal performance. Delivering 130 watts at 70°C ambient, the LB130 power supply is the smallest in the industry featuring conduction cooling that eliminates space and associated costs needed for fans. Meeting EN55015 standard for Electro Magnetic Compatibility (EMC) immunity and Class B Conducted EMI, the LB130 does not require an external Electromagnetic Interference (EMI) module – saving valuable space and costs. In addition, the power supply can turn on at -40°C, eliminating the need for a costly heating element. The LB130 also meets the European lighting harmonic requirements from 130 Watts to 5 Watts, enabling the lighting fixture to comply with EN61000-3-2 class C for 100% to 0% dimming. Featuring over 50,000 hours of life expectancy at 70°C ambient temperature, the LB130 provides the key element for a LED solution over traditional lighting.

The new model features a universal input of 90 to 264 VAC and 56 V output voltage. Moreover, the LB130 Series high power density power supply is ideal for backlight, panel and architectural lighting as well as light controllers needing a highly reliable and energy efficient power solution in a small form factor at an affordable cost.

Featuring a three-year warranty, the RoHS compliant LB130 model has more than 50,000 hours of lifetime expectancy operating at 70°C and has EN/CSA/UL/IEC 60950-1, 2nd Edition approval markings. ■

PhosphorTech Releases New RadiantFlex Products

PhosphorTech has just released its latest RadiantFlex phosphor sheet product series for ultra-high color rendering (CRI) LED applications and, furthermore, has recently demonstrated a High Light Extraction (HLE) version of its remote phosphor RadiantFlex sheet capable of improving a white LED's wall plug efficiency (WPE) by as much as 31%.



RadiantFlex	Power Gain [Wrad(out)/Wrad(blue LED)]	Quantum Gain [PhotTot.(out)/Phot(blue LED)]
RF524-HLE	127%	139%
RF530-HLE	131%	145%
RF540-HLE	119%	124%
RF545-HLE	128%	145%
RF620-HLE	116%	139%
RF630-HLE	121%	155%
RF640-HLE	121%	162%
RF650-HLE	112%	159%

Comparison of the RadiantFlex and conventional phosphor technology

High CRI RadiantFlex Series:

The new products are available from "warm white" (CCT~3000 K) to "cool white" (CCT~5500 K) versions with CRI as high as 96 using blue LEDs between 450-455 nm. These products offer unmatched

luminous efficacies when compared to competing technologies having similar CRI. Such high performance is achieved by the unique ability of the RadiantFlex manufacturing process to accurately layer different phosphors and achieve unique spectral shapes while minimizing self-absorption and scattering losses.

High Light Extraction RadiantFlex Series:
The new technology enables the thin remote phosphor sheet to couple directly to the top surface of a COB LED encapsulant using a high performance silicone layer that can withstand temperatures as high as 260°C. This results in increased light extraction and more effective thermal management that can lower the phosphor operating temperature and improve both efficiency and longevity. The remote phosphor sheet can be die-cut and applied to the LED surface using standard pick-and-place equipment. This technology has also been used to demonstrate LED light engines with ultra-high color rendering index (CRI Ra~97) with high R9 in all colors ranging from “warm white” (CCT~3000 K) to “cool white” (CCT~5500 K).

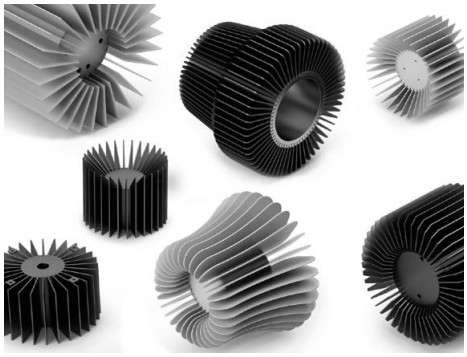
About the RadiantFlex Technology:
The most common usage of phosphors in solid-state lighting (SSL) involves pre-mixing micron-size particles with a polymer and directly depositing the phosphor slurry on the LED die. Unfortunately, such a traditional approach results in lower wall plug efficiency (WPE) due to optical scattering losses and light trapping within the phosphor/polymer matrix. Furthermore, as LED power increases, this method becomes more limited because of the significant thermal and optical loads on the phosphor, which lead to further drop in efficiency and performance at higher temperatures and power densities. Therefore, the remote phosphor approach becomes more attractive.

The RadiantFlex technology and corresponding patent-pending manufacturing process are a direct result of over a decade of research in various remote phosphor application methods, phosphors, and substrate materials.

Unlike conventional remote phosphor plates, the RadiantFlex technology enables package-level application of phosphor layers to blue (and UV) LEDs. This removes the need for expensive mixing chambers and external reflectors and provides higher performance at lower costs. The RadiantFlex approach also eliminates the need for LED producers to handle phosphor powders and invest in expensive phosphor mixing and dispensing equipment. This will result in considerable R&D savings for LED and lamp manufacturers who typically must spend significant time and resources developing a custom phosphor mixture for each application. As is well-known in the SSL industry, achieving high CRI with high luminous efficacy in white LEDs is a complex process plagued with repeatability and uniformity problems since it involves a carefully controlled mixture of several different phosphor compounds. The RadiantFlex technology eliminates those problems and enables detailed analysis and quality verification of the phosphor layers prior to integration with the LED. This results in significant savings in terms of materials and resources that are typically involved in any new LED product development & manufacturing. ■

Fischer Elektronik - Round Cellular KTE R Heat Sink

It is sufficiently well-known and not a question that LEDs have become the lighting medium of the future in many areas of daily life. Innovative cooling concepts to cool the LEDs are more requested and in demand than ever to be able to use the advantageous properties of the LED truly effectively and with a particularly long service life.



Fischer Elektronik offers customization of the surfaces, cores and heat spreaders for its new KTE R series round heat sinks

Fischer Elektronik supports this ongoing demand by expanding its extensive product range of LED heat sinks with cellular heat sinks in a round model with individual design possibilities of the series KTE R.

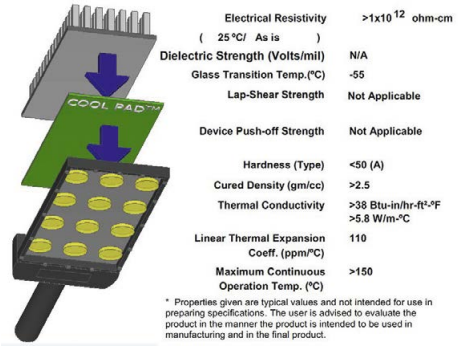
To receive the LEDs, they consist of a full aluminum core with continuous grooves in which aluminum plates are attached for heat abduction via a pressure/adhesive bond.

The core diameter to the LED receiver, the plate number, thickness and geometry can also be adapted to all conventional LED modules and sizes according to customized specifications. Due to the design flexibility, there is also the possibility to integrate complete LED systems including reflectors and the corresponding LED holders as well as fan motors for active cooling.

Different surfaces, mechanical processing as well as receptacle cores for heat spreading from copper can also be realized. ■

AI Technology’s Second Generation of Patented Cool-Pad™

AI Technology, Inc. (AIT) introduces Cool-Pad™ CPR7154, a new class of thermal interface material that dispenses like a thermal pad, but performs with characteristics like that of a grease or gel when device temperatures increase to above 45°C. Cool-Pad™ CPR7154 is optimized to accommodate large areas with different heights and gaps of less than 3-mil along its interfacing area. It is filled with a modified oxide mixture and is electrically insulating at normal voltage. It is designed to have high compressibility as applied in comparison to traditional thermal pads. Once the device temperature reaches 45°C, Cool-Pad™ CPR7154 will “melt-flow” to fill even the smallest of trapped air along the interface between the device and heat-sink or heat-spreader.



AIT’s Cool-Pad™ is simple to use and offers high performance

Cool-Pad™ CPR7154 is semi-tacky on both sides for optimum thermal transfer performance. Cool-Pad™ CPR7154 has high thermal conductivity and low Tg characteristics that impose minimum thermal stress on bonded parts during thermal cycling or shock testing. While Cool-Pad™ has some intrinsic tack strength; it is not designed for bonding. A mechanical fastener must be used to provide assembly integrity.

A mechanical fastener of 5 psi or more is recommended to provide intimate contact between the Cool-Pad™ and the interfacing surface. Because Cool-Pad™ is compressible, it will fill in uneven height differentials and warps between the mating surfaces. The ultimate performance of Cool-Pad™ is achieved after the first cycle of melt-flow phase-change at 45°C or automatically when the device heats up during operation or with externally applied heat if the device is not anticipated to reach 45°C.

Cool-Pad™ CPR7154 is designed for thermal interface applications to withstand the worst of temperature and moisture exposure in outdoor LED luminaire applications with modules from different brands. ■

MechaTronix's Small Spot Light LED Cooler ModuLED Pico

As an extension to the success of the ModuLED modular LED coolers, MechaTronix developed a new era of passive LED cooling in a diameter of 47 millimeters, named the ModuLED Pico. The secret of the ModuLED Pico can be found in the way that the ultimate thermal performance has been reached in this narrow diameter.

MechaTronix's new ModuLED Pico with its unique thermal design serves various LED platforms

The ModuLED Pico has a unique thermal design, based on the ideal balance between creating cooling surface and generating space for free air convection cooling.

Also the outer surface is extended to generate extra radiation cooling. Radiation can count for up to 40% of the total cooling performance in free air convection environments, and mainly depends on the visible surface and the emissivity of the surface.

Even under a tilted position of 50 degrees the cooling performance remains almost unchanged. This makes the ModuLED Pico the ideal cooling source for tiltable spot and down light designs.

Two new versions are available and focus on the medium LED spot and down light market from 600 to 1,800 lumen. With a fixed diameter of 47 mm and lengths of 50 mm and 80 mm the ModuLED Pico have a thermal resistance of respectively 5.2°C/W and 4.2°C/W.

The ModuLED Pico is foreseen as a variety of standard mounting patterns for all the newest generation LED modules and COB's. In this way lighting designers can standardize their designs with a limited number of LED coolers.

Just mechanical compatibility is of course not sufficient, so a thermal validation will be necessary with a combination of the LED module/COB and the cooler. Either the application engineers from the brand partners or MechaTronix's LED design team offer assistance on thermal compatibility questions. ■

WAGO's New SMD PCB Terminal Block for Small LED Modules

The 2059 Series compact SMD PCB terminal blocks stand out thanks to their compact size, their small pin spacing and a high rated voltage, making them particularly well-suited for small LED modules in spotlights, downlights or street lights. The smallest WAGO terminal block, with a mere overall thickness of only 2.7 mm, is extremely flat, covers a wire cross section range of AWG 26 to AWG 22 (0.14 to 0.34 mm^2), for solid conductors, and has pin spacing of 3 mm. The PCB terminal block is designed for a rated current of up to 3 A and a rated voltage of 160 V.

WAGO expands its SMD family with the new, just 2.7 mm high, extremely compact 2059 Series PCB terminal blocks

Design Benefits of the WAGO Terminal Blocks:

- The terminal block small size means it requires less space for the connection technology used. Its low profile, along with its light color, reduces on-board LED shadowing.
- The terminal blocks are available as 1-, 2- or 3-pole versions and can be connected in series without losing any poles. This means that no extra terminal block versions need to be kept on stock when a higher number of poles is required - increasing flexibility and reducing costs.
- Use and handling is especially easy, as solid conductors can simply be directly inserted and also removed quickly using an operating tool.
- The PUSH WIRE® connection provides a high-quality and maintenance-free connection.

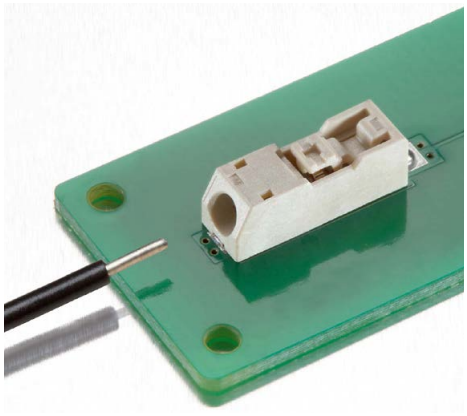
Besides the smallest terminal blocks of the 2059 Series, WAGO covers an extensive range of applications with its 2060 and 2061 Series, up to maximum conductor cross sections of 1.5 mm^2. The 2060 and 2061 Series terminal blocks are equipped with an integrated push-button that can be used to very easily connect fine-stranded conductors and to remove the connected conductors.

The 2060 Series SMD PCB terminal blocks are ideal for surface-mounted PCB applications. Just 4.5 mm high and a conductor cross section of 0.2 to 0.75 mm^2, these terminal blocks offer great benefits in the smallest of space. The 2061 Series SMD PCB terminal blocks have a cross section range of 0.5 to 1.5 mm^2 and are perfect both for industrial applications and for direct feed-in of LED modules.

All SMD PCB terminal blocks are available in tape-and-reel packaging for use in automated machines, allowing them to be fully integrated into SMT assembly and processing. ■

Molex Low-Profile Lite-Trap™ SMT Wire-to-Board Connectors

Molex Inc. announces its new Lite-Trap™ SMT Wire-to-Board Connector System featuring an overall compact size that meets the needs of thin LED lighting-module applications.



Molex's new Lite-Trap™ easy-to-use push-button latch allows simple field assembly and removal for manufacturers of thin LED lights

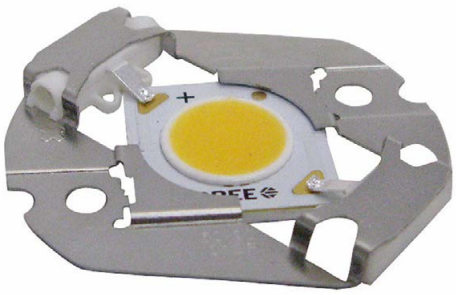
LED lighting manufacturers are continually looking for ways to reduce component height on their boards in order to achieve thinner designs and minimize shadowing or interference with the light source. Molex's push-button style Lite-Trap wire-to-board connectors, with a profile height of just 4.20 mm, provides one of the lowest profile and wire insertion forces available on the market today compared to wire-removable type connectors.

The termination method of the Lite-Trap connector is similar to the established Wire Trap connectors Molex introduced, as well as certain 'poke-in' types, but requires a lower wire insertion force. A stripped wire is inserted into the connector and pushes open a dual-contact gate-style terminal design that "traps" the wire, providing a secure electrical contact and high wire-retention force. The Lite-Trap connector also features a user-friendly latch that is easy for operators to engage and disengage without the use of a tool. These features combine to offer easy field assembly and removal if needed, even for untrained technicians.

Other features of the Molex Lite-Trap connector include a long wire insulation design that provides stable wire placement for additional contact assurance. In addition, an innovative wire stopper feature facilitates correct wire insertion depth placement. ■

Ideal Introduces Compact Low-Profile COB Array LED Holder

Ideal Industries, Inc., a leading supplier of LED components to OEM light fixture manufacturers, introduced the new Chip-Lok(TM) Jr., a compact, low-profile version of the company's original Chip-Lok COB (Chip On Board) array holder. The new Chip-Lok Jr. provides improved design flexibility when integrating smaller arrays into compact fixtures and lamps.



Ideal named its new COB Array LED holder, which is consistent with Zhaga size and mounting parameters, Chip-Lok Jr.

The new Chip-Lok Jr., with its small footprint, fits virtually any size fixture and is configured to hold arrays from Cree, Citizen and most other leading manufacturers. It helps OEMs to lower system cost, increase reliability, and bring their designs faster to market.

Measuring only 35 mm in diameter, the Chip-Lok Jr. occupies approximately 50% less area than the original. It stands 0.3mm in height above the array to allow unmatched access to LES for optics. Screw mounting holes at 25 mm and 35 mm spacing further enhance design flexibility. The size and mountings are consistent with Zhaga parameters, providing a means for OEMs to standardize on luminaire components and utilize COBs from different manufacturers.

The Chip-Lok Jr. holder is fabricated from hardened stainless steel to prevent the "creep" to which plastics are prone, assuring greater thermal pressure for the life of the luminaire. This metal frame also provides a thermal path so the array can run significantly cooler while offering superior structural strength when compared to arrays mounted using plastic holders. Because Chip-Lok Jr. array holders help lighting manufacturers reduce chip temperature, the OEM can benefit from extending array life or reducing the size of their heat sink. ■

Instrument Systems Goniophotometer for Angular-Resolved Measurements

The LGS 1000 from Instrument Systems allows angle dependent spatial radiation characteristics of large LED modules, solid-state lighting (SSL) products, as well as lamps and luminaires to be determined. The Munich-based company presented key upgrades for its largest goniometer system at this year's Light + Building fair in Frankfurt.

With Instrument Systems LGS 1000 and the optional luminous flux integrator, the measurements can be taken faster and are more accurate

The LGS 1000 can be operated together with a photometer as a conventional goniophotometer or with a spectrometer as a high-quality goniospectroradiometer. This allows all important performance characteristics such as luminous intensity distribution curves, luminous flux, color coordinates and even color rendering index to be measured.

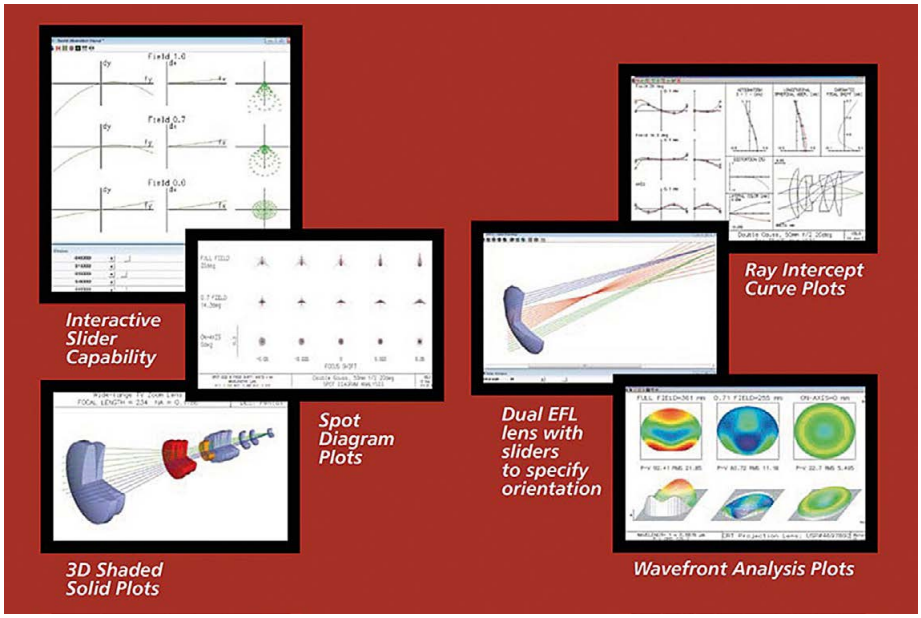
As an optional accessory, the newly developed luminous flux integrator allows the characteristics of lamps and luminaires to be determined in their required burning position. An added benefit is that the measurements can be taken faster and are more accurate. Furthermore, Instrument Systems supplies an innovative correction procedure for position-sensitive samples. If a low-maintenance measuring system with a compact footprint is a top priority, the LGS 1000 together with correction of the burning position provides a genuine alternative to a large and expensive rotating mirror goniophotometer.

Alongside the new accessory options, the basic version of the goniometer also offers an array of advantages. Accessible steps allow samples up to 2 m in diameter and weighing 50 kg to be easily mounted. Notwithstanding the robust dimensions, the LGS 1000 can still be accommodated in a laboratory with a standard ceiling height. The two synchronously controlled servo motors with precision angle encoders facilitate simultaneous movement with minimal vibration. The reproducibility of the sample positioning is smaller than 0.1° at nominal load.

The comprehensive SpecWin Pro software package offers easy evaluation and reporting of the measured data. Alongside a turnkey solution for electrical drive and measurement of samples, SpecWin Pro can generate the important IES and EULUMDAT formats for the lighting industry.

Lambda Research Corporation Announces the Release of OSLO v6.6.2

Lambda Research Corporation, the leading designer and publisher of illumination and optical design software, announces the latest release of OSLO – v6.6.2 – which contains significant updates and enhancements.



OSLO is available in four editions, OSLO Premium, OSLO Standard, and OSLO Light, plus a free educational version OSLO EDU

OSLO (Optics Software for Layout and Optimization) is a powerful optical design program with the scope needed to meet today's optical design requirements at an affordable price. In addition to classical lens design features, OSLO combines advanced ray tracing, analysis, and optimization methods with the only compiled macro language in an optical design program, to quickly solve a wide variety of new problems in optical design.

Release v6.6.2 consists of several updates and improvements: most notable is support for the Hikari index interpolation formula and an overhaul of the glass catalogs to reflect the latest data from CDGM, Hikari, Hoya, Ohara, Schott, and Sumita.

Primarily used for lens design, OSLO enables optical designers to determine the optimal sizes and shapes of the components in optical systems and is capable of modeling a wide range of reflective, refractive, and diffractive components.

LED MR16 Lamp Smoothly Mimics Halogen Dimming

Ledzworld, the innovator behind the top brands in commercial LED lighting, displayed a breakthrough color temperature adjustable LED MR16 lamp that perfectly emulates the color tones of halogen light bulbs when dimmed at Light + Building. Now users can create the right color temperature ambiance through dimming while enjoying the energy-efficient and long-lasting benefits of LED lighting.

The second generation of Ledzworld's "Color Temperature Adjusted" (CTA®) dimming technology allows a CCT range from 2700 K down to 1600 K while adjustments can be made to meet customers' specific demands

Seen as a large barrier to wider adoption of LED lighting, full-linear dimming has been an obstacle for many manufacturers. LED MR16 lamps on the market today simply reduce light output when dimmed, but maintain the same Correlated Color Temperature (CCT) throughout the dimming. This leaves much to be desired when it comes to the ambience in a room.

Utilizing a second generation of the company's patented and award-winning "Color Temperature Adjusted" (CTA®) dimming technology, Ledzworld's new CTA 2.0 LED MR16 lamp not only adjusts the light output strength while being dimmed, but also gradually transforms from a bright soft tone color temperature at the highest level, to a warm flame color at the lowest dimming level.

The CCT on the new lamp will range down from 2700 K to 1600 K depending on the dimming level, and adjustments can be made to meet customers' specific demands. ■

Samsung Debuted New Smart Bluetooth Controllable LED Bulb

Samsung Electronics launched a range of LED lamp solutions. The highlight is a Smart Bulb that includes Bluetooth controllable LED lighting designed for the future.

Samsung's new Smart Bulb will be available for B2C and B2B markets, whereby B2B customers can also deploy Zigbee

Unlike traditional Wi-Fi controllable LED lighting, the Smart Bulb utilizes Bluetooth technology which eliminates the need for a bridge and wireless AP, enabling the user to connect and control it directly from a smartphone or tablet PC. By installing an application, users can access and control up to 64 Smart Bulbs with no additional equipment or set up required.

The Smart Bulb can be dimmed down to 10% brightness and is CCT tunable from 2700 K to 6500 K. With a lifetime of 15,000 hours per Smart Bulb, users will receive approximately 10 years of highly-efficient light.

B2B customers can deploy the Zigbee Smart Bulb that allows lighting to be controlled from anywhere and from smart devices such as a smartphone and tablet PC. ■

UGetLight Introduced New Liquid Cooled Led Bulbs

Beijing UgetLight Co.,Ltd (Ugetlight) took advantage of led replacement trends under worldwide incandescent lamps bans by introducing its new generation of led-"UGL" liquid-colored led bulbs at Light + Building 2014. Adopted liquid cooling patent technology, liquid cold LED light is now considered as the best replacement of traditional incandescent lamps.

UGetLight's latest liquid-cooled LED bulbs were released at Light + Building covering 6, 8 & 12 W A19 lamps of different CCTs from 3000 - 6500 K

UGL liquid-cooled LED bulbs are made for bringing artificial lights back to tradition and prevail over tradition. UGL liquid-cooled LED bulbs are designed with the same look as incandescent bulbs and use liquid cooling patent technology to give a true 360-degree light resembling regular incandescent lights and prevent thermal deterioration of the LED Therefore UGL liquid-cooled LED bulb is the simplest and most perfect replacement of traditional lamps.

The bulbs are respectively equivalent to 60 W, 75 W and 100 W incandescent bulbs. Each bulb is rated for 50,000 hours of life has a CRI above 80, gives 360 degree lighting under working temperature at 40-55°C. ■

Verbatim Innovative Optics Improves LED Lamp Performance

Verbatim unveiled a dichroic-effect MR16 LED lamp and advanced omnidirectional optics for Classic A lamps.

Some of Verbatim's new optics are the Mirageball (right) used in A lamps (left) and the dichroic-effect optics of the new MR16 lamps (center)

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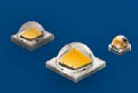

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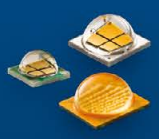


INTEGRATED ARRAYS

ARRAYS

MODULES

Verbatim's dichroic MR16 LED lamp is a cost-effective, energy-efficient replacement for dichroic halogen lamps popularly used for track lighting, pendant fixtures and retail display lighting. The lamp provides all the energy saving benefits of LED lighting together with the sought after surround lighting effect that is the characteristic of dichotic halogen lamps. The Verbatim 4W dichroic MR16 LED lamp with GU5.3 base delivers excellent optical control with minimal spill and a crisp 30 degree beam angle focusing light where it's needed. With a compact body, the MR16 does not interfere with fixtures.

Using a unique lens created via a two-color molding process developed by Mitsubishi, Verbatim will also showcase Mirageball optical technology. This special optic lens delivers uniform omnidirectional light distribution – something that LED manufacturers have found difficult achieving without shadows or rings being formed from the light. The new Classic A lamp is perfect for floor lamps or wall sconces where a very even and wide angled light is necessary.

Soraa Announces Simply Perfect™ PAR and AR111 Lamps

Soraa, the world leader in GaN on GaN™ LED technology, announced a full range of LED AR111, PAR30, and PAR38 lamps that will be available to ship in late Q2. All Soraa lamps feature 3-phosphor LEDs with violet pump that enable benefits such as Point Source Optics for beautiful, uniform beams of high intensity,

Like all other Soraa lamps these new products also feature 3-phosphor LEDs with violet pump

Violet 3-Phosphor (VP^3) Natural White and VP^3 Full-spectrum Vivid Color, which reveal the magic of whiteness and colors in every environment. Now, Soraa's Simply Perfect™ Light is available in a portfolio of larger form factors essential for retail, hospitality and residential applications.

Soraa's large lamp portfolio of AR111, PAR30 Long Neck (LN), PAR30 Short Neck (SN) and PAR38 lamps achieve 1000 lumen output with VP^3 Natural White and VP^3 Vivid Color technology, defined by full-visible-spectrum, high whiteness rendering, 95-CRI, and 95-R9. The family of large lamps will be available in 25°, 36°, and 60° beam angles, and in a wide range of color temperatures.

The AR111 is an important lamp for object lighting, requiring narrow spots, crisp beam edges, and no glare. With a peak intensity of 27,500 cd, Soraa's 8° 95-CRI/95-R9 AR111 is the only LED product that matches halogen levels, The PAR30LN and PAR30SN lamps offer the only 8° narrow spot option on the market without active cooling, achieving a center beam intensity of 28,250 cd.

Phosphor-Free White Light from Nanopyramid LEDs

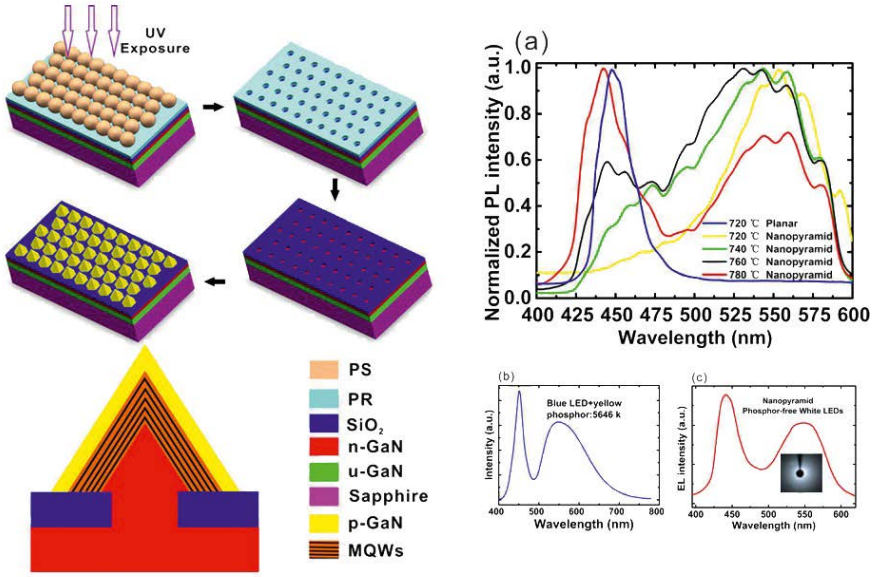
Researchers of the Chinese Academy of Sciences's institutes of Semiconductors and Mechanics, and Tsinghua University have used nitride semiconductor nanopyramid structures to create LEDs with spectra that are similar to those provided by 'white light' LEDs with yellow phosphors [Kui Wu et al, J. Appl. Phys., vol115, p123101, 2014]. A similar CAS/Tsinghua team previously reported such devices, using a polystyrene nanosphere mask to make holes for selective-area growth of nanopyramids.

The light-emitting structures are grown on the semi polar facets of the nanopyramid. Growth in semi polar directions of the crystal structure should avoid electric field polarization and strain-dependent effects that make the growth of high-indium-content indium gallium nitride (InGaN) difficult. High-quality high-indium InGaN is needed to achieve longer-wavelength light emission for 'white light'.

The n-GaN template consisted of a 2 µm n-type layer on 2 µm undoped GaN buffer on sapphire substrate. A mask layer of silicon dioxide was deposited and patterned using a hexagonal array of polystyrene nanospheres. The photoresist patterning created 400 nm diameter holes in a 900 nm periodic array. The pattern was transferred to the silicon dioxide by inductively coupled plasma (ICP) etch.

Metal-organic chemical vapor deposition (MOCVD) then proceeded to grow the nitride semiconductor material on the exposed n-GaN template. The initial growth was 1050°C n-GaN for 4 minutes to form nanopyramids with {10-11} facets. Next, a five-period InGaN/GaN multiple quantum well (MQW) was grown (720-780°C), followed by a 13 minute 950°C p-GaN layer. The resulting nanopyramids were about 600nm high.

The photoluminescence spectra of the nanopyramids gave two peaks around 445nm (blue) and 550nm (yellow).
The balance of the peaks depended on the MQW growth temperature. In particular, the higher-temperature growth increases the blue relative to the yellow peak.
The researchers attribute this to the decomposition of the yellow-emitting regions, which have higher indium content.



Left: Fabrication schematic for phosphor-free nanopyramid LEDs by nanospherical-lens photolithography. Right: (a) Room-temperature photoluminescence spectra of nanopyramid LEDs with MQWs grown at different temperatures, along with reference structure grown on planar template. (b) Spectrum of 'white LED' (blue LED with yellow phosphors). (c) Electroluminescence spectrum of nanopyramid LEDs at 20mA; inset shows corresponding optical microphotograph

When grown at 780°C, the nanopyramid LEDs exhibit a spectrum which is similar to phosphor converted white LEDs using yellow phosphors.

Microscopic inspection of ectroluminescence showed that the blue radiation comes from the apex of the pyramids, while the yellow radiation comes from the base region which has higher indium content and wider, less quantum-confined wells, leading to a smaller energy gap.

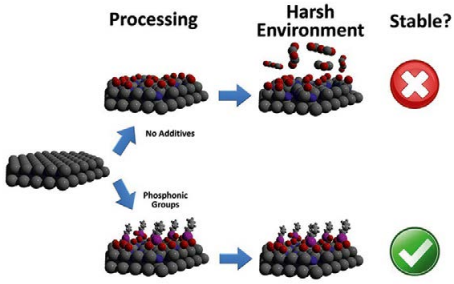
The researchers admit that the nanopyramid radiation is still weak:, but believe that the brightness can be improved by optimizing the growth parameters, including the size, aspect ratio, and the structure of MQWs."

Conventional LED fabrication processes need to be developed to cope with the rough surface of the nanopyramid structures.
The researchers are working on device structures and chip processes that will enable detailed electroluminescence characterization of nanopyramid LED structures.

On the basis of finite-difference time domain (FDTD) simulations, the researchers believe that the nanopyramid arrays have a light extraction efficiency about four times higher than for conventional planar MQWs that suffer from a small escape cone at the air-GaN interface. The simulations give an escape cone as high as 85°, compared with less than 40° for planar structures. ■

New Technique Makes LEDs Brighter, More Resilient

Researchers from North Carolina State University have developed a new processing technique that makes LEDs brighter and more resilient by coating the semiconductor material Gallium Nitride (GaN) with a layer of phosphorus-derived acid.



By coating polar gallium nitride with phosphonic groups, the researchers increased luminescence without increasing energy input (Image Credits: Stewart Wilkins)

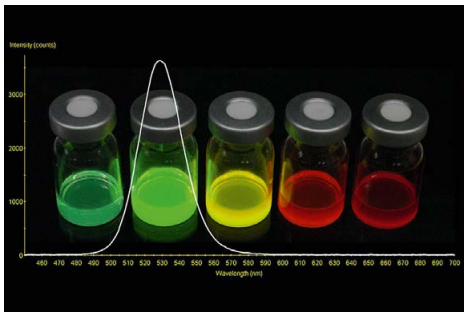
By coating polar GaN with a self-assembling layer of phosphonic groups, it is possible to increase luminescence without increasing energy input. The phosphonic groups also improve stability, making the GaN less likely to degrade in solution. More stable GaN is more viable for use in biomedical applications, such as implantable sensors.

The researchers started with polar GaN, composed of alternating layers of gallium and nitrogen. To increase luminescence, they etched the surface of the material with phosphoric acid. At the same time, they added phosphonic groups – organic molecules containing phosphorus – that self-assembled into a monolayer on the surface of the material. This layer further increased luminescence and improved the stability of the GaN by making it less likely to react chemically with its environment.

Thick-Shell Quantum Dot Technology to Increase Brightness

Quantum Materials Corporation and Los Alamos National Laboratory's announced Quantum Materials optioning Thick-Shell 'Giant' Quantum Dot patented technology with the potential of 10 to 100-fold improvement in solid-state brightness over conventional nanocrystal quantum dots (QD). High brightness leads to efficient use of materials and increased performance in electronic displays and solid state lighting.

"Blinking" is a tendency of quantum dots to flash off momentarily often noted as a challenge for certain quantum dot applications. LANL scientists also discovered that thick-shelling quantum dots dramatically reduces fluorescence intermittency by better separating absorption by the shell and emission by the core, significantly suppressing blinking.



Quantum materials optioning Thick-Shell 'Giant' Quantum Dot patented technology promises improvement in solid-state brightness over conventional nanocrystal quantum dots (QD)

Commercial product lifetimes can be increased in QD-LCD backplane displays, solid state lighting films and projection lighting because the thick-shell technology has demonstrated the ability to extend the service life of quantum dots exposed to higher temperatures and/or high intensity light. Further, non-blinking quantum dots that can produce higher light output with less heat generation will spur new product development and optimized design.

LANL also achieved thick-shell "Giant" QD near-infrared (NIR) emission for a major advance affecting medical imaging applications, optoelectronics, lasers, telecommunication and solar photovoltaics. For example, targeted cancer cells will be easier to identify and track, and varied absorption and emission ranges offer tailored performance in electronics and solar designs.

Quantum Materials plans to integrate the LANL thick-shell technology into its quantum dot product line. The Company's automated process is capable of manufacturing industrial-scale quantities while maintaining tight uniformity and makes possible the reliable, economical production of thick-shell tetrapod quantum dots having the exact characteristics necessary for specific applications.

Stephen B. Squires, Quantum Materials CEO and Founder believes that the number of quantum dot performance improvements afforded by adding thick-shell technology to their Tetrapod Quantum Dots will set them significantly ahead of their competition. The ability to manufacture uniform industrial-scale quantities of quantum dots engineered for optimal application-specific performance parameters will expedite acceptance of these new technologies by display and lighting manufacturers.

Combining LANL thick-shelling abilities with QMC's tetrapod quantum dots' properties of high uniformity, and narrow emission (higher color purity) is expected to be revolutionary in affecting quantum dot lifetime, quality of performance, enhancing of stability, and color rendering.

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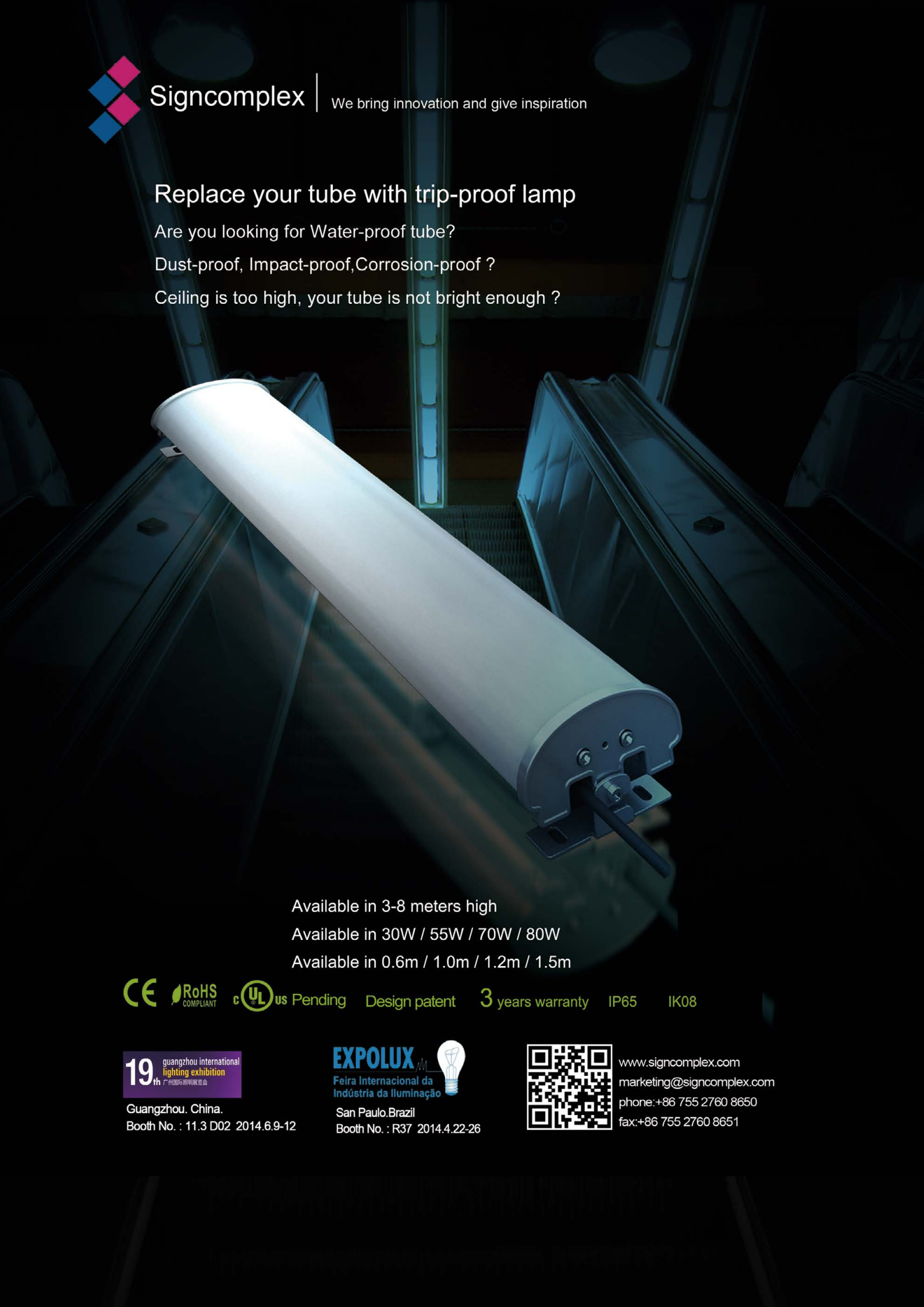

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Tech-Talks BREGENZ: Martina Paul, General Secretary, CIE

Martina Paul

Martina Paul is general secretary of the International Commission on Illumination (since 2007) and Managing Director of the CIE Scientific Services GmbH (since 2009). She has vast experience as senior manager in international organizations, including eight years as Deputy Secretary General of HOPE'87, an NPO in operational relationship to UNESCO. Ms. Paul's main expertise and focus lie on change and stakeholder management in a global context. She holds a Master's degree from the University of Economics and Business in Vienna.

With the rise of LEDs as the future lighting technology, the relatively stable lighting industry faces many changes and challenges. One of the main challenges is the ever increasing speed of transitions, something already seen in the semiconductor business. Standardization organizations are facing similar challenges. On the one hand they should define standards that will last as long as possible and on the other hand the standards need to be as clear and precise as possible. Martina Paul, Secretary General of the most important standardization body, the International Commission on Illumination (CIE) was invited to the Tech-Talks BREGENZ to discuss these topics.

LED professional: First of all, we'd like to say thank you for talking to us about the latest trends in the area of solid-state-lighting within the scope of the Tech-Talks BREGENZ. To begin, could you tell us a little about the history of the CIE and what your duties are as General Secretary?

Martina Paul: The CIE is actually a very old organization. Its predecessor was founded on the occasion of the World Expo in Paris in the year 1900. The gas industry called about 500 engineers and scientists together to standardize the photometric properties of street lamps. At that time, street lamps were run on gas. At the beginning, the CIE was called the Commission de Photometrie and then in 1913 it changed its name to Commission Internationale de l'Eclairage or the International Commission on Illumination in English. Through disrupting technologies like solid-state lighting and regulatory interventions to promote energy efficiency, the stakeholders have also changed. There are new groups of stakeholders which did not have anything to do with lighting in the past, such as the semiconductor industry.

I personally come from the area of organizational development and change management. I have always worked in international organizations within very complex environments. My main competence lies in being able to reduce complexities and to find solutions for complex problems for various players on a global context. Light is a very challenging subject and at the same time, inspiring, especially when leading this organization as its CEO through the technological changes.

LED professional: Can you tell us a little bit more about the organizational structure of CIE?

Martina Paul: The CIE not only covers the subjects of light and lighting, light quality and measurement and the description thereof, the metrics, but color is also a key topic. One of the first crucial standards that the CIE published was in 1931: the so-called color matching functions, which was the basis for how the human eye sees color. The CIE has a very broad spectrum that has expanded to the areas of photobiology, photochemistry as well as image technologies. Like all standardization and scientific organizations, the CIE is based on national committees. Right now there are 51 committees from all over the world. These committees must organize the stakeholders that work with light and lighting in their respective countries. It happens quite often that the CIE committees are consolidated on a national level and are identical to the national lighting organizations. We still differentiate between national full members and industrial, supportive members who, together, finance the CIE. The direct work is done in so-called Technical Committees which are part of the divisions.

LED professional: You mentioned scientific work – which is the basis for every regulation. Is the scientific work carried out in Technical Committees or is it "out-sourced"?

Martina Paul: Since the laboratories are CIE members, it is actually the same. We are currently working on defining a new Color Fidelity Index. Division 1 is responsible for color and perception. Right now we are at the point where a lot of experiments are carried out. Ten laboratories from all over the world have joined together in order to be able to carry out the final experiments. Once the experiments have been evaluated, they will be published by CIE as a technical report. The scientific work is carried out in the laboratories and the evaluation and publication is carried out through CIE. The transition from a technical report to a standard is done through formal polling steps. Most of the time, the technical report is the groundwork that is sent to the national committee to be commented on. It sometimes takes months of negotiations to integrate all of the changes asked for by the interest groups.

LED professional: Who decides which technical reports become standards, and how are the technical reports evaluated as suitable?

Martina Paul: Technical reports present the underpinning science and evidence, the groundwork, and might suggest the basis of a standard on that evidence. In the past, technical reports would be assessed within the community while a resulting standard was being formulated. Today the pace of change is so swift that this method is challenged and we have something of a conflict between scientific certainty and the speed of changing technology and demand for new standards.

LED professional: Light is often perceived subjectively or culturally and has cultural preferences. If you want to make something into a standard, should you take these different aspects into account? For example, light color has very different traditions. How do you find a common denominator so that a general regulation, norm or standard can be created?

Martina Paul: Some things cannot be made into a norm. A guideline consensus is needed to know what should be normed and what shouldn't. There are also norms that are only valid in, for example, Europe, the USA or China. And it should stay like that. Not everything is suitable for international standardization. It is necessary to have guidelines for global standardization and the CIE only works on global standardization tasks.

LED professional: Besides the CIE standards there are also the ISO standards. Can you explain the synergies and differences between what the CIE and the ISO do?

Martina Paul: The International Organization for Standardization or ISO is an affiliation of national standardization organizations like the DIN in Germany or the ANSI in the USA and is made up of over 200 member organizations.

The CIE was officially recognized by the ISO as an international standardization organization in 1986. Out of four organizations worldwide that have this status, the CIE was the first one to receive it. This status means that the CIE has the right to draft standards and position them with ISO.

LED professional: To what extent are the ISO technical committees involved in the development procedures of the CIE standards?

Martina Paul: Up until now, the CIE has made all of the basic and fundamental standards including the application-oriented standards. A disadvantage of the CIE is that it is only partly connected to national standardization bodies, namely only where there are national CIE organizations who are connected. The ISO technical committee was founded in order to increase the intake of new standards into the national standards inventories.

An agreement was made that the ISO committee would run complementarily to the CIE which means that the scientific part and the fundamental and basics in the domain would remain with the CIE.

An example would be the current topic of "Energy Performance of Buildings". The way basic metrics like daytime light parameters is described is very important. There is a work group in the ISO technical committee that also works with the CIE and the balloting process runs directly through the involvement of the national standardization organizations. In this way the organization path has been changed but at the same time it has been made more transparent and sustainable.

LED professional: Could you tell us a little more about your job as General Secretary of the CIE and what the current tasks in the ISO TC are?

Martina Paul: I have been the General Secretary at the CIE for 7 years now. My job, together with the President, is to represent the CIE to the public. The General Secretary is the only paid political function. All of the other people do their work on a voluntary basis in addition to their day jobs. Most of them have a certain amount of time allocated to them by their employers for the standardization and/or scientific work for international organizations. But in the end, it is volunteer work. The DIN is a driving force behind the ISO committee and holds the administrative office, which in turn means that they hold the right to suggest who will be the chairperson. This means that since I am the General Secretary of CIE I was appointted by DIN. My duties are not technical in nature but rather our task as chair-people is to create a consensus and to make sure that there are properly agreed, consensus-based documents that can be adopted.

LED professional: Apart from the interesting organizational topic, let's take a look at the contents. What changes has solid-state-lighting brought to the CIE and what topics are classed as important and have been addressed?

Martina Paul: Naturally, LED and OLED technologies can be labeled as disruptive technologies. The original light sources manufacturers are not the same ones that produce LEDs or semiconductors. Industries that we had no contact with at all in the past have suddenly become important players in this market and these players don't have a lot of experience with light. Because of this, a brand new value chain has developed and the market is still not completely reassessed. Coordination of the stakeholders has been an important task in the recent past and this phase is pretty much completed as far as I can see.

Content wise, a lot of changes have had to be made. Certain fundamentals have been written in stone and don't have anything to do with light sources. Some things like the area of colometrics only changes a little. But the LED has other photometric characteristics with various colors and/or spectrums and is a point light source. The human eye perceives the color of the LED light source differently than it does with a traditional light source. This means that the traditional color and glare metrics aren't 100% correct any more. There is a technical committee – Division 3 – that is working on the subject of "New Evaluation of Glare from LEDs".

LED professional: Will this new knowledge be added to the standards or will the standards be "updated"? Can you give us an example of what subjects currently have a high profile?

Martina Paul: The standards in question are being reviewed and might be updated if so requested. There is a technical committee that is concerned with the subject of OLEDs and we are already working on this technology. Division 2 – Photometry – will also start concentrating more on the subject of OLEDs.

We have also published a new report – Nr. 206 – titled "The Effect of Spectral Power Distribution on Lighting for Urban and Pedestrian Areas". This report shows that the human eye perceives light from certain LEDs as brighter than traditional light sources, which means it can be dimmed and energy is saved. The boundaries are naturally the deciding factor and this is where measurement is relevant.

These are the areas where classic metrics don't work anymore and new metrics are necessary.

LED professional: How long do you think it will take for the reprocessing of the content process of change and the subject of SSL? Can it be estimated?

Martina Paul: There are discussions going on right now and I will be holding a workshop on the subject of "Standardization and the Art of Imperfection" soon. This means that we should consider standardization more as a work in progress. Perhaps it would be a good idea if we agreed on one terminology that simply means that right now the descriptions are snapshots and that work will continue. This is why I don't feel I can commit to a time. My theory is that standardization as conventions should be seen differently today, namely as snapshots for a time period of at least three years. It should be clear in the standard where there is room for development.
You asked before about how we present flexibility. This is the exact challenge that we have, where we quote bandwidths or where we have to put certain areas "under construction".
We have to define it in terms of scientific organization where we make it easy to identify and define knowledge and unawareness. One has to abandon the definition of the forever-valid standards or scientific findings. This change process that we are now going through is an interaction of technological changes through SSL and globalization and the new orientation of the market structures in general.

LED professional: We see the changes in perception just as you have described. What other aspects are there due to or through the initiation of SSL technologies?

Martina Paul: The main thing is measurement techniques and the measurement of LEDs because they have other characteristics and are also different in regards to spectral characteristics.
In addition, metrology has changed and as a result the concept of measurement uncertainty is a concept that is worked with more and more. Both private and state labs are, in many cases, not sure as to what measurement uncertainty means. In the last LED professional Review you had an article by two CIE experts about that. Marketing observation is carried out by being able to compare products and this is achieved by being able to compare measurement methods. The CIE is now working on a measurement standard and we have come quite a long way with it. The draft for a measurement standard is already being polled. Just as an aside, I'd like to tell you the difference between regulators and standardizers. The CIE doesn't make regulations, but rather, standards. Standards are voluntary whereby regulations are mandatory and are stipulated by the lawmakers. Of course, the state can link certain standards to market initiation but the standards are not legal regulations. The International Energy Agency (IEA) is a classic regulator agency that is manned by governments. It has its own Annex 4E that concerns itself with testing and test methods.
The CIE has an agreement with the IEA, namely that the regulators will promote and implement CIE measurement standards.

LED professional: How far along is the standardization of the Color Fidelity Index?

Martina Paul: Color rendering has to be newly defined because LEDs have different spectral characteristics. For this reason, Division 1 is very busy developing this CFI because the CRI


Martina Paul

developed by the CIE is no longer applicable in some cases.
As I mentioned earlier, we are in the last measurement round; measuring samples and evaluating the results. This experimental round is being managed by a Japanese university professor. The CFI is the most important and most needed new definition in the industry. We surveyed all of the divisions and found out what they think are the necessary standards and which technology reports are necessary and then passed on the results to the industry. It turned out that internal and external ideas were congruent, which I, as General Secretary, find as a good sign. Through this there is a type of prioritization and standardization plan. CFI is at the very top of that list. We estimate that it will take another one and half to two years before the CFI becomes a standard.

LED professional: Today LEDs can be run on a pulsed mode or digital information is conveyed through the light. Because of this there are sometimes totally dark phases in the light, which leads to the question of how this will affect humans. Is this also part of the CIE's range of duties?

Martina Paul: Visual aspects of time-modulated lighting systems are presently discussed in TC1-83 and a report will soon be published. In addition there might be non-visual effects of modulated lights and this subject has been placed with Division 6 – Photobiology. This division is also working on the question of how blue lights affect people. Very complicated and elaborate studies are necessary for Division 1 and Division 6 because people have to be involved as test subjects.

LED professional: You are also chairperson of the ISO TC 274. Can you give us some insight into the goals and tasks of this TC?

Martina Paul: The TC 274 is a technical committee of ISO and is in the initialization phase. This TC will, for the most part, cover the application specific part of the norms. The idea is that, next to the basic fundamental standards, there will be additional standards for the application in specific lighting situations like interior lighting, exterior lighting, road lighting, tunnel lighting and so on. These will be worked on by the TC 274.

LED professional: Let's take a look at current trends in the area of energy saving. What is the CIE's position in the areas of Smart Lighting or the use of day lighting?

Martina Paul: The subject of day lighting is, of course, very important and is being worked on by the CIE. As a basis there is, for example, the sky definition, the day light definition like the CIE "General Sky" which is an international CIE standard. This subject has come to the forefront again through the "Energy Performance of Buildings". The subject of Smart Lighting, where it concerns the product standards in the area of electronics, is covered by the IEC. To differentiate, it must be clarified that the CIE concentrates on the application and fundamentals whereby the IEC concentrates on the parameters and safety, etc. of real products. There is the famous safety norm: IEC 62471. Photobiological Safety of Lamps. This document was initially a CIE Norm – Standard 009 that is now a joint standard of both organizations.

LED professional: You need a connection to real life – the industry – to do your work. How do you make these connections?

Martina Paul: The Global Lighting Association (GLA) was originally called the Global Lighting Forum and covered the national/regional lighting associations globally. Over the years, association structures were created and commitments were formed and now it is the GLA with its headquarters in Brussels. The GLA is associated with LightingEurope, the new organization structure in Europe, and can be understood as the voice of the international lighting industry. The CIE and GLA signed a Memorandum of Understanding last year. This cooperation is sustainable, efficient and built on a broad foundation.

LED professional: Thank you for participating in the Tech-Talks BREGENZ. To close, what is the CIE planning for the Year of Light 2015?

Martina Paul: The UNO General Assembly has declared 2015 to be a worldwide Year of Light. The CIE plans to have a global Open Lab Day that should take place in May 2015 and our 51 National Committees which span all continents will contribute with a variety of events.

I'm looking forward to coming back to Bregenz for the LpS 2014 at the end of September. Thank you. ■

LpS 2014

LED professional SYMPOSIUM +EXPO

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Dietmar Zembrot, President of LightingEurope

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Light + Building Review: Trends, Innovations and Technological Tidbits

The world's largest bi-annual lighting exhibition can be summarized with the words "It's all LED". But LEDs themselves were not the only things there. There were OLEDs and smart controls as well. The out-and-out explosion of LED products and LED-related products makes it impossible to cover everything even if focusing on the component level. Based on a vast amount of impressions, Arno Grabher-Meyer from LED professional selected some of the highlights to illustrate the latest trends.

Light + Building 2014 (L+B 2014) not only set a new exhibitor and exhibition space record with 2,458 exhibitors, but also announced a new attendance record with over 210,000 visitors from 161 countries. Traditionally, the best represented visitor nations after Germany were Italy, the Netherlands, France, China and Austria. There were also significant increases from numerous expanding markets, such as Russia, South Africa, Mexico, Turkey and Indonesia. Particularly striking was the return of visitors from Southern Europe with high double-digit rates of growth characterizing visitor numbers not only from Spain and Portugal but also Greece. While the spotlight on energy efficiency and intelligent building management anticipated a foreseeable trend some other trends in the lighting area were probably less obvious but certainly not less important.

LED Light Sources – Applicability, Quality & Integration

Those that expected the speed of LED efficiency improvements to approach the physical limits and slow down were completely wrong. Most manufacturers quietly stated that the practical value of efficiency increases in regards to energy savings may not be as important as it was one or two years ago. This was due to the simple fact that in 2012 an increase of 20 lm/W meant an increase of 20% to 30%. Today, in many cases it is only 10% to 15%. In 2012 the latest, best publicized and demonstrated components offered 80 to 120 lm/W while today some products are proclaimed to offer up to 200 lm/W both in hot systems and system levels. When comparing incandescent lamps to LEDs in 2012, the energy saving potential was approximately 80%. In 2014 it is close to 90%. An increase of only 10% may not seem like much when regarding energy cost savings, but this increase means that efficacy has doubled, and LED manufacturers have emphasized that while being a good marketing argument, there is still much more. It is true value for packagers, module and luminaire manufacturers. Every single lumen per watt efficacy gain eases design options, reduces heat issues and in the end, lowers manufacturing costs. For this reason it seemed that every LED manufacturer at L+B advertised efficacy improvements for their LEDs. For example, Cree announced a new lab record of 303 lm/W just before Light + Building, and Osram demonstrated the world's most efficient LED replacement tube prototype with a system efficiency of 205 lm/W that could become available by the end of next year.

As a result of this rapid development, a general trend of the tier one LED manufacturers followed. The increased efficiency allows for tighter packaging of LEDs without sacrificing thermal properties too much. They introduced so-called high lumen density array LEDs of different dimensions. This trend more or less picked up pace last autumn at the LpS 2013 with the introduction of Cree's CXA1520 LED. It culminated at this year's Light + Building with an extension of Cree's product range, the introduction of Osram's Soleriq P 9 and products from Samsung, Sharp, Xicato, Luminus, Bridgelux, Lumileds or Lextar, just to name a few.

These efficacy improvements lead towards more cost effective Mid Power LEDs and a tendency towards Low Power LEDs. In addition to

improved packaging technologies that reduce the packaging costs, the implementation of these products in different applications is now an affordable solution. Especially for area lighting, products based on these LED types may simplify the optical design to reduce glare. How intense a company exercises this trend is definitely a question of their strategy. LG Innotek even added primary micro optics with batwing distribution to the tiny 3030 package to support area lighting better. This new LED allows sleeker luminaire design with fewer LEDs per module and increased overall efficiency at lower costs and maintained emission uniformity compared to standard LEDs without optics. Mass production of the 3030IOL is expected in October of this year.

Figure 1:
Philips Lumileds' Luxeon M is one example of the industry's "high flux" LEDs that allow tight beam control

Minimized or no packaging is another trend. Improvements of manufacturers of flip-chip technology and phosphor molding processes led to the introduction of LEDs with well-reduced package dimensions as well as package-free or substrate-free (white) LEDs. Manufacturers like Samsung, Toshiba, Lextar, ProLight Opto and TSMC demonstrated increasingly smaller package sizes on the mid-power and high power LED level while providing sufficient current capability and luminous flux. In this category, Toshiba's GaN-on-Si based LEDs are the industry's smallest white mid power LEDs. With a package size of just 0.65 x 0.65 mm, they achieve a luminous efficacy of 130 lm/W and superior heat dissipation that allows them to be driven with a forward current up to 180 mA.

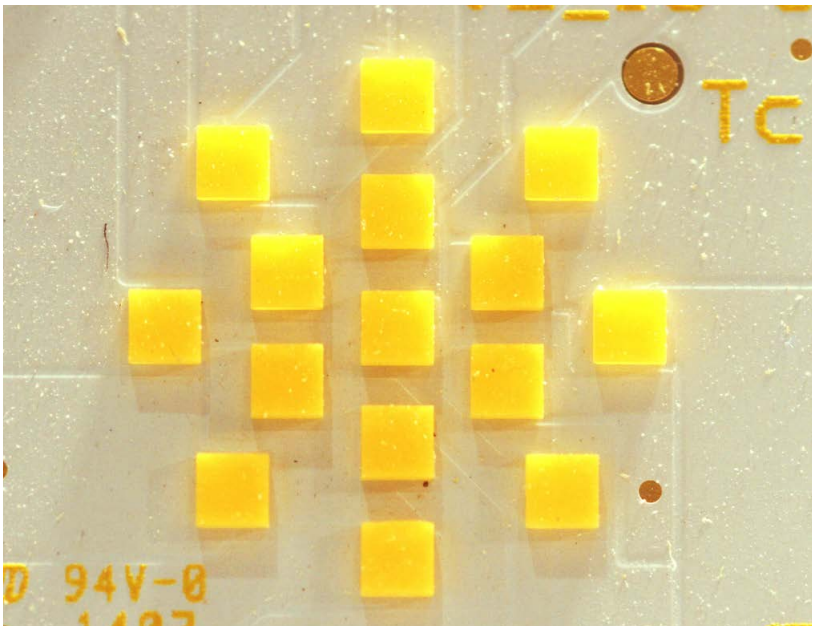


Figure 2:
TSMC's package-free flip-chip LEDs on a CoB module

Not really new, but something that is continuously increasing, is the trend of offering CCT and color tunable LED packages. The strategies and philosophies of the different companies vary between following the Planckian locus accurate using at least 3 different LEDs or simply shifting power between two LED types of different CCT. This trend is heavily supported by another very recent development that will be discussed as an example in a related application.

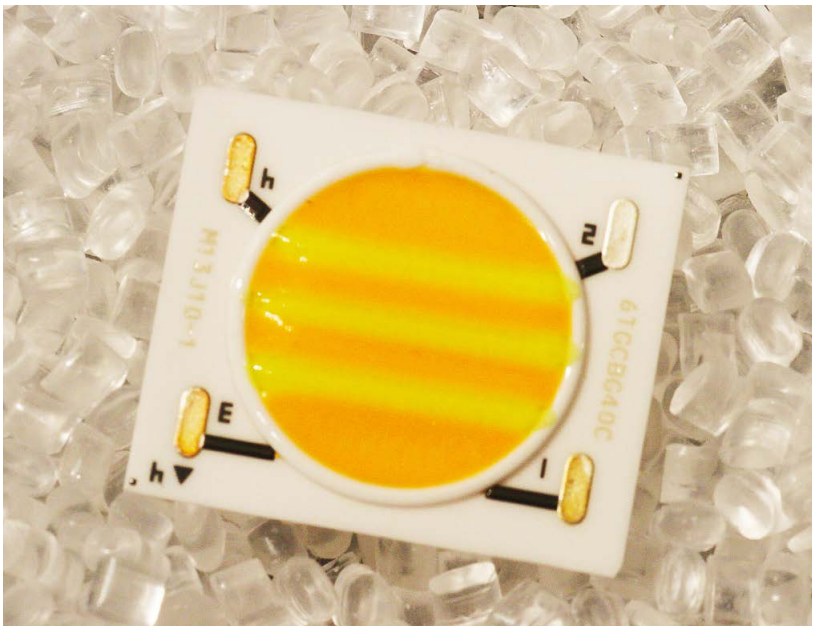


Figure 3:
Sharp counts on simplification of the color tunable approach, combining two different CCTs in one product, like here in the Tiger Zenigata

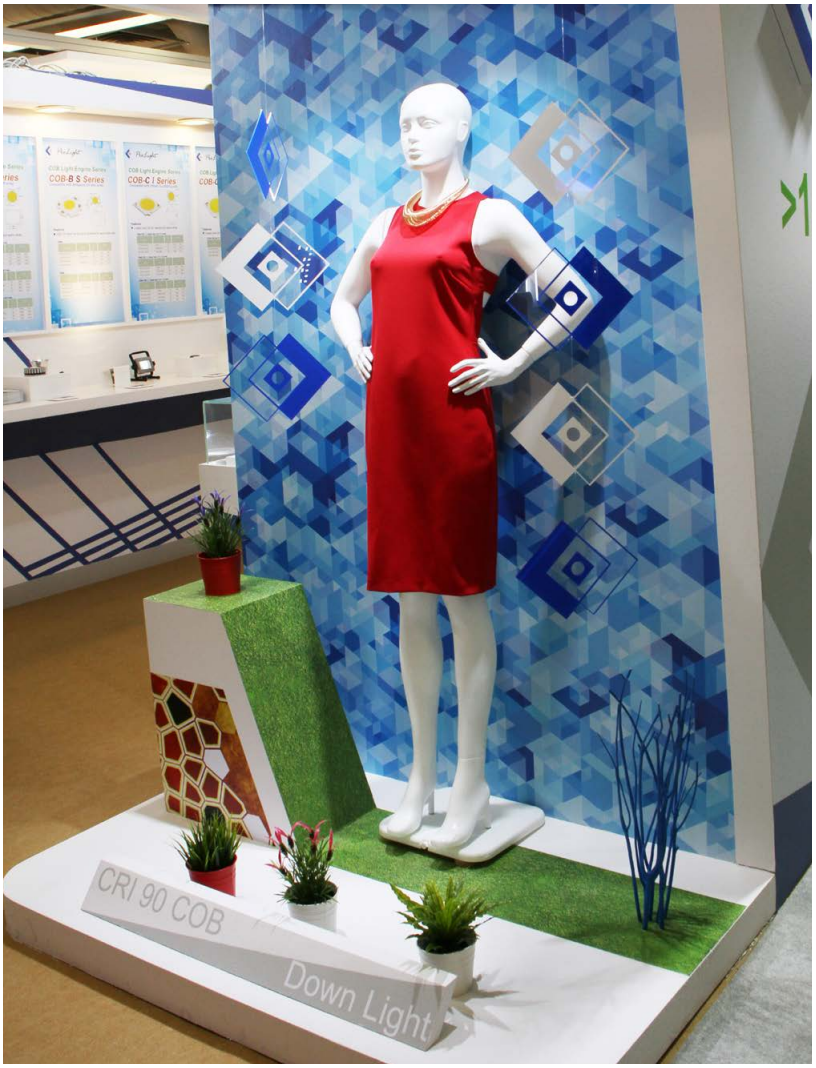


Figure 4:
Either CoB LEDs or modules with improved white renedering capabilities were demonstrated from most manufacturers; here from Prolight Opto

There was an article in the LED professional Review (LpR 40) - entitled “HD-Retina LED Technology, Light Quality Beyond CRI” - This topic was found everywhere at the L+B show. Almost every LED manufacturer presented a series or type of LED with very similar properties. By setting the color to a certain point below the Planckian locus, the typical yellowish-green tint of white objects that are illuminated by phosphor converted white LEDs was eliminated. A thoroughly mixed phosphor composition allows saturated colors and neutral, pure white at the same time. Philips calls this technology “Crisp” white LED technology, Xicato the “Vibrant” series, and Citizen calls it simply “Below Black Body Locus” (BBBL), while other companies have their own fancy names for these products. Some of them even do not define a CCT value. Bridgelux also offers similar products to their clients, for instance for the HD-Retina lights.

Figure 5:
More specific modules, like Bridgelux’s OLM for street lighting, aim to make manufacturing easier by reducing design effort and time to market

It is hardly surprising that module manufacturers, like Tridonic with their “FASHION” module series or “Tunable White” LLE series, follow the same trends with very similar approaches regarding CCT, CRI, color tuning or lumen density. But module manufacturers also utilized their design freedom to show additional concepts, initiating trends. Approaches for simplifying manufacturing and adding features and electronics were the most interesting ones. But there were also attempts and different interpretations of the Zhaga standards that were meant to satisfy the specification of the standard while adding additional features like mounting options.

BJB not only demonstrated their robotic lines for manufacturing luminaires, they also had their own newly designed socketed module on display that simplifies mounting and is available in a DC and AC version.

Bridgelux also launched another product in the module business. Following the introduction of their Vero in 2012, they presented the

Figure 6: **Sophisticated design and improved efficiency allow for integration of drivers, antennas, transmitters and other features into LED modules. Xicato's CTO, Gerard Harbers, presents the monitoring features of their new XIM series**

Outdoor Lighting Module (OLM) Series this year. Different power ratings with related efficacy and different photometric properties were designed to satisfy different applications and requirements. Bridgelux aims to help luminaire manufacturers by reducing time to market, R&D costs, time saving manufacturing and the elimination of some technical uncertainties.

Xicato started a true offensive of product announcements immediately before Light + Building. Two product announcements followed the general trend of increasing lumen density and efficiency. With the introduction of the XTM series, Xicato now offers Zhaga compatibility if required. But the most advanced and most interesting new product is their XIM series. The concept allows Xicato to follow the different demands of their customers to implement sensors and other features while providing similar photometric properties like all other Xicato modules of the standard and vibrant series. They are currently offering a basic set of surveillance and controls options for the module using their own integrated µC based driver. A cost effective simple 48 V AC/DC power supply can power numerous modules which can be controlled using DALI or 1-10 V dimming. That simplifies system design and lowers costs. The concept allows a clear control of all parameters to determine lifetime and integrate full electrical and temperature protection.

Figure 7: **Xicato's new XIM module impressively demonstrates smooth and flicker-free dimming down to 0.1%**

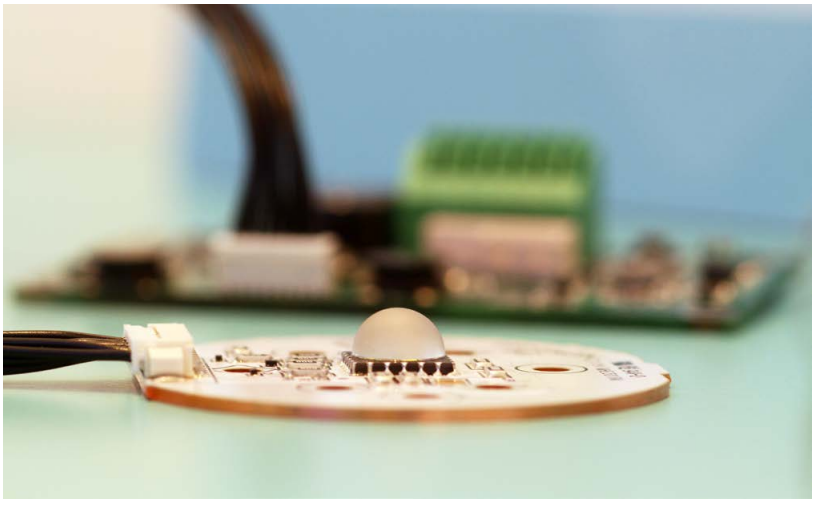


Figure 8: **Another example for improved implementation of drivers and control features is LED Engin's LuxiTune module, featurung perfect color tuning capabilities in a small footprint**

The vision of the developers for future product generations is to eliminate multiple visible sensors in a space and to integrate all of them in the module that shares the gained information with other building automation and surveillance systems. This visionary approach anticipates the predictions of the "Lighting Controls Report" which is also part of this LpR issue. Beyond these properties the product was very impressive with its smooth flicker-free low level dimming to 0.1%.

Figure 9:
Another hot topic was human centric lighting which is mainly an issue of controls. Here is a demonstration by Vossloh Schwabe

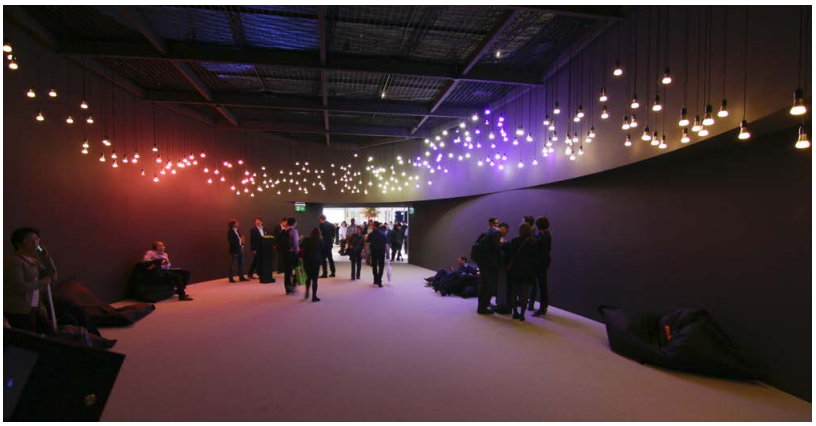


Figure 10:
Philips promotes its hue as the model for human centric lighting at every exhibition. The key to its capabilities lies in the controls in combination with its wireless ability

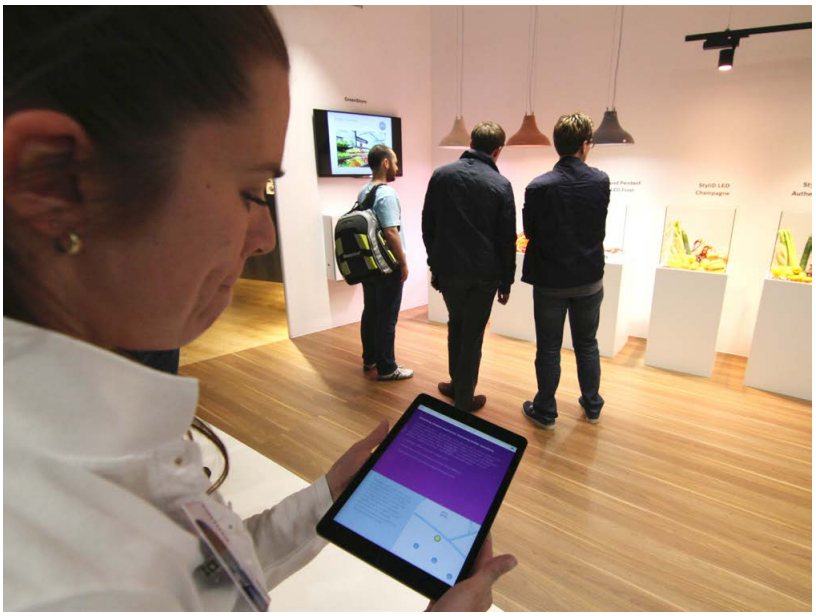


Figure 11:
Philips showed another controls concept with its connected retail lighting system. If the system finds wide-ranging acceptance, who knows what the future will bring

Drivers, Controls & Sensors – Wireless and Intelligence

For years now, different catchphrases have been around and different concepts have been presented on the market, from LiFi to power line and wireless. For this reason, people were hoping for new trials. When observing the activities of The Connected Lighting Alliance establishing the ZigBee Light Link for the residential market, one was hoping to see a matured wireless solution or two. The big surprise was that expectations were exceeded! This can only mean that developments had already started before TCLA started to promote it to the public. There were also other wireless systems on display. EnOcean introduced a 2.4 GHz-based system that can remotely control the Philips hue which is the model for ZigBee LightLink systems.

Actually, practically every system provider had some kind of wireless solution that can be controlled with an app on smartphones and tablets. But it isn't only the lighting system providers that are players in that field; IT and software specialists also offer solutions. Currently, the origin of an app is still relatively easy to determine. While IT specialists offer apps with a better look and feel, lighting specialists often have more unemotional but very functional user interfaces.

Integrated intelligence is another surprisingly wide spread topic that was covered by several companies. Co-exhibiting with Vossloh-Schwabe, a small Austrian company, Illumination Network Systems, demonstrated a highly integrated digital active IR sensor that precisely detects presence and activities. The system allows accurate spatial association and the performance of an adequate system action.

Philips demonstrated an even more accurate indoor positioning system using LED lights and a signal coming from the lights that is picked up by a smartphone. This visual light communications (VLC) system works with a unique identification code implemented into each lamp during manufacturing. The lights transmit continuously on a set frequency invisible to the human eye. To work properly, the mobile device camera needs to be active and the app calculates the position based on a triangulation of the lights. The phone therefore has to be able to "see" the lights in order for the VLC to work. This system is therefore mainly intended for retail shops and similar applications.

Another nice controls idea that showed where the future of controls might lie was presented by Artemide with the hand gesture controlled design luminaire Scrittura, designed by Carlotta de Bevilacqua and Laura Pessoni. While gesture control is already an option for different TVs and therefore not completely new, it is quite a progressive approach for a luminaire manufacturer, going one step further than the current smartphone or mobile device based controls concepts.

Optics – Silicone, Glass, and Complex Shapes

Most optics manufacturers and optical materials providers were working hard on improvements in product details. There were three remarkable findings when looking for optical solutions.

Some major optics manufacturers extended their activities in providing silicone based products. While PMMA or PC products are mainstream for standard applications, silicones are competitive alternatives when it comes to bigger lenses and some more complex optical requirements. The unique property of silicone being processed without shrinking and maintaining elasticity allows special designs with undercut shapes. This means unique optical and mechanical properties can be offered that allow simplified assembling. In addition, the well-known sealing properties can offer an easy solution to better IP-ratings. Some of the manufacturers that demonstrated novel silicone based optics were Khatod, Carclo and Ledil.

Another, more general observation in the field of optics was that it is more and more a mix of different technologies that are used to come to an optical solution. The variations are almost unlimited. Reflectors are combined with a dedicated lens, or a lens combines refractive elements as well as totally internal reflection (TIR) and reflective coatings in one piece in addition to the no longer uncommon combinations of separate elements of different technology.

Figure 12 (left): **Elastic silicone optics with undercut shapes allow simplified assembling**

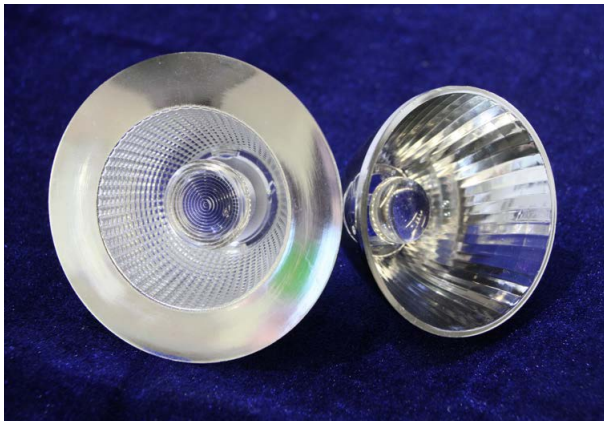
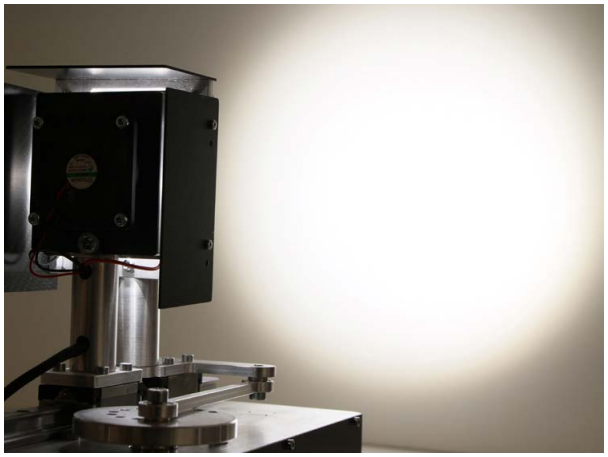


Figure 13 (right): **Optics that are based on a mix of different technologies (TIR, refraction and reflection)**



Figures 14 & 15: **Zoom optics made of glass - like this one from B&M Optik - show astounding good efficiency and light distribution properties at narrow and wide angles**

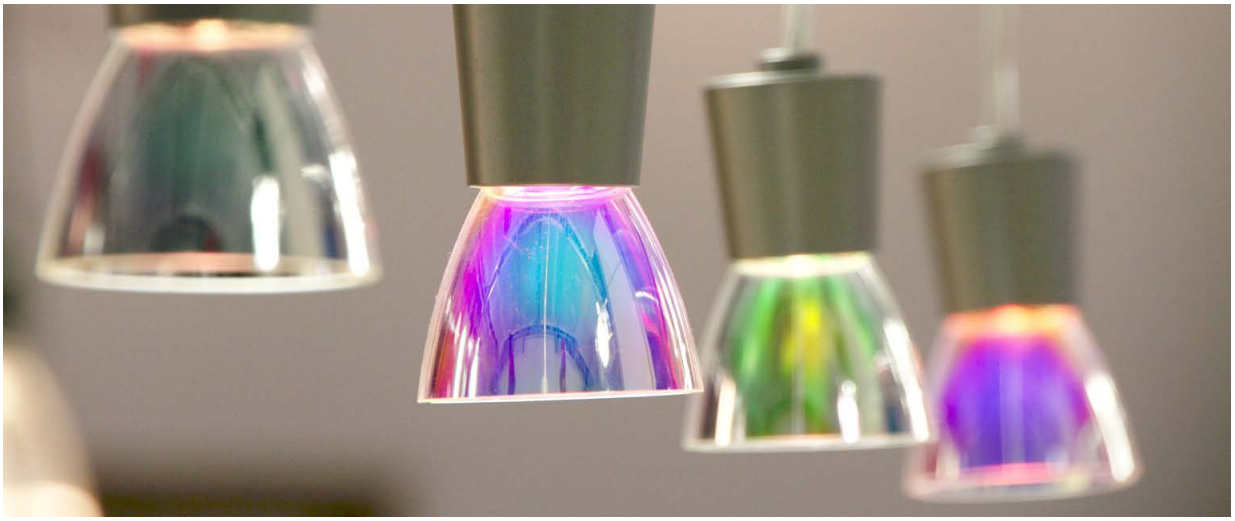


Figure 16: **The improvement of LED properties - especially LES - supports the revival of glass optics, at least for demanding design and pleasant appearance and exclusive haptic**

The most remarkable finding regarding optics is the revival of glass optics. It seems that a critical limit has been overcome and the manufacturers of traditional glass optics are seeing sales figures that allow the profitable application of technologies for mass production. As a result, the same haptics and appearance for optics can now be applied to LED technology at the same reasonable price as was possible with incandescent, halogen or HID lights. The companies are positive that for some types of optics, they can provide solutions at the same or even lower price target than PC or PMMA lenses.

The product range of these companies now covers a broad range of different optics like high bay lamps, streetlights or dichroic reflectors for ambient residential or hospitality applications. The best known exhibitors of glass optics were B&M Optics, Stumpe Glas, Gaggione and Auer Lighting.

Supplementary Products & Materials – Diversification and Adaptation for SSL

Dispersed throughout the whole exhibition area were a huge and hardly manageable number of manufacturers that offered products from housings to clamps, connectors, plastics, silicones and optical materials or thermal management products.

For many of these companies SSL products count for a fraction of their business. For all these groups, though, it is a fact that over the past few years LED lighting has become an important fraction. This has encouraged them to develop more products especially or optimized for SSL.

The following companies are just an example of those that displayed their products:

Connector specialists like Molex and WAGO introduced new terminal blocks for small LED modules while Ideal Industries extended their Chip-Lok array holders with a compact low profile version. In addition to the above mentioned products, BJB demonstrated two connector systems for OLEDs; one for back-side powered and one for side powered modules.

Some of the most renowned raw material specialists for silicones like Bayer Material Science and Dow Corning were on stage at Light + Building with new products especially adapted for SSL requirements for better manufacturability. At the same time, Albis Plastic showcased thermally conductive plastics.

Some thermal management solution providers co-exhibited with one of their clients. An example is MechaTronix who introduced a new series of small but powerful passive coolers at the Edison Opto booth. Bergquist and Fischer Elektronik exhibited alone and introduced a new series of round cellular heat sinks.

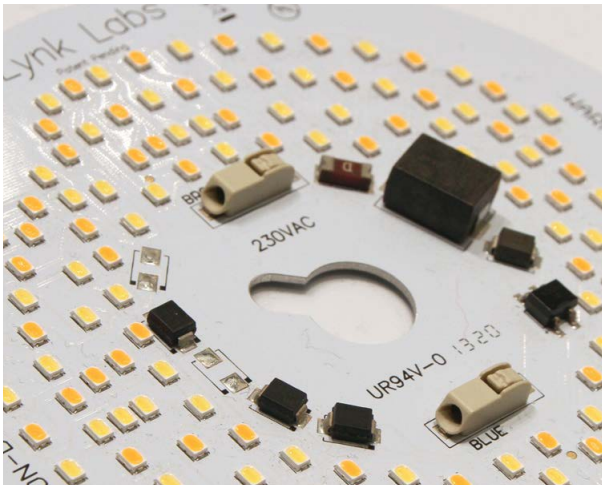
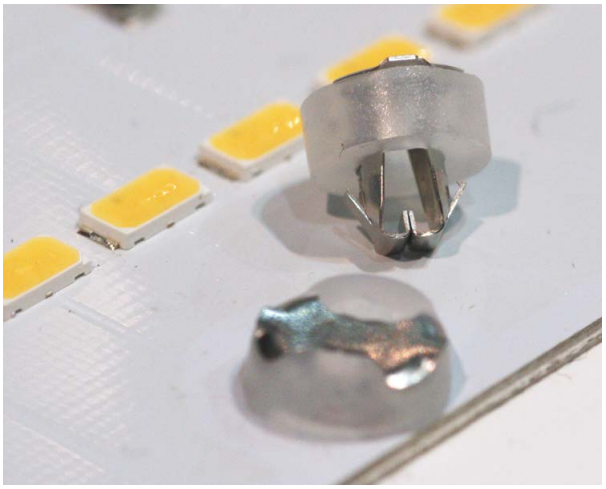


Figure 17 (left): **WAGO's newly designed terminal blocks better support SSL requirements**

Figure 18 (right): **New silicones, like the ones from Dow Corning with dispersed phosphors allow new optical solutions for special applications**



Figures 19 & 20: **Mounting clips that ease module assembly without compromise (left) and robots for fully automated assembly lines (right) were among others presented from BJB**

Lamps, Luminaires & Systems – Design, Intelligence and Controls

Today the evolution of LEDs and LED modules allow design solutions and concepts for luminaires that were barely practicable or functional one or two years ago. In comparison, this is true for lamps and system solutions as well. They are all supported by the controls technology. Wireless solutions using smart devices and even gesture controls as well as the digitalization of driver systems utilize affordable remote controlled multi-channel solutions. Dimming for this type of system is a basic task now. The doors are wide open for the next evolutionary step to become mainstream, color and CCT tunable light. What started with the Philips hue approximately one year ago is continued in products from Samsung and LG Innotek. It is certain that other companies will follow.

While the free color tuning option adds a certain complexity to the system that requires some understanding from the user, there is the simpler and, in many cases, satisfactory approach of luminous flux dependent CCT that was already demonstrated by Philips in 2012. This mimics the behavior of dimming incandescent or halogen lamps, something that especially addresses the habits and requirements of users in the western hemisphere.

Supported by improved and sophisticated controls technology, Zumtobel demonstrated their new office light, Sequence, an optimal combination of direct and indirect lighting modules that can be individually controlled. The individual modules are grouped together in three logical sets, each consisting of 4 outer modules and 6 inner modules, whereby each group has its own DALI address. The electronic control system ensures gentle transitions between modules, despite the fact that there are only four addresses for 14 modules.

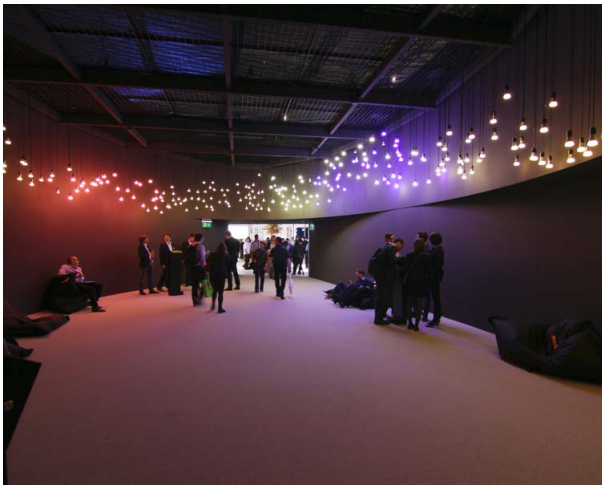


Figure 21 (left): **Philips demonstration of the hue as a human centric lamp**

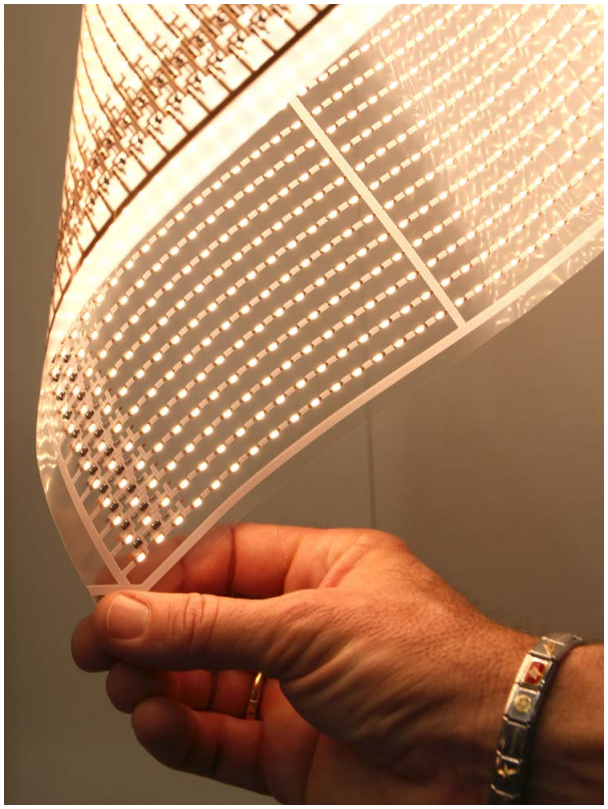


Figure 22 (right): **Ingo Maurer's interpretation of how to use the Cooledge Light Sheet**

Figure 23 (left): **Osram design object**

Figure 24 (right): **Lextar luminaire concept with indirect color changing illumination and direct white light; Inset shows indirect illumination elements**

Figure 25:
Zumtobel's "Sequence" is a result of innovative controls design in combination with an elaborate optical concept

Besides the trends primarily introduced by controls, there were also some remarkable design objects on display. While a comprehensive report would blow this article out of all proportions, two examples will illustrate the creativity of the designers. Isagani Vengco, Senior Designer at Ingo Maurer used the unique properties and possibilities of the Cooledge Light Sheet, which made its official European debut, for his interpretation of a flexible light. The reduction to almost nothing but the Light Sheet is the consequent result of the well-recognized minimalistic style of the Ingo Maurer team. The question "is it a luminaire or is it a module" arises, and the answer may be: "It is light". A more architectural approach runs like a continuous thread through all the lighting objects from the architect Georg Bechter. He uses the advantages of LED modules and lamps to make the luminaires made of plaster an integrated part of the building. He calls that "The magic of disappearance".

Figure 26:
Soraa's products distinguish themselves from other replacement lamps by using GaN-on-GaN produced LEDs for their violet pumped tri-phosphor white concept

Testing – Improving Handling, Speed & Accuracy

Often regarded as unspectacular and sometimes as a necessary evil, the measurement branch became more visible with the introduction of LEDs. However, the tools and innovations were often not really exciting. Light + Building 2014 may have changed this. Well, it still might not be striking but at least the image of a wallflower may shrink when looking at the latest developments. GL Optic, for example showed new APIs that allow the use of iOS based Apple devices to be used to control measurement tools and to process measurement data. Wireless connection between the measurement head and the control device via Bluetooth makes handling in field applications more convenient.

Figure 27:
Incandescent lamp filament mimicking designs, that were already presented at last year's LED Lighting Taiwan, were now an omnipresent feature of at least one replacement lamp series of numerous manufacturers like vosla

A goniophotometer with advanced measurement algorithms allows continuous measurement to improve speed without sacrificing measurement accuracy. opsira showed this technology with their updated robogonio.

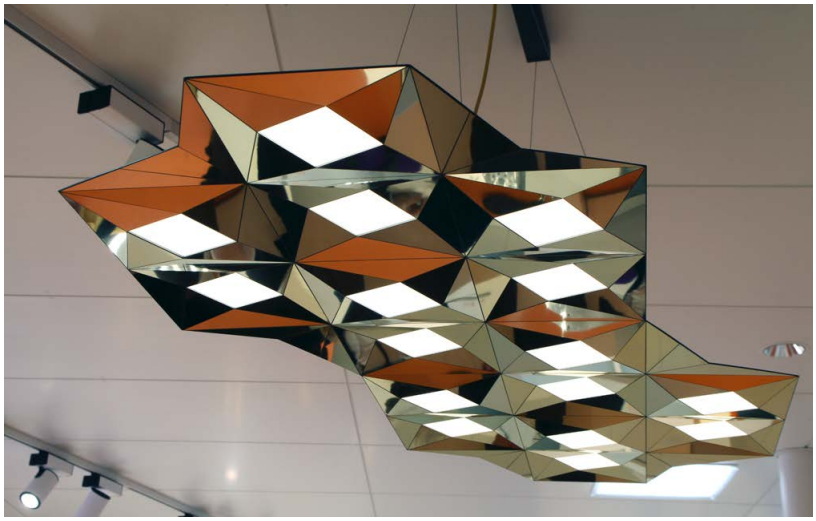


Figure 28:
Osram used OLED luminaires in their catering and meeting zone

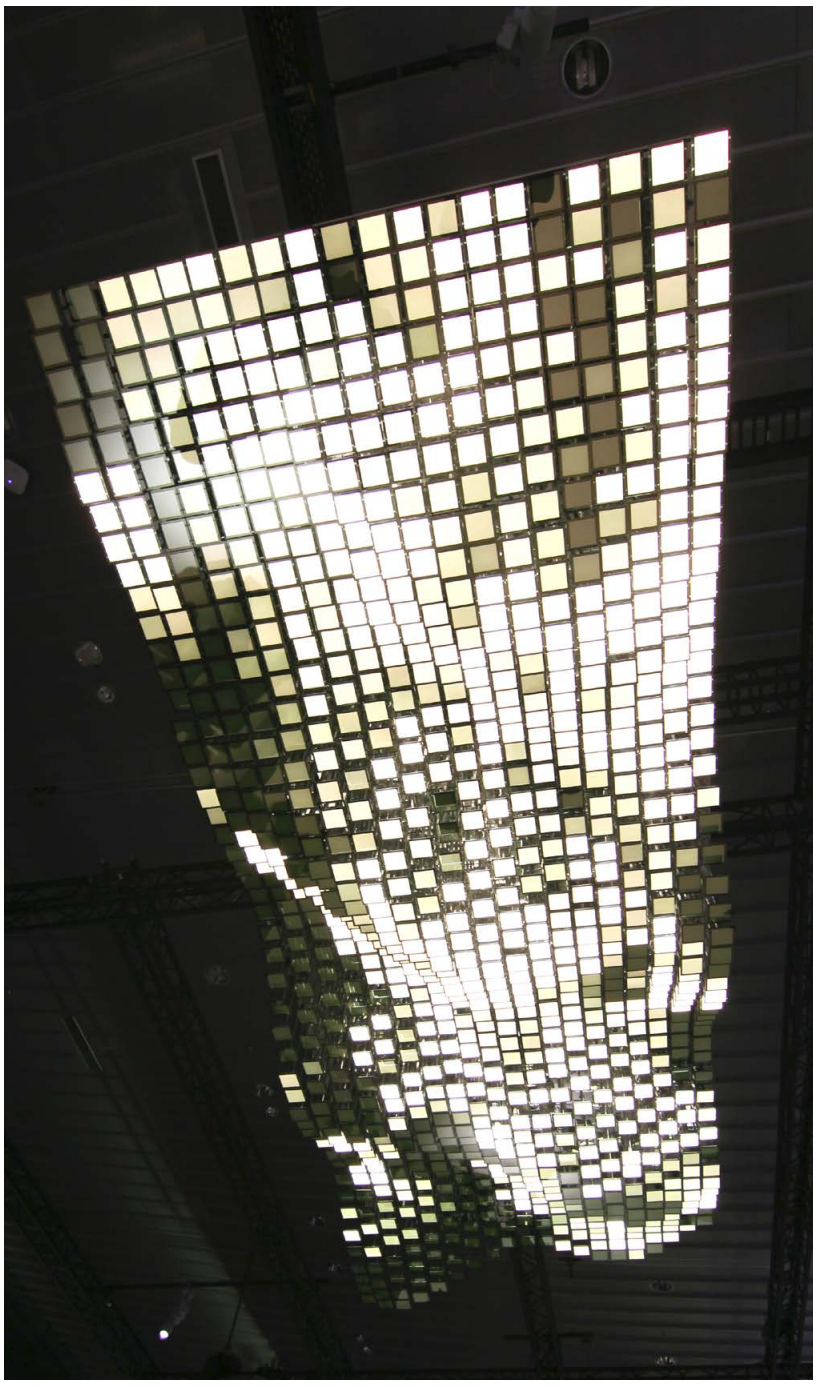


Figure 29:
Philips used OLED modules for an artistic lightshow at their booth

OLEDs – Color Tuning, Flexible or Transparent

Since the first OLEDs were launched parallel to LED lights at Light + Building, it looked like progress had slowed down. This year's exhibition proved this idea to be wrong or at least to be a thing of the past. OLEDs are catching up quickly and the roadmaps of some manufacturers show ambitious but promising forecasts. The debate about whether LEDs or OLEDs are the true future in lighting is pointless. The characteristics of these two technologies cannot be compared. Even when approaching the same lighting segment, both have advantages and disadvantages, and both will find their place in the future. This is the visible message of OLED manufacturers, luminaire manufacturers and designers.

It is true that the costs for OLEDs are currently too high to become mainstream. It is also true that it will take some time to lower manufacturing costs. But the time will come. Mass-produced OLEDs offer acceptable efficiency, lifetime and luminance values. A massively improved next generation has been announced for 2014. Beyond that, the manufacturers showed wide-ranging diversification.

The big European players in the OLED business demonstrated relatively conservative behavior. It seemed like they only improved the familiar products step by step without making any promises. Philips improved luminance to 9,000 cd/m^2; Osram's new Orebos generation now offers 65 lm/W; and Tridonic introduced a new version of a frameless OLED module that allows seamless planar fields of bigger dimensions and a flexible OLED.

In comparison, the Asian OLED specialists were more aggressive by clearly demonstrating and advertising their improvements and diversification. Konica Minolta showed color tunable flexible OLEDs. Verbatim, already displaying color tunable OLEDs in 2012, demonstrated the next generation that offers greater efficiency and luminance. These two color tunable products show two completely

Figure 30 (left): **Toshiba's impressive transparent OLEDs emitted 90% of the produced light in one direction**

Figure 31 (right): **LG Chem displayed the world's largest OLED panel measuring 320x320 mm. The homogeneous brightness was astonishing**

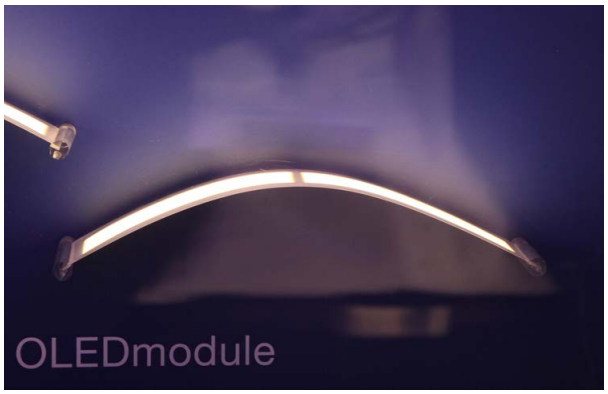


Figure 32 (right): **Tridonic's highlights were flexible and frameless OLEDs**

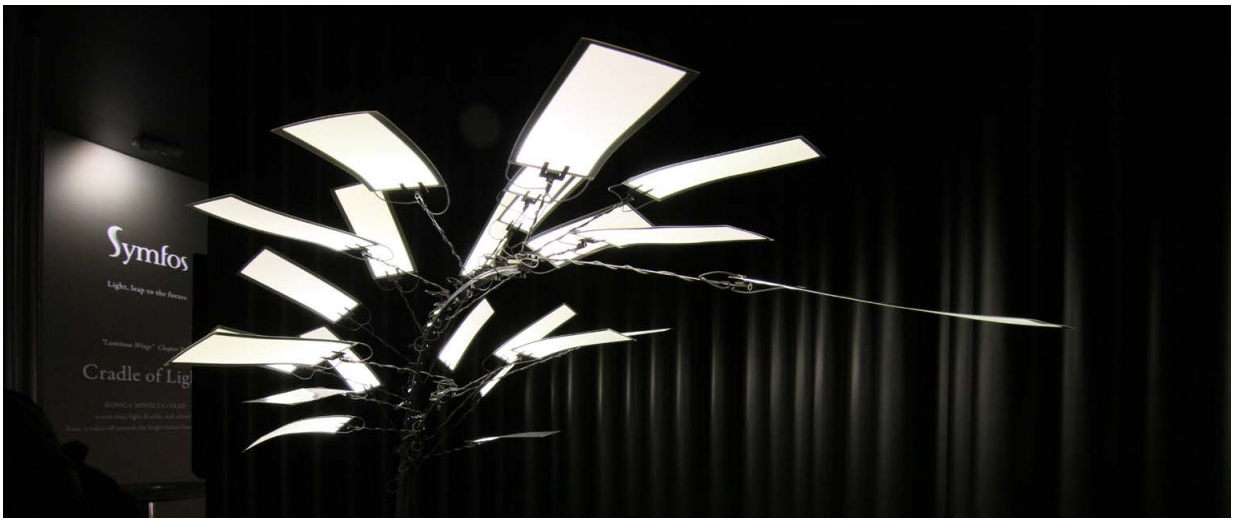


Figure 33: **Konica Minolta showed their color tunable and white OLEDs**

different approaches. While Konica Minolta's flexible OLEDs consist of layers emitting the different colors, Verbatim has a pixelated structure comparable to displays and are only sold as complete modules including the electronics.

LG Chem showed the biggest variety of OLED modules demonstrated by luminaires of their clients. Probably most impressive was their N6SD30 OLED panel. At 320x320 mm it is currently the largest OLED. The 1 mm thick module delivers 850 lm at a CCT of 3000 K and 60 lm/W. For the dimension of the module with its 40,000 hour lifetime, 85% homogeneity is absolutely remarkable, as well as a CRI of 90+ for all LG Chem OLEDs. Normally their OLEDs are driven to have a luminescence of 3,000 cd/m^2 and if a reduction in lifetime is acceptable, it can be increased up to 8,000 cd/m^2. LG Chems OLEDs are based on a multi-photon emission OLED structure to achieve these impressive performance values.

Toshiba Lighting presented their first samples of transparent OLEDs that have the extraordinary ability of being able to emit 90% of the light in one direction and being transparent when switched off. The new design options opened up by transparent OLEDs have the world eagerly awaiting the first designer products to hit the market.

Summary – The Most Conclusive Demonstrations

Highlighting the most convincing or important trends of a show is often a little biased depending on how well the exhibitor presented their products or technologies. Only a few relatively objective measures can be applied. However, aside from the fact that the 2014 Light + Building set new records, there may be one superior trend that supports most of the other tendencies.

Controls with all its facets are the key technology for successful products in the future. The type of controls and whether wireless controls based on smart devices, gesture control or simply DALI, will be the top runner depends on the application. While gesture control is very progressive and DALI is established, wireless, like ZigBee LightLink and Bluetooth, is the most popular approach.

The Internet of Things (IoT) has already become reality. Controlling all technical equipment where and when one wants with one device is a strong argument.

The evolution of the light source is still advancing. The topic is integration - which can mean “multi-color” or “warm white/cold white” solutions to allow color or CCT tunable solutions or the fusion of the light source itself with intelligence in the form of sensors, drivers, controls and wireless connectivity.

While being far from mature and still too expensive, the displayed OLEDs demonstrated the potential of this technology both for design as well as practical aspects. The quality of the different approaches, flexible, color tunable and especially transparent OLEDs, made a big noise in the lighting-world.

In addition to that, cutting costs was again a general trend for all components. Un-packaged chip LEDs, ease of handling and manufacturing through improved connectors, matched connectors and modules, advanced modules with integrated electronic features, optics with integrated sealing or the snap-on option are the most obvious examples.

All in all, the easily recognizable innovations and trends have switched over from the light source to the controls level. OLEDs now have the status that LEDs had in 2010, and the maturity of LEDs and LED systems has to be acknowledged. This year it is necessary to look much more carefully at the details to find the small differences and to figure out trends. One visitor put it in a nutshell when he said: “Even the worst LED panel manufacturer has learned to provide acceptable luminance homogeneity.”

Implementing an Automated High-Tech LED Luminaires Production Line

In recent years an extensive and a rather imaginative range of LED products has been marketed by increasingly proactive manufacturers from Eastern Asia. Although the prices of these products are very competitive, Darko Crha, Managing Director at Data Link, sees the quality as being questionable. On the other hand, he knows that one should not underestimate them, as things are changing at a fast pace and almost on a daily basis. He therefore proposes a far-reaching automation of module and luminaire production.

LED technology is undoubtedly the future in lighting and every lighting manufacturer planning to survive in the market cannot afford to have a different vision of its future development and production. But it appears that western lighting manufacturers are still convinced that their market position is not compromised and they rely on high prices they are able to achieve for their products in today's marketplace. Perhaps competitors should be taken more seriously, as their products will improve in terms of quality and design and it will not be long before European manufacturers are stunned to find that, regardless of their reputation, the quality they offer simply does not justify the high price customers are expected to pay. Brand image and customer loyalty can mitigate the effects of rising competition to some extent, but there are limits to that as well.

Multiple major players have taken globalization and its faithful companion, market liberalization, lightly. Their profit-oriented strategy urged them to relocate their production without criteria to countries with significantly lower labor costs and far less regulated business environments. Over the years that move yielded extra profits, but now it has started to backfire, resulting in an economic crisis, increasing unemployment, social unrest and many other pressing issues. A growing number of companies have decided to bring production back home, but now they are dealing with a major problem – high costs of human labor. The only logical and possible solution to this problem is the implementation of intelligent solutions and automated manufacturing operations.

The key question remains how to make a top-quality product and market that product at a competitive price? The answer is quite simple - one can use machines instead of human workers. However, translating that into practice is far more complex. Replacing human workers with robotic systems sounds promising, but doing that is neither simple nor cheap. Such an endeavor requires extensive scientific interdisciplinary knowledge and skills. One is certain, in the high-volume commercial production of LED luminaries the same trend like in the automotive industry will happen - introduction of robots on a large scale and decreasing production costs with simultaneous product quality upgrade. A fast-growing market in demand for these products will dictate future development and the described approach will be the answer.

Preconditions for Implementing Automated Manufacturing

To adapt products to automated manufacturing, i.e. robotic production, at least two key preconditions have to be met. The first one is that it has to involve high-volume commercial production of products to meet market demand in terms of volume and quality. The second one, practically enabling low-cost serial manufacturing, is that the product will have to be technological, which means having its technology and design adapted to this type of production. That is often the key problem in terms of their design, as designers often have complicated solutions that are not suitable for the low-cost serial production and

especially not an automated one. Since the lighting industry can be described as traditional and so far certain rules and standards have applied, with the arrival of LED technology experts are now increasingly exposed to almost absurd design requests. It is as if there is no wider understanding of the fact that new technology brings new rules and that it is unwise to consistently follow or copy obsolete and old solutions. For example, in Europe there is still a requirement that a street lamp has to have tempered glass, even though that brings significant optical losses and actually offers no protection, as under it is no longer a breakable glass bulb, but a compact module with LED, which is far more mechanically solid, compact and resistant than the protective glass protecting it.

Of course, robots will never be able to do everything and various processes will continue to be carried out by human workers. There are limits to automation that cannot be crossed or that are not economically feasible, at least for now. Human involvement in highly automated processes will continue being necessary, but if production is smartly organized, it will be limited to preparation of material and semi-products, logistics, maintenance and other processes that cannot easily and lightly be transferred to machines.

There is still the issue of the standardization of LED light sources, which has slowly become a condition sine qua non for widespread use and further product cheapening and popularization. LED will always offer a wider range of options than conventional lighting sources, such as classic incandescent, HPS or fluorescent lights, but standardization has proved to be a necessity. The standardization of LED modules will enable automated and serial production and make finished products more affordable. Needs for lighting can be categorized and are mostly equal or similar, so logic dictates that it is unnecessary for every lighting manufacturer to develop own solutions.

Experiences with Robotic Lines

A general experience is that robotic production lines significantly reduce the amount of scrap and raise the quality of finished products. Furthermore, robotic production reduces the need for human workers which results in significant cost savings. Returns on investment in automation of production are very fast, often in only a year or two, owing to energy savings and low labor costs.

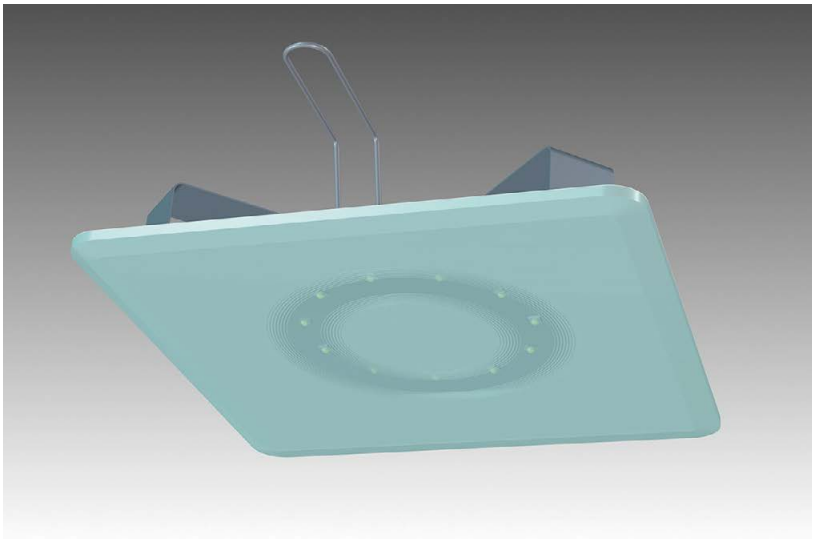
Unlike people, robots are flawless in carrying out their programmed assignments. They do not need to take a break and productivity at work is never reduced. Of course that significant funding is required for acquiring robots and hiring experts that can successfully implement this production model. Except for the already mentioned automotive industry, massive use of robots in European companies is still far ahead. The level of automation in today's European companies is reduced to specialty lines, partially automated, without the possibility of gradual migration toward more complex products or production line repurposing. Well-designed robotic lines can be easily repurposed or used for the production of different products, which is often what is needed in today's dynamic market. One of the important characteristics of modern robotic lines is their ability "to see", i.e. a wide use of vision systems and intelligent sensors. All critical operations have to be monitored via optic systems that are able to detect error in a timely manner and immediately stop production and remove defective products from the manufacturing line. Current prices of optical systems are moderate and their use should not be avoided anywhere they could be of use. They greatly contribute to production quality and increase productivity.

Types of Robots and Robotic Lines

Europe and the United States of America are falling behind countries like Japan or South Korea in the industrial use of robots. Germany is an exception and EU leader in the industrial use of robots, primarily owing to its highly developed automotive industry. Robots are often despised or viewed as superior to humans, which is why there are often unreasonably complex demands from a robotic unit in designing automated lines.

From the aspect of complexity of operations assigned to robots, there are two models. The first one is the Japanese model where robots are massively used for relatively simple handling operations. Due to high labor costs, the Japanese will without hesitation use robots for simple operations in the production process. The second one is the European model that is characterized by robots being used for demanding operations and complex tasks, which slows down production and makes it unnecessarily complicated. It is always better to make each robot in charge of a simple line operation, which can be upgraded or modified, if necessary.

Figure 1:
Typical kinematic diagram of Selective Compliance Assembly Robot Arm (SCARA) configuration (left) and the real world equivalent SCARA robot (right)



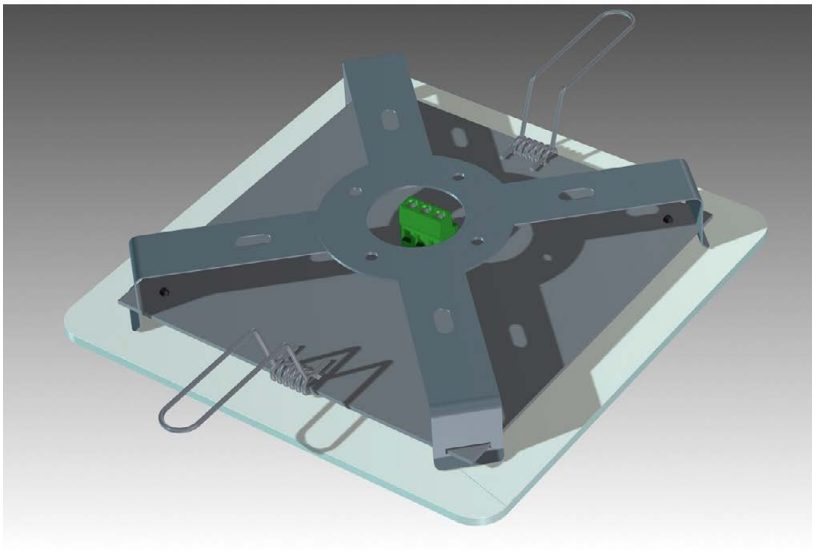


Figure 2:
Photorealistic rendering of the luminaire design for fully automated manufacturing

Today's Selective Compliance Assembly Robot Arm (SCARA) type assembly robots are cheap enough to be used for simple operations in the manufacturing process, while the complexity of processes and products is achieved through parallelism, i.e. the use of multiple robots in a series. Also, automated lines with SCARA robots are far more flexible than classic automated lines with gantry or linear and pneumatic systems, which still prevail in industries. It is much easier to repurpose a robot or program it to do additional operations required for process enhancement. The use of robots also makes the investment less risky as they can simply be used for a different purpose should a significant change in the production process occur.

Implementation and Utilization of the Robotic Production Line

The defined goal was to develop and produce an affordable and durable LED down light that can compete with other commercial products of this type available in the marketplace. Consequently, the company opted for the robotic line concept with minimum human involvement. As mentioned above, the first step was to design and think of a product that can be produced on an automated line. The product had to be devised in a way that enabled simple and fast production and have as few components as possible.

Figure 3:
Image of the finished luminaire from figure 2

The implementation of automated production included several phases. First an LED down light adapted to the automated assembly line was designed and developed. It did not take long to come up with a very compact model with excellent thermal management, which is essential for a quality and long-lasting LED lamp. Due to known issues related to electrolytic capacitors, which are the main cause of the short lifespan of LED drivers, AC LED technology was used. This significantly reduced the price and complexity of the finished product, making the lamp a compact product suitable for automated production. For the segment LED driver a chipset

produced by a reliable manufacturer is used. This guarantees long operating life of the down light. The lamps of this type are no longer intended for industrial use, where the stroboscopic effect of the AC driver was normally encountered, but now they are suited for use in hallways, staircases, bathrooms and other areas in commercial and residential buildings that need high energy-efficient lighting.

This is a very compact lamp that can be manufactured in a variety of forms and it is a suitable substitute for standard products available on the market and retrofitting. It is especially suitable for use in staircases and access corridors in hotels where motion sensors or switches are often used. As this is an LED source, the light immediately reaches full intensity and there is no warm-up time, as is the case with compact fluorescent lamps.

The first production phase takes place at a separate line, where its light engine with an integral power supply is produced. This light engine is produced with classic SMD technology at specialized lines, which are mostly standard equipment easily procured on the global market from several well-known producers. The base material used is an aluminum-based PCB (Printed Circuit Board), which has excellent thermal conductivity and also serves as a cooler for integrated segment drivers and LEDs. Large production capacity is achieved by placing ten LED lamps on a single panel, which are then processed simultaneously. That way the production capacity is achieved which can easily feed an automated lamp assembly line.

After LED panels are finished, they undergo functional testing and all network parameters such as rated power, total harmonic distortion (THD), power factor, etc., are measured. Units that have not passed the testing are marked and later separated for repair or discarding. Panels are then divided into separate units and stacked in special holders. They are then removed during the second phase, which is product assembly.

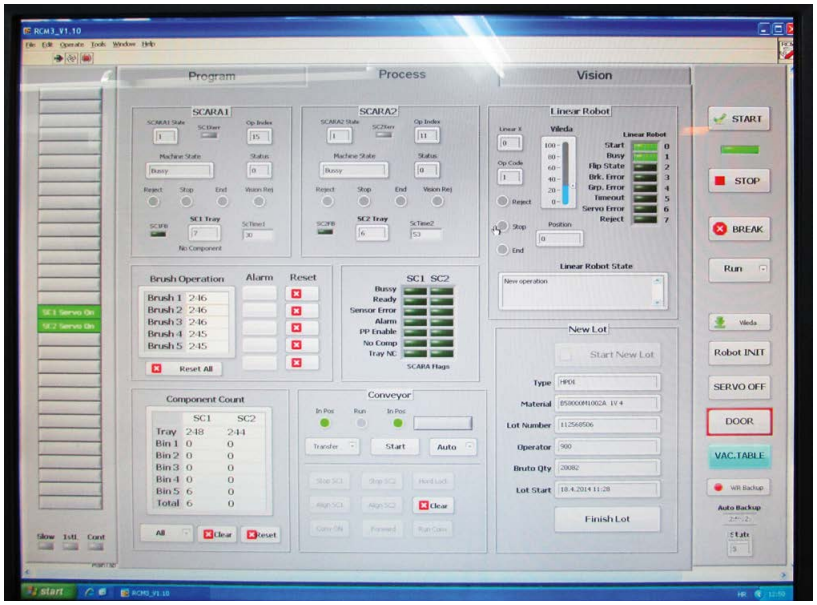


Figure 4:
The centerpiece of an automated system is the control program displayed on a monitor

Figure 5:
Example of a robotic line that has proven to be a cost-effective and reliable tool for today's requirements for luminaire manufacturing

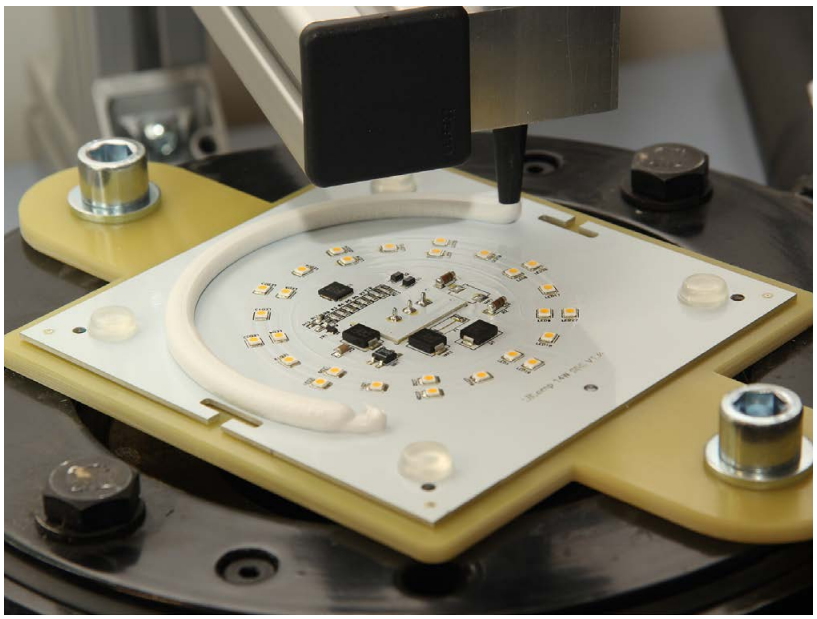


Figure 6:
Automated glue dispensing is just one of the tasks that is fulfilled accurately by the robots

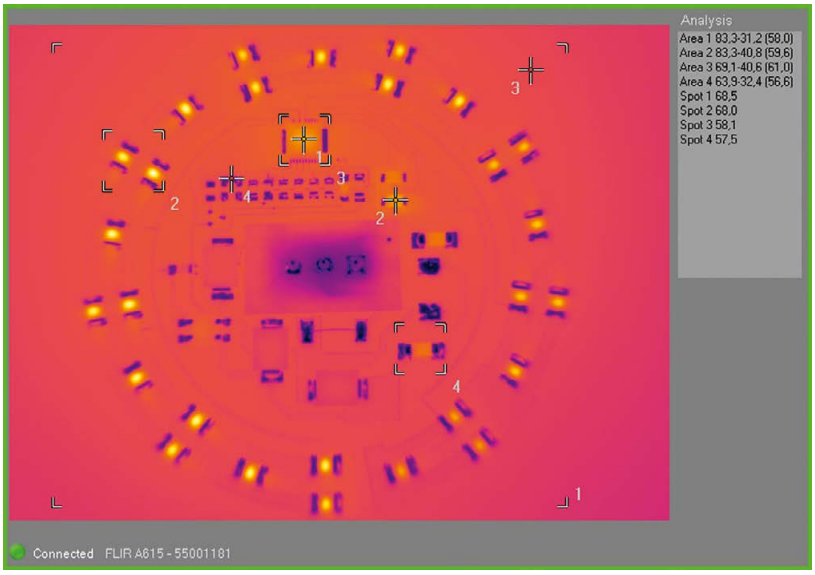


Figure 7:
A first testing like thermography of the module is performed to find defective products or products exceeding predefined limits. Such modules are separated and manually repaired or discarded before the automated assembly starts

The second phase takes place at an automated line where the lamp is finally assembled. The line comprises three SCARA robots and several different conveyors operated by a program based on the National Instruments LabVIEW platform. This combination of a control program and executing elements has been used for years in different sophisticated production lines that were customized for several clients. One of the special features of LabVIEW software is that it contains all of the modules necessary even for the most complex hi-tech production. The same platform can be used for discrete programming of different state machine models or, if that is not sufficiently fast, programmed hardware functions can be used through an extensive offer of FPGA hardware. Also, the program allows for simple incorporation of complex vision system functions, which are necessary in this type of production. The use of robots that are able to “see” significantly increases the quality of the final product and reduces scrap.

The three robots are divided into functional units and programmed to execute different operations. The first one is taking finished light engine modules from the conveyor and connecting them to glass slabs, which is the frame of the lamp. The second robot applies adhesive that holds together the two basic elements of the lamp. The third robot handles finished lamps and places them on the exit conveyor. The manufacturing line tact time is about one minute, which means that in a single shift 400 products can be easily made. All of the key production phases are covered by vision systems, so as to ensure timely error detection, i.e. defective products. After assembly, lamps are put on the shelves for at least 24 hours for the adhesive to dry. Finished lamps are tested again and afterwards packed in boxes. This phase is done manually, fast and with minimum workers required, because automation of particular segments is not cost-effective.

This type of an automated manufacturing line can be used for manufacturing a variety of lamps by a simple activation of a particular execution program and replacement of several mechanical grippers.

Conclusion

All of the above leads to the conclusion that LED technology is only just getting started and will lead the way to energy-efficient and reliable lighting. Due to its superiority, especially durability and energy efficiency, LED is on the path to replacing most of today’s conventional light sources and that development will require mass production of quality and affordable lamps, lighting modules and armatures. Mass and affordable production requires a high level of automation and today that is impossible without using robotics. That is something major European and American companies will have to take into account, because that is the only way to compete with East Asian competitors.

Even at first glance, products presented by prominent manufacturers at the recently held Frankfurt Light + Building fair showed what seemed a rather low level of innovation in the LED product range. Products have not been designed for a high-volume serial production, but are mostly already seen solutions produced by traditional methods at standard manufacturing facilities, which makes them expensive and non-competitive. It seems as if some market leaders are showing lack of innovation. The main reason is, probably, that the lighting industry is still based on traditional electrical and mechanical solutions adapted to the conventional lighting technology. LED has suddenly brought entirely new challenges before manufacturers and new rules of the game are far more technologically advanced compared to the old ones.

With LED lighting electronics engineers are encountering an increasing number of challenging tasks in terms of power supplies and LED module construction. Other fields offering multiple opportunities for development include optics and lens or mirror systems that improve the usability of semiconductor light sources even more. These fields offer much room for advancement; especially in dealing with the way dotted LED lights are unappealing to the human eye. These are all great challenges market leaders will have to take on in order to keep their market shares. They also offer big opportunities for smaller companies fostering innovation, offering them a way they can succeed in the global marketplace and win their market share. ■

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LED Expo Thailand 2014
(May 22-24)

Guangzhou international lighting exhibition
(June 9-12)

Producing Cost-Effective LED Lamps and Modules Using 3D Technology

When it comes to life and performance, LEDs top almost every other illuminant. Unfortunately, this is also true in terms of production costs. To combat those costs, new methods and processes are required and MID technology (Molded Interconnect Devices) could be the answer. Barbara Stumpp and Stephan Krause, Strategic Product Manager LDS at LPKF Laser & Electronics AG, discuss how this technology offers considerable freedom for the arrangement of LEDs and more efficient production with cost-saving potential.

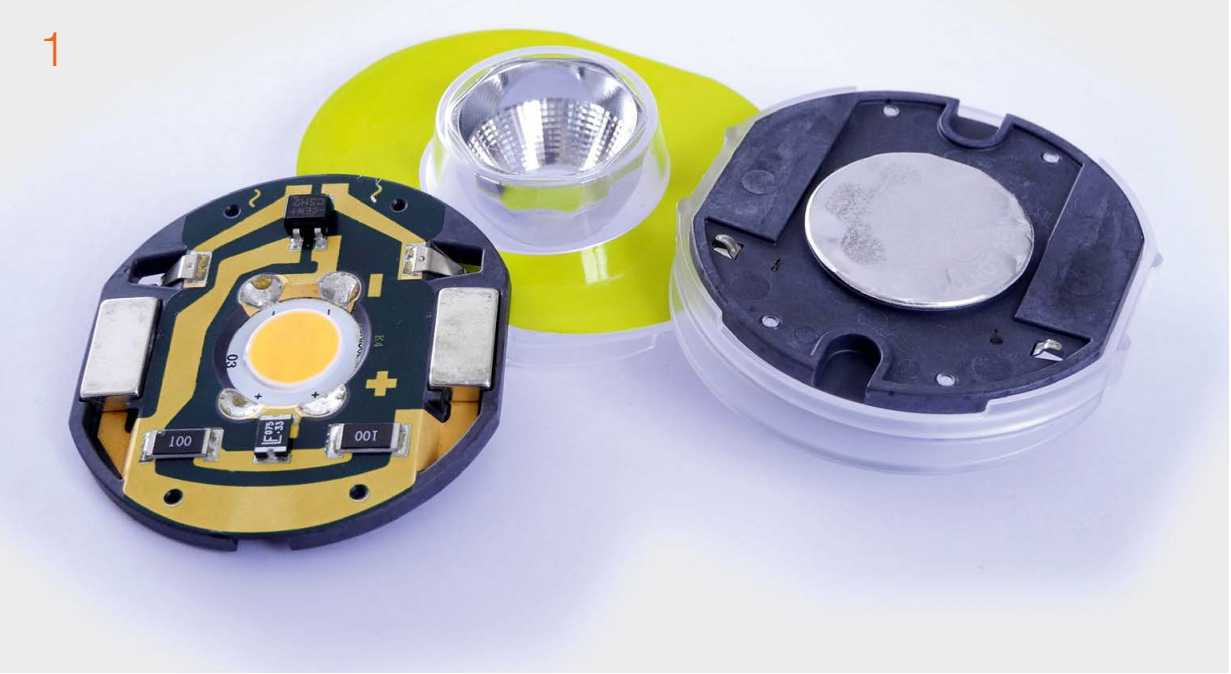
LEDs or light-emitting diodes give cars their brand-specific lighting. They also illuminate the 49,000 m² outfield of the Innsbruck airport without significant 'light pollution'. The advantages are, compared to conventional lighting, long-term stability, low power requirements, a low construction depth and a possible lifetime of some 10,000 hours. Saving power is also a good idea for private households. Yet if the average consumer pays up to 15 Euros (more than 20 US$) for a new LED-bulb (about five times the cost of a halogen lamp) they will most likely ignore the long life time and the up to 80% lower consumption and only have eyes for the price tag. The structure of the LED component is one major reason for its costliness: it is flat and radiates to one side only. The consumer, though, prefers 300° light emission. Achieving this necessitates optics and reflectors or placement in diffuser domes.

Another reason for the high costs is that LEDs only use direct current. Hence, an electronic component that converts alternating current into direct current is needed. In addition, being able to dim the lamp requires additional electronics. People who monitor their homes with smart phones via the Internet favor suitable light management. By driving the LEDs via RFID-like components there is no need to pry open any walls for the necessary cables. Sensors that automatically control the lighting require even more electronics within the LED lamp. And to top it off: Being that the white light of the LEDs is generated by mixing the light from red, green and blue LEDs, the color of light is controlled through additional electronics. In order to prevent lighting from costing the earth, new solutions are needed which not only make the high-tech version of LED lighting cheaper, but the 'normal' LED lamp used in everyday life cost effective as well.

The MID process (Molded Interconnect Devices) offers cost-efficient production as well as geometrical leeway. Interconnects and electronic components are placed directly on a three-dimensional plastic body. Among various MID processes, Laser Direct Structuring (LDS) dominates. This method functions with thermoplastic material doped with a laser-activatable additive. When the laser beam hits this substrate, it uncovers the additive and forms a roughened track. The additives provide the seed for the subsequent electro-less metallization in an electro-less plating bath. Circuit paths made of copper with a thickness of up to 10 µm are common practice, followed by a finish with nickel and gold. For higher currents, electrolytic plating can produce thicker layers that function as heat sinks. In industrial applications laser systems with up to four laser processing units provide short cycle times.

With a recently developed new LDS prototyping process, prototypes can be produced quickly and cost-effectively, short-cutting the transition from prototype to mass production. LDS technology has been suitable for mass production for years. And so, for example, circuit paths and antennas can be applied on mechanical components.

The problem of tipping the lamp body with the electronic components was solved by a unique 3D capable MID dispensing & placing system. The 3D



Figures 1 to 3: **Examples of 3D manufactured LED modules and lamps - Clip'n Slide track system of home lights. The clips (1) – produced by means of LDS technology - simply adhere to the track via magnets (2). Placing circuit paths on any 3D metal body - the new LDS powder paint opens new opportunities in LED technology to manufacture traditional looking LED lamps (3)**

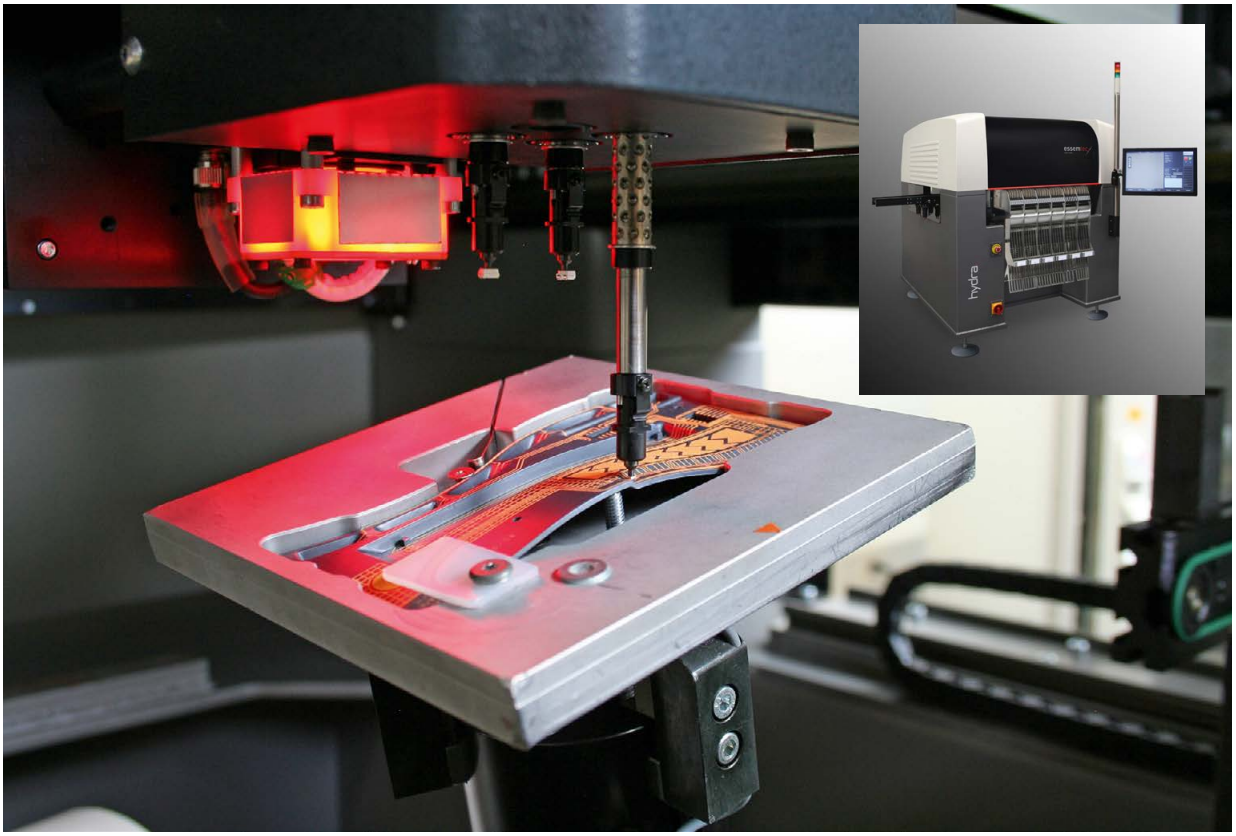


Figure 4:
A view inside the assembly unit Hydra - a robot places the component in the working chamber. Inset: The assembly unit Hydra

placer Hydra can produce up to 2,500 components/hour in 3D mode. There was also the problem of dispensing and placement on a non-horizontal surface being affected by gravity. An integrated robot works inside the machine, but in contrast to the usual procedure, the device for the movement of parts works as a master and the robot as a slave.

The new facility is a combination of a 2D pick-and-place machine with a specific substrate holder. This is positioned at the required angle by the robot. Glue and solder can keep the components even when the part is upside down. But design requirements have to be considered. The facility can process substrates with a size of 300 x 300 x 50 mm^3 and weights of up to 2 kg with a placement accuracy of less than 60 µm. All this enables Hydra to perform a systems engineering close to mass production.

Despite efficient use of electricity, LEDs become hot during operation. They can withstand a junction temperature of 125° to 135°C, up to a maximum of 185°C for a long lifetime. In addition, the LED driver influences the life span. Hence, thermal management is required.
For LEDs arranged linearly, aluminum rails are sufficient, but 2-dimensional LED lamps need a heat sink. Such a heat sink also offers the required mechanical stability and meets country-specific certifications. Developing suitable heat management for an LED lamp was challenging indeed.

In order to simultaneously use spatial metallic base bodies as bearers of the components as well as heat sinks, an LDS-compatible powder coating was developed. The two powder coatings consist of the thermoset materials polyurethane and polyester. During coating, the electrically charged powder is electrostatically absorbed into a grounded work piece. Unused powder can be recovered. During curing, the coating is cross-linked at 170° to 200 °C, without any softening occurring throughout the course of reheating. The LDS PowderCoating PES 200 is white, silk mat and thermally stable. The disruptive voltage of 8.44 to 6.27 kV depends on the thickness of the coating, which lies at approximately 80 µm. The LDS PowderCoating PU 100 is glossy white and thermally stable with a disruptive voltage of 7.43 to 4.29 kV at layer thicknesses of 60 µm. Both powder coatings are chemically stable and UV resistant. The PES 200 provides high puncture resistance at sharp edges, while the PU 100 requires the edges to have a radius of a minimum of 2 mm. In terms of temperature stability the PE 200 withstands 240°C, the PU 100 some 270°C for 5 seconds.

Important advantages of the LDS Powder Coating include the powder coating's particular compatibility with electrically conducting base bodies; as well as the reflow process in which the electronic components can be soldered directly onto the base body at temperatures between 240° and 270°C. The process will also work with base bodies consisting of other materials like plastics or glass, provided that the electric surface conductivity and the adhesion are sufficient. Also, both coatings are neither hazardous nor dangerous.

MID-Tronic has built a demonstrator that uses a massive aluminum body that has been coated and cured with the LDS PowderCoating as a heatsink.

Subsequently, the conductor paths are structured by the laser and then metallized. This demonstrator works splendidly, yet it is a bit on the heavy side. The primary goal, though, was to create a functioning part. In the future, a hollow aluminum body or a body made of heat conducting plastic, manufactured by low cost injection molding processes, could be used instead of a massive body.

In order to achieve higher layer thicknesses of the conductor tracks of 35 to 70 µm on the plastic components for improved heat dissipation, one can boost them galvanically after the electroless metallization. Since the main portion of the heat is passing through the substrate, the development of thermally conductive, LDS compatible plastics is necessary. Being able to place LEDs directly on the heat sink will be a big advantage. In addition, this process makes a circuit board and thermal interface material redundant.

One can reach heat conduction in polymers by means of fillers. However, there is a singular problem: the polymer becomes brittle with too much filler. Because of the large number of fillers with a large width of thermally conductive properties, the engineers are confident that they'll find the right mix for any application. Because the production of the base body has to be economic, injection molding is the method of choice.

Fillers in injection-molded parts don't have the same orientation everywhere. Their orientation is determined by the exact place in the component. Therefore, the conductivity is not the same throughout the component. The engineers found out that the thermal conductivity's intensity depends in part on geometry. In effect, this means that the engineers are able to design suitable parts: their heat conduction reaches peaks at the desired LED place. Thus, design work optimizes the effect and the price for material takes a back seat.

Conclusions

These development efforts make it possible for MID technology to offer great potential for LED lighting. This is because the method is efficient, cost-effective and ready for series production. Moreover, an appropriate automatic placement machine is already available. This method offers an almost unlimited number of surface geometry for LED lamps, plus it works with free-form substrates. What's more, the use of thermally conductive plastics instead of aluminum enables inexpensive LED lamps with an exquisite design. Having the possibility to quickly conduct design changes, the technology helps to save money. Along with this, additional electronic components and functions can be integrated without additional process stages. Thanks to this new technology, LED lights will become lighter, smaller and cheaper in the future. ■

White LED Color Design and Variation Reduction

Lighting is becoming a clear domain of LEDs, especially white LEDs, because of the well-known advantages of this technology over conventional light sources. However, LED lighting also has its issues, namely color design and consistency. Ichikawa Akira from Asahi Rubber Inc.'s development group explains the problem and proposes a solution, developed in his company.

The white LEDs produced at the end of the 20th century saw a striking increase in capabilities due to various innovations. Building on this progress, the improvements were only expected to accelerate, surpassing the current light sources in various fields. This is due to the excellent characteristics of white LEDs. For example, thanks to their long life, one can design lighting modules or fixtures that have the distinction of being "maintenance free". And thanks to their stable characteristics in low temperatures, modules for use in cold storage warehouses can be designed.

In this way, the value of LED Lighting modules is created as the demand for these design advantages and superior characteristics is realized. On the other hand, there are weaknesses inherent to LEDs in which they have not met the demands of the marketplace, such as color, which one must respond to in the future.

New solutions to some of the main problems facing white LEDs, color design and consistency, shall be elucidated and discussed. The hue, when represented numerically as "chromaticity" and the brightness, when represented numerically as "luminous flux" (lm) or "luminous intensity" (cd), combine to form expressions of the qualities of light along with the "color-rendering index."

Construction of a White LED

While there are many methods for creating white LEDs, the most common type utilizes a blue chip and phosphor, due to its high efficiency. This is also the type of LED that will be considered hereafter.

The mixture of blue light produced by the LED chip, combined with the carefully regulated amount of light produced by the excitation of the phosphor in reaction to the blue light, are perceived by the human eye as white light. These white LEDs can be designed with optimal ingredients, such as a blue chip with yellow phosphor for high output efficiency, or a chip with red and green phosphors for high CRI, to create ideal optical characteristics for various applications.

LED Color Design

Ingredients used

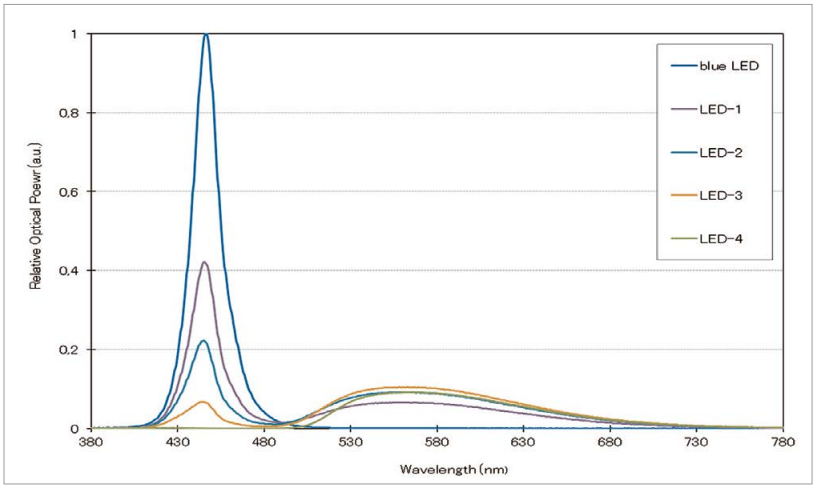
The creation of a white LED requires an emitter chip that possesses a wavelength between 430 and 470 nm. Next, it generally requires various phosphors such as yellow-green emitting YAG phosphor, yellow-green emitting Sialon phosphors, green to orange emitting silicate phosphors or red emitting CASN phosphor. Through the careful manipulation of the added phosphors relative to the peak wavelength of the base LED chip, customized design of color and CRI is possible.

Controlling hue

The spectrum data from the combination of a blue phosphor chip and YAG phosphor can be seen in figure 1. The amount of YAG phosphor emitting yellow light around 560 nm was adjusted to match appropriately with the blue chip emitting at a peak wavelength of 450 nm. Through the addition of this phosphor the blue spectrum decreases in favor of the emissions in the yellow spectrum. Adding more phosphor increases this trend even further. This trend is shown in the data in table 1, and the plot on a chromaticity diagram in figure 2. The addition of this phosphor moves the produced color towards the area of the 550 nm light produced by the phosphor. Using an appropriate balance of blue emissions from the chip along with yellow emissions from the phosphor, one can bring the measured spectrum to the white light point (x=0.33, y=0.33), creating a white LED.

Furthermore, when using red and green phosphors in place of yellow, the mechanism in which it shifts the color is identical. By increasing the amounts of either of these phosphors, the produced spectrum can be shifted towards the color space produced by that particular phosphor, to create those colors. By drawing lines between the various phosphor-emitted colors and the blue emitter chip's location on a color space, shows the possible colors that can be created. The achievable area using this method is depicted in figure 3.

Figure 1:
Amount of Phosphor added and LED spectral analysis



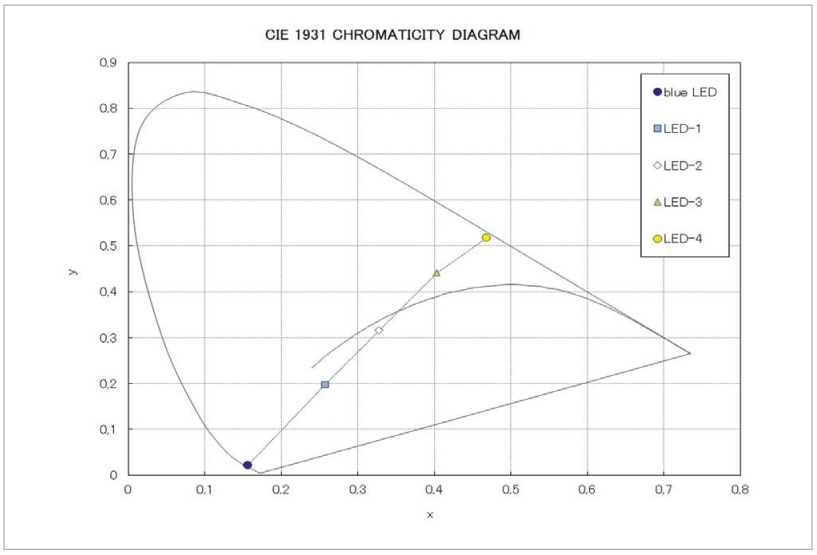
Controlling CRI

Color Rendering Index, or CRI, refers to a test created by JIS in which pre-determined test colors are illuminated by both the tested light source and a standard light source, and the difference in perceived color is measured, with identical rendering being 100 and any differences lowering the score. Color rendering levels can refer to the standard set (Ra: average of R1-R8) or the special color rendering levels (R9-R15). These values represent one of the important qualities of light when illuminating living areas or product displays.

Table1:
Optical characteristics of LEDs with different amounts of added phosphor

Sample Name	Added Phosphor (%wt)	Luminous Flux (lm)	Chromaticity x	Chromaticity y	Color Temp (K)	Deviation duv	Average CRI (Ra)
blue LED	0	11.8	0.156	0.021	-	-	-
LED-1	4	71.8	0.257	0.197	-	-	-
LED-2	8	95.4	0.327	0.315	5,813	-0.011	72
LED-3	15	105.9	0.403	0.440	3,895	0.021	63
LED-4	30	88.3	0.468	0.517	3,286	0.035	49

Figure 2:
Chromaticity points of four LEDs with different amounts of added phosphor in the CIE 1931 Chromaticity Diagram



An example would be designing an LED with a color temperature of 5000 K (bright white), assuming the use of an LED with a 450 nm emitting chip. What type of phosphor would be the ideal choice for this application? As discussed previously, yellow phosphor, which functions as a partner color to blue, allows to create LEDs that achieve these colors. Furthermore, with a combination of green and red phosphors, one can create the color using a combination of the 3 primary colors, RGB. Also, there are various types of red and green phosphors that emit in different spectral ranges. From this, one can plainly see that the methods for designing a specific color temperature or a point on the color space can be varied. It is necessary to select the appropriate phosphor that will produce the desired color and CRI levels.

Figure 3:
Achievable chromaticity area with blue emitter chip and phosphor in the CIE 1931 Chromaticity Diagram

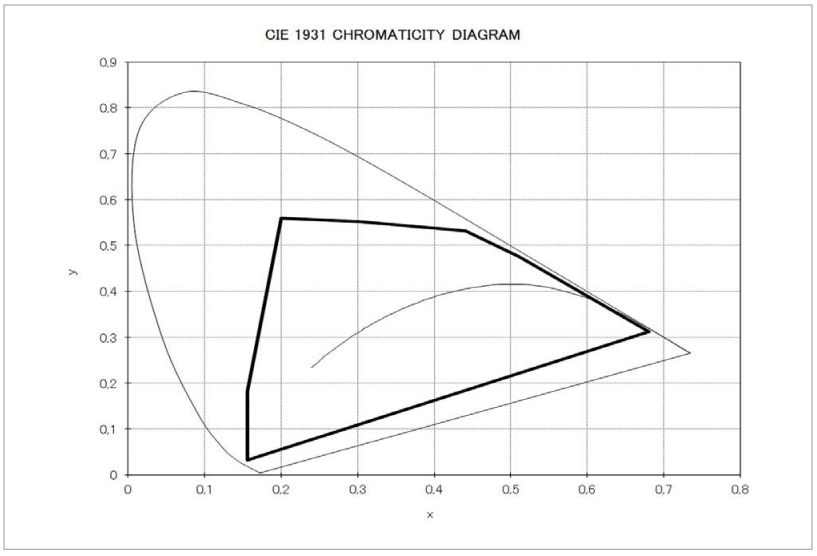


Table 2 shows the optical characteristics of a 5000 K LED. The amount of phosphor added to each sample determines the characteristics of the resultant LED. When aiming for a high luminous flux the CRI figures drop, and conversely, when aiming for high CRI, the output drops. Whether focusing on high luminous flux or output efficiency, or high CRI, with an appropriate blend of phosphors, the various requirements of customers for different LEDs can be satisfied.

Table2:
Optical characteristics of LEDs with Tc = 5,000 K

Sample No.	Luminous Flux (lm)	Average CRI (Ra)	Chromaticity		Color Temp (K)	Deviation duv
			x	y		
No.1	100.7	69	0.344	0.358	5,054	0.004
No.2	95.8	71	0.345	0.355	5,025	0.002
No.3	90.5	73	0.343	0.352	5,080	0.001
No.4	85.8	80	0.346	0.356	4,967	0.002
No.5	79.2	87	0.347	0.352	4,926	-0.001
No.6	73.4	91	0.345	0.351	4,996	0.000
No.7	67.9	96	0.344	0.348	5,025	-0.002

Problems with custom color design

Depending on the usage of fixtures, there are certain desirable colors and CRI levels that are not normally found in LED makers' catalogues. These would be so-called custom LEDs. For example, custom LEDs could fulfill the need for a light source that matches a company's corporate color, or a specific color temperature and CRI level that could be desirable for a product display. However, designing a custom LED is not simple. In order to achieve the desired color and CRI, repeated adjustments of the carefully controlled components could be necessary based on the feedback from sample evaluations. Due to the emitter chip and phosphor being internal components of the LED, along with the encapsulant, creating a sample is something that requires considerable time and effort.

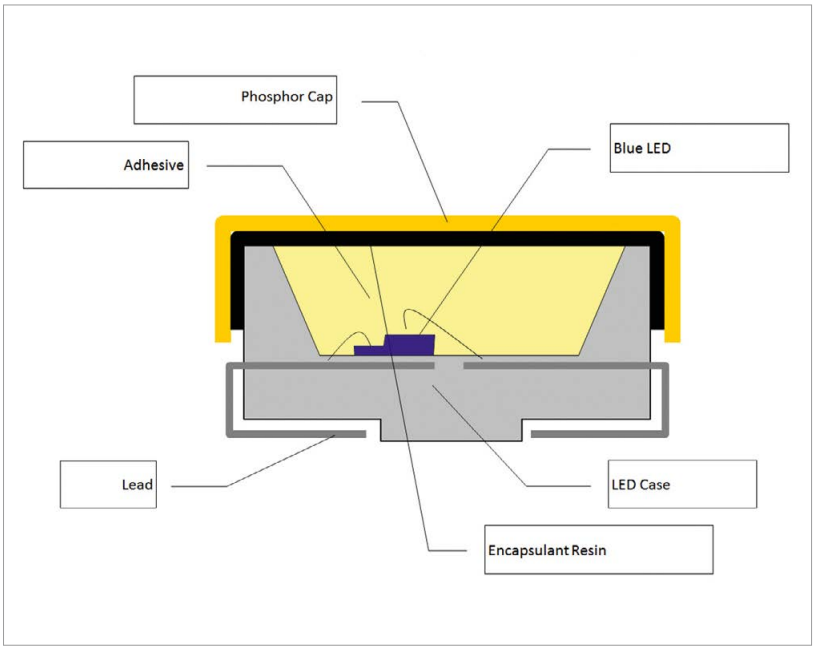
Appropriate LEDs for custom color design

The new designed "ASA COLOR LEDs" are constructed to facilitate custom color design. They differ from a standard white LED construction, with a silicone rubber cap attached to the top of a blue LED.
The construction is demonstrated in figure 4. Either a surface mount or a through hole LED is selected. Then a cap that conforms to the shape of the LED is designed. The cap, having had phospors mixed appropriately, is attached with silicone based adhesive applied to both items.
The color can be designed by adjusting the type and amount of phosphors present in the cap.

Designing a custom LED in response to the demand from a customer is referred to as "color matching". Color matching is a process guided by the desired color. The amount, type, and mixed ratio of phosphors is controlled, then matched with a blue LED and evaluated. Furthermore, if there is a demand for higher brightness due to the intended usage (lighting fixtures, etc.), the process can be controlled to match other specifications (color/color temperature, brightness/luminous flux, etc. and CRI levels). Various equipment such as a photospectrometer are used to evaluate the LEDs. The adjustments process, allows the design of LEDs that can comprehensively cover the needs of the conditions that they will be used under, such as the input voltage. The result of this is the ability to create products that can distinguish themselves in the marketplace.

It is also easily possible to accommodate mass production of custom LEDs designed in this manner. This requires a specifically designed production process to be able to accommodate an ever-increasing number of custom color LEDs.

Figure 4:
Structure of the ASA Color LED



LED Color Variation

Current problems

Designers of lighting fixtures in particular, struggle with the color variation present in LEDs. When looking at lighting fixtures that use LEDs, in the case of indirect lighting fixtures with a linear design, variations in the color of LEDs when directly illuminating a wall can be a problem. The degree to which this is a problem can change depending on the components and the specific LEDs, but this is one of the problems contributing to a lower value product.

Typically, in order to combat LED color variation, the base LEDs are classified based on their brightness and color characteristics. Therefore, color and brightness ranks are almost certainly created to designate these LEDs.

When the usable LEDs are sectioned off in this manner, the production yield decreases, and also leads to an increase in cost. Furthermore, when attempting to increase production yield by using multiple color ranks, colors

will change when shifting from lot to lot in production. In these cases, it can become a large problem in the process of lighting fixture design.

The root cause of variation

The main components are laid out in the following 2 points. There tends to be a two dimensional shift, leading to variation in the color of white LEDs, based on these components. Figure 5 illustrates this color variation.

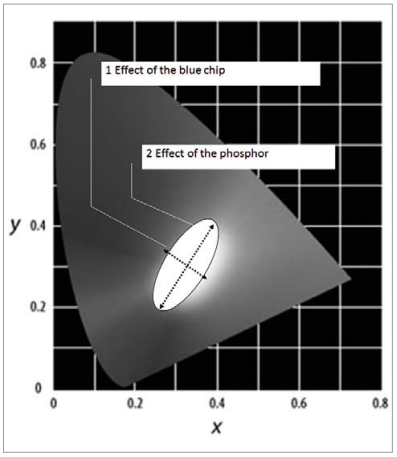


Figure 5:
Schematic diagram of possible color variation

Variation in the emitter chip

The emitter chip is constructed by growing a semiconducting crystal on a base. Uneven growth in this process can be a cause of variation, having an effect on the optical characteristics. A blue emitter chip is used in the creation of a white LED, but if the wavelength of that LED is short, the resultant white LED can be tinged pink, likewise, a longer wavelength chip can cause the white LED to appear greenish. Furthermore, variations in the output of the chip can cause variation in the luminous flux and power of the LED.

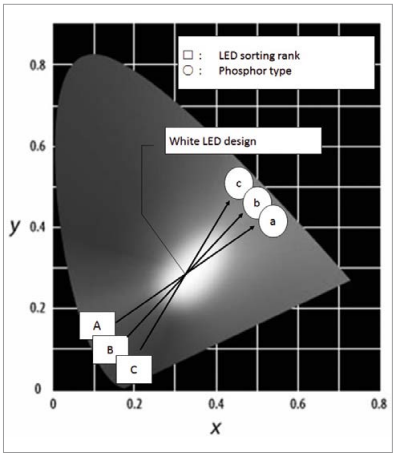


Figure 6:
Diagram of color adjustment through phosphor usage

Variation in phosphor use

Phosphor is encapsulated in the LED packaging. The phosphor is mixed with the silicone or epoxy resin that is to become the encapsulant resin for the LED, dispensed into the LED housing, and then heat cured into the desired form for the LED. However, phosphor particles with a large specific gravity tend to sink within the liquid encapsulant, making an even mixture of phosphors difficult. Furthermore, when mixing using various types of phosphor with different specific gravity and molecular weight, the rate of sinking can differ between them, further increasing the difficulty. Mixing constantly while dispensing into the LED housing also proves ineffective, with unpredictable amounts of phosphor leading to variations. If the amount is too small, the color appears too blue, while if the amount is too large, it appears yellow. In cases with multiple phosphors, the resultant ratios can lead to various discolorations.

How to combat variation

The development of the ASA ColorLED led to a production process in order to reduce color variation and avoid standard LED binning practices.

The basics of the newly developed production methods are:

- Sorting of blue LEDs based on optical characteristics (Wavelength/ Output) (Figure 5: variations caused by chip wavelength)
- Adjustment of the phosphor amounts in response to the dominant wavelength of the LED. (Figure 5: variations based on phosphor)
- Brightness adjustment through uniform phosphor mixing and cap thickness control (Figure 5: color variations)
- Adding additional compounds to the cap in response to the power of the blue LED. (Elimination of Flux Variation)

When, in the product design phase, receiving a desired spec (optical characteristic figures) from a customer, it is essential to carefully regulate each step along with the base LED selection carefully.
Due to the various demands of the different customers, the blue base LEDs need to be sorted into 120 different categories. Furthermore, there are 120 different types of caps to match with the different LED specifications. The amount/ratio of phosphors is carefully regulated in regard to the specific LED characteristics. Ultimately, creating the appropriate cap creates the required uniformity in the optical characteristics of the blue LEDs, as can be seen in figure 6.

Conclusion

As the LED market grows, customer needs related to “quality of light” will continue to increase to an increasingly higher level. In response to this demand, various companies are developing products to respond to more advanced customer needs.

While methods for overcoming LED coloration problems are still being developed, ASA believes that seeing them through helps to create components that add value to LED products. ■

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Technology Aspects for the Smart Buildings Lighting Controls Business

In the management summary of the latest memoori report, "Smart Buildings - The Lighting Controls, it says that "2014 is a Good Time to be in the Lighting Controls Business". Arno Grabher-Meyer from LED professional takes a look at what this means in terms of the technical backgrounds and trends investigated in in the memoori report.

It cannot be denied that lighting in buildings is about to undergo a rapid transformation as Light Emitting Diodes (LED) become the number one source of light. LED offers a number of significant benefits, with the most important one being that it consumes 75% less energy than conventional sources and has a much longer life.

What's not so obvious is that the transition to LEDs for lighting may disrupt the rest of the building automation (BAS) industry. This is because other technologies and trends are evolving at the same time that could be woven together in ways that would turn concurrent evolutions into one large revolution. Which technologies and trends will lead to a change that may result in the emergence of new players and new application delivery mechanisms, is to be determined.

Impact of LED Lighting

LED lighting will be the number one driver for lighting controls over the next 10 years and beyond and will have a massive influence on not just the growth but the structure of the lighting and lighting controls industry. The future market for lighting controls is strongly dependent on the demand and penetration of LED lighting.

Projections of double digit market growth, increases in the use of integrated electronics, and mounting opportunities related to smart control and intelligent lighting have already provoked significant transformation across the value chain, and attracted a multitude of new market entrants.

This fact per se shows a means of existence for a controls manufacturer already having products for the LED lighting market or at least to release such products in 2014.

However, the question which kinds of products, which technology and which LED lighting segment has to be served now and in the future still has to be answered.

Recognized Technology Developments & Future Trends Touched on in the Report

The lighting controls market – like all electronics based products – continues to develop in line with general advances in silicon and software. Technology had already moved significantly from analogue to digital by 1996, although not completely.

The "intelligence"' within a lighting control system has also moved towards the light source (lamp) and the sensor. This trend is particularly illustrated by the growth of DALI based control gear (and sensors), where addressability is digitized as opposed to the use of specific lighting control module (LCM) ports.

There is also a tendency for lighting controls suppliers to use established 'standard' protocols for higher-level communications. The biggest change over the last 10 years has been the development of gateways that connect almost all protocols to the Internet. The control network is able to use the building's structured cabling (CAT5/6) and access to the software can now be web based.

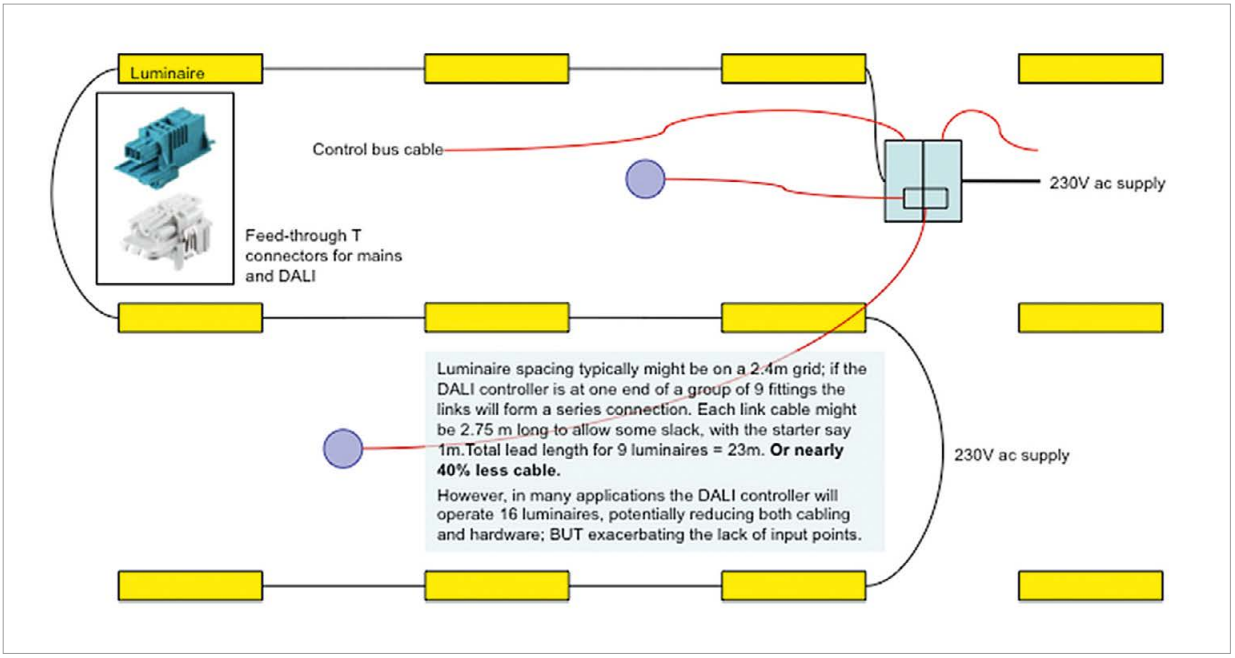

Figure 1:
In comparison to the first wired lighting controls systems, state-of-the-art installations like DALI already simplify the wiring structures

For lighting controls there are five major open standard protocols that are commonly used and all these can connect to the Internet. These include: LON, KNX, DALI, DMX & CAN.
There are also moves to make lamps addressable over Wi-Fi and, in effect morphing towards the 'Internet of Things' (IOT).

Much of the recent development work in lighting controls has been devoted to the "telemanagement" of street lighting and lighting outside public places, which, as a result of LED lighting has created an enormous demand. Both RF and mains borne signaling have been tested and developed for this market. Currently the RF medium is preferred due to difficulties in the way streetlights are supplied and share their 230 V.
This application has required two development strands; the hardware to create the required networks and the software to provide the asset management, configuration, control and monitoring facility. One of the challenges has been to meet the justified cost per street lamp for the control equipment.

Future trends

The evolution of lighting over the next 10 years will be mostly about LEDs and this will tend to have the most impact on the development of lighting control equipment. The 'Internet of Things' (IOT) will also be highly influential as more and more devices will be able to communicate with each other.

There is some debate about the use of direct current wiring in lighting that comes from the use of larger PSUs to supply multiple LED sources. This discussion arises because it is easier to create long life, high quality drivers for LEDs in the higher power ratings. For example a 200 W unit might be able to power 20 pieces of 10 W fixtures each producing in excess of 1000 lumens (net). Adding intelligence into PSU could well be economic and this may have a significant effect on wiring practices.

Another related approach under debate is "Power over Ethernet" where useful power (DC) is added to CAT5 or CAT6 cabling to drive low wattage loads, like LEDs.

From the lighting side there is increasing evidence that varying the color temperature of white light may have benefits; both in the workplace and in the home. This will require controls of some sort to change the apparent color of the lighting fixture. Early tests with fluorescent lighting used 2 sources – allowing anything from 4,000 K to 17,000 K. Using LEDs makes this simpler and much more controllable, and – more importantly – efficient.

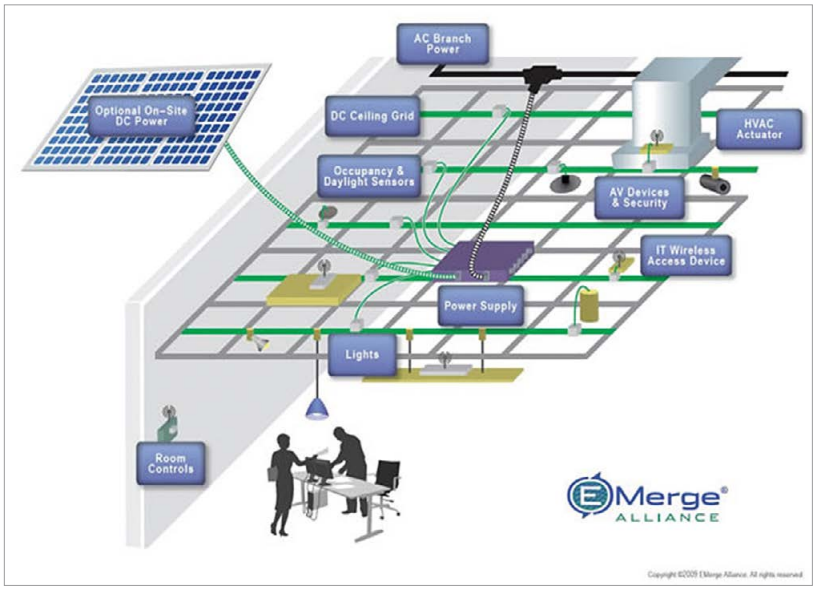

Figure 2:
EMerge Alliance is one of the major proponents for DC grids, especially for lighting. They provide a clear standard for the wiring structure as well as safety, voltage, current and power requirements

Wireless (RF) control has been around in lighting controls for some time; however, the growth in street lighting control has developed this technology further. Combine this with the progress already made by EnOcean and Zigbee using low power wireless and the importance of this medium cannot be ignored.

We think that wireless is now at the stage where it could deliver a reliable and cost effective control system that can open up the burgeoning retrofit market.

There is also the potential to connect smart phones and/or tablets to lighting controls to give users access using Wi-Fi or Bluetooth. Looking at developments in microelectronics, the cost of really quite complex control chips is falling. Philips has launched a "domestic" lighting product called "hue", which is based on a lamp that can be addressed from a smart phone or tablet via a network connected bridge. There are, in effect, no dedicated lighting controls; just a smart device, color changing light bulbs and a bridge.

Extrapolating this technology into the non-domestic market is a logical scenario that still fits the concept of control systems that have their intelligence in the lamp and the sensor / user control.

On the commercial side, the introduction of LEDs has brought with it new lighting companies as well as opened opportunities for established businesses. Verbatim – long known as a provider of data storage solutions – has entered the LED market offering products based on developments from Mitsubishi Chemical. Japanese companies, Sharp, Panasonic and Toshiba are all moving into lighting and in Korea Samsung and LG have made the same move.

Taking both technical and commercial pressures into account the future for lighting controls is both exciting and could be very disruptive. Any new research into the market will need to explore a very changed business landscape brought about by the disruptive LED (and OLED) technology, the progress of the 'Internet of Things' and the range of new players operating in the market.

Figure 3:
Philips with its "hue" recognized the spirit of the times and combined a replacement lamp with color tunable functionality, sufficient luminous flux, simple installation and convenient wireless controls capabilities

Wireless Controls

Although lighting control systems have been shown to provide tremendous benefits, many parts of the commercial building market have been reluctant to install them in anything but the most basic configurations due to cost and complexity of wired systems and the disruption caused by their installation. Many of these systems have added costs due to labor, equipment and wiring. Beyond the high cost of the initial installation, the commissioning, management and upkeep of these systems has resulted in hesitation in the market. Lighting has been structured largely the same since the time of Edison, but the addition of lighting controls adds a new, unfamiliar element (control wiring) to the system.

A new generation of lighting control systems is eliminating these cost and complexity concerns while increasing system capabilities by removing the dedicated control wiring. Through the use of modern enterprise-class wireless networking technology, the difficult control wiring is eliminated, allowing for system-wide controls strategies without significant upgrades to existing lights or added costs.

Wireless lighting control systems offer full-featured control with added flexibility, reliability, scalability, ease of installation and use. And the cost of

FROST & SULLIVAN

4th Annual Executive Congress on LED Lighting

Leading India's Green Energy Revolution

8th July, 2014 - The Imperial, New Delhi

LED LIGHTING

LEADING INDIA'S GREEN ENERGY REVOLUTION

Today, India deals with challenges of energy deficiency, sustainability, and electrification for its urban and remote rural regions. Of the entire energy consumption in India, lighting accounts for 20 percent. Light Emitting Diode (LED) has emerged as one of the effective solutions to India's energy challenges.

With this background, The Electronics Practice at Frost & Sullivan is glad to announce its event titled - 4th Annual Executive Congress on LED Lighting - Leading India's Green Energy Revolution on 8th July, 2014 in New Delhi.

India is expected to witness establishment of LED fabrication and LED products manufacturing in the short term along with National Electronics Policy bearing fruit, Street lighting, industrial, and commercial applications are driving the LED market growth in India.

Frost & Sullivan expects the Indian LED market to grow over US $1 billion in the next four years. The market will witness a growth rate of more than 40 percent till 2016. It is also anticipated that the LED lighting market will move towards high quality, adaptable lighting with more efficient output.

It is the premier platform that brings together industry stakeholders, thought leaders, and decision makers in the Indian LED market.

Whom to expect at the event

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- Suppliers of other conventional lighting devices and luminaires manufacturers
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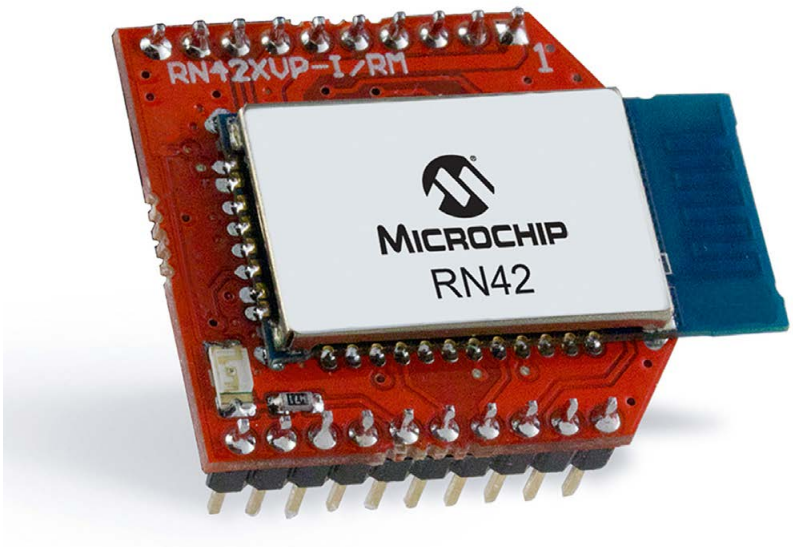

Figure 4:
Different wireless systems like EnOcean or ZigBee offer a mesh network structure using very compact modules like this ZigBee module

wiring alone is incentive for many building owners to look at wireless systems: saving installation costs, reducing copper wire use, and improving payback time.

Mesh Networks

Wireless lighting systems are often organized using "mesh" architecture. This means that each device in the network can communicate with a controller through at least two pathways, and can relay messages for its neighbors. Data is passed through the wireless network from device to device using the most reliable communication links and most efficient path until the destination is reached.

The mesh network is self-healing, in that if any disruption occurs within the network (such as a device failing), data is automatically re-routed. Mesh networks also provide self-configuration - when a new device is added (or an existing device is moved) the network automatically works out what type of device it is (e.g. router or end device), where its neighbors are, and determines the best path through the network.

After devices are configured, they regularly poll their neighbors to collect information about signal strength and possible errors so that they can recalculate transmission routes if required. The built-in redundancy of having multiple pathways available helps to make the mesh network both robust and reliable.

However, as other technology industries have repeatedly taught us in the past, the path to progress leads to the use of "open standards" for communication. In open systems, a manufacturer chooses an existing communications language that is freely available for development, and their products can communicate directly with other manufacturers' products. This way, each manufacturer can concentrate on the products in their area of expertise, rather than spending resources and effort creating and maintaining a proprietary language for their products to speak.

Such lighting controls and compatible devices exist today - and not all the compatible devices are lighting-related. For example, the popular ZigBee wireless protocol includes devices of all types, from sensors to switches to plug load devices and thermostats.

This means that a ZigBee lighting controls network, designed to manage the hundreds or thousands of lighting products in a building, can also communicate with and potentially manage the non-lighting devices. This opens the door to that promise mentioned earlier: a lighting network providing the communications infrastructure for the whole smart building. Lighting controls could provide the backbone for other controls networks in buildings and become the focal point for convergence and integration.

The Impact of Integration & IT Convergence

IT Convergence is the name that has been given to the joining together of the Enterprise Business in buildings with the building technical infrastructures through using the common communications technology that is now applied to all the IT functions.

If devices can now talk to each other and exchange data and then this is turned into actionable information through analysis in relational databases and artificial analysis software, the performance and value of a building can be greatly enhanced. Further, if this information is shared with that received from the business enterprise then it is most likely that further value can be added and new services delivered.

This will require significant change in the way that technical infrastructures are engineered and installed. Partnering with companies having software and IT networks skills will be vital. The technology that has made this possible, XML and web services, is being used today through embedded web serving at the DDC controller or the master PC, and direct connection through the internet or intranet.

Each technical infrastructure can be designed without knowledge or concern of the others, for provided that they are web-enabled they can transfer data at the management level. This approach requires all the stakeholders on the supply side to work much closer together than they do today and this will have a major impact on the design and installation of technical infrastructures in buildings.

The control of the buildings environment through digital controls was first applied to HVAC hardware and is now referred to the Building Energy Management System (BEMS). But most BEMS systems today aren't wireless, so they don't speak ZigBee, mostly just BACnet. Lighting in most buildings is the second largest energy

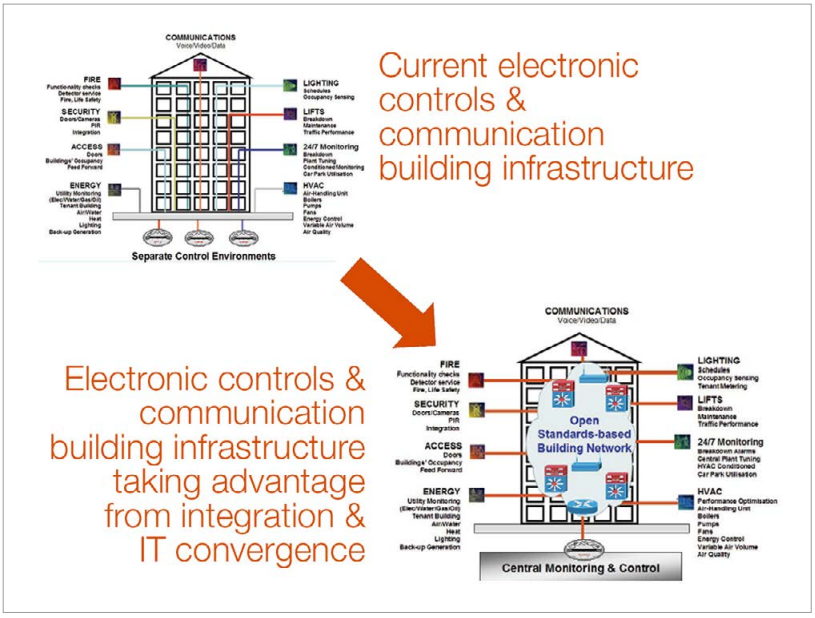

Figure 5: **Currently a building infrastructure is based on numerous separate signals and control environments. Centered on an open standard building network, the future structure should (based on an electronic system convergence) be based on a unified digital signal and control environment (Credits: Cisco & NSCA Convergence Summit)**

load but it easily represents the greatest number of potential control points, and they could be designed to speak both ZigBee and BACnet. Furthermore, most HAVAC systems still lack smart controls, because ROI was not very compelling. Lighting-Centric projects will be motivated by LEDs and will naturally incorporate wireless and cloud technology. In some smaller projects where heating and cooling has been achieved through a combination of chilled beams and natural ventilation, bus-based lighting controls have taken the responsibility for controlling HVAC services. This situation will mix the providers from different areas.

Whatever changes take place in this business; they will be in the general scheme of evolutionary things. However, an industry that has experienced a slow and gradual change for the last 30 years may well be regarded by many players to be 'cataclysmic'.

Evaluation and Interpretation of the Findings

While none of all the recognized future trends is completely unknown, it is conclusive that the selected ones are promising candidates that they will benefit from the introduction of LED lighting because they are all adding some value to an LED lighting system.

But two candidates stand out from the others; direct current wiring and wireless. Both are explained in greater detail in the report.

Direct current wiring, propagated as DC grids is truly a huge topic, not only for LED lighting, but in general. While the dimensions are not currently completely clear, if an approach on a room, building, local, regional or even global level should be targeted – most specialists agree that DC grids will allow energy saving compared to the currently established AC grid. The main reason is not that AC converters were much less efficient per se, but - as argued in the report - converters for higher loads (within a reasonable range) may be designed more cost-effectively when using high quality components. Such topologies can be equipped with useful intelligence, leading to more efficient products with added value. DC grids finally have certain advantages when alternative energy sources like photovoltaic, wind energy, or fuel cells are used. Solid state lighting is certainly a technology that supports these trends, but it will take time because this DC grid technology is mainly applicable for newly built systems and only partly applicable in existing infrastructures. It is hard to predict how fast this approach will pick up speed, but it is an interesting mid and long term strategy to keep in mind.

As a counterpart, wireless controls systems using ZigBee, EnOcean or Bluetooth can be applied very well in replacement solutions. The future seems to be wireless. Continuously increasing labor costs increase the initial costs of wired installations while the costs for a wireless system decrease. In turn, capabilities increase rapidly due to fast technical progress. Furthermore, it perfectly supports the trend leading to the Internet of Things (IoT). New sensor technologies like energy harvesting self-powered sensors and smaller components also perfectly match with this technology. But currently, there are still some drawbacks to be overcome. Too many proprietary and incompatible systems are entering the market, confusing the end-user and discouraging some of them to invest in such a system. It may also look like the technology is, for the most part, interesting for residential use or just a small number of applications. But this will probably change quickly. Clever marketing strategies like the introduction of the Philips hue via Apple stores so as to reach technology freaks and financially potent clients first followed by making the product available through other channels after "awaking the desire" will probably speed up propagation of the technology.

Meanwhile, mesh networks are almost standard in wireless communication. Some of the most important wireless solutions like ZigBee and EnOcean support this structure. The advantage of this structure is that they support the integration of other home automation and energy management tasks into the system. Therefore it seems relatively obvious that systems that are built on this technology are the first choice to be combined with LED lighting. This leads to a win-win situation for both technologies.

IT convergence and integration is certainly one important key for modern and affordable building structures and management. Only interconnected systems can maximize energy saving further while being economic.
For example, why should numerous presence sensors for different systems

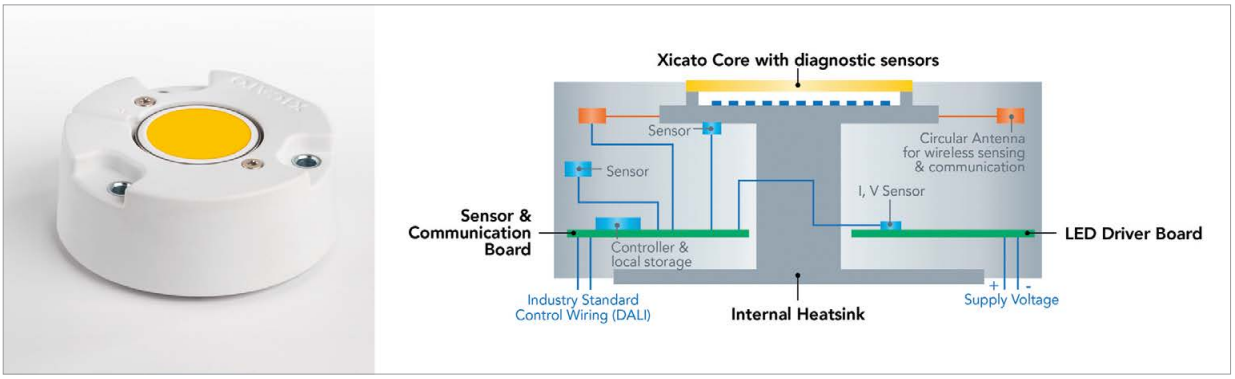

Figure 6:
Some SSL module manufacturers like Xicato already recognized the trends shown in the report and introduced intelligent modules including wireless controls options at Light + Building 2014

like lighting and ventilation be necessary? The shared information from one sensor would be sufficient. Why should two different networks be used for IT and building management (except in very critical cases like banks)? And so on. Luminaires are relatively evenly distributed in a building. Modern lighting systems should be networked lighting systems and therefore ideally suited to take over information transfer of other building management systems and even conventional IT. There may be data integrity issues. But they can be solved for most users. Ecological and economic pressure makes the step in this direction almost inevitable. The argumentation and conclusion of the report is therefore logical: New players will appear in the domains of building automation, lighting controls and IT.

Someone may now argue that "Power over Ethernet" (PoE) is also very interesting and innovative but was ignored in this section. PoE definitely lacks universal applicability. It is limited to 36 W per line and due to the thin wires huge losses of 4.4 W per 100 m. Therefore it may play a role for some applications, but certainly not if higher power needs to be distributed over longer distances.

Conclusions

LED technology has already caused a major disruption in the lighting industry and the lighting controls business which used to be separate. This will certainly require reconsidering and adapting current business models. This all happens in combination with two other megatrends, the accelerating use of wireless network technology and the rapid migration to web-based applications and services. The resulting (r)evolution may be slowed down by the current supply structure and distribution network of the lighting industry, but not stopped. Whilst the case for retrofitting buildings with LED lighting has become very compelling it needs wireless technology in order to bring down the installation cost and improve the return on investment in the building energy management market. Entering other application and technology domains is a challenge for engineers as well as for sales and marketing people and certainly needs some adaptation of the whole logistics structure. But it may open a great business opportunity. ■

Acknowledgements:

LED professional wants to thank Jim and Allan P. McHale for providing the report "Smart Buildings: The Lighting Controls Business 2013 to 2017", and giving their permission to use parts of it for this article. Besides the technology aspects, the authors Jim and Allan P. McHale also analyzed drivers and barriers, the supply structure & distribution channels, business models, and mergers and alliances. To learn more about this and other memoori reports, please visit http://www.memoori.com/research/.

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Product: BJB "twist-lock" module system (holder/module/reflector)

BJB's latest LED module system consists of a holder that supports optimized contact between the module with thermal interface and the heat sink, and easy to mount, exchangeable reflectors

Next LpR

Design & Reliability
Issue 44 - July/Aug 2014 - Short Overview

Optics:

Discomfort Glare Perception of Non-Uniform Light Sources

With the introduction of LEDs in general lighting, the discussion of discomfort glare perception gained renewed attention. Although the Unified Glare Rating (UGR) is widely adopted for glare assessment, disagreement exists on how to evaluate non-uniform sources. The latest research results showed that point array LED luminaires provoke more discomfort glare than uniform sources. In these cases the UGR currently used is a bad predictor. The article discusses the results and why a redefinition of the glare index may be necessary. ■

Electronics:

How To Power and Protect LEDs Properly

LEDs have already become the lighting source of choice in general lighting for most applications. However, it still isn't completely clear how to power them properly and how to protect them from the hazards they face within their respective implementations. The background and two solutions for protecting LEDs in the electronics design will be explained. ■

Electronics:

Fast and Final – Time to Market Reduction for Cost-Effective AC LED Driver ICs

There are many different circuit topologies for AC LED driver ICs. Apart from finding the most suitable circuit topology, designers face other challenges such as bill of material limits, ESD targets and aggressive time to market requirements. This paper reviews common AC LED driver topologies. Features such as PFC or dimming in the context of a new application specific analog library utilizing X-FAB Semiconductor Foundries 350 nm low cost ultra-high-voltage CMOS technology will also be reviewed. In addition, the article will highlight how this type of silicon proven analog library can help mitigate some of the critical challenges and risks for designers. ■

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Imprint

LED professional Review (LpR), ISSN 1993-890X

Publishing Company

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